Design and Evaluate Support for Non-musicians' Creative Engagement with Musical Interfaces

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Abstract

In the past few decades of Human-Computer Interaction (HCI) studies, experience related topics are proposed as central concerns beyond usability when designing an interactive system. Based on two existing research frameworks within HCI: creativity support and engagement, this research contributes to this trend by asking how to design and evaluate support for novices' creative engagement with digital interfaces. Drawing on HCI theories of experience, flow, engagement, and research on creative engagement in different domains, this research defines creative engagement as when the user is engaged in an active and constructive cognitive process, and in pursuit of a creative outcome. This thesis presents findings from three case studies to explore the effects of factors that might affect non-musicians' creative engagement while musicking with interactive music systems. These factors include 1) the control metaphors of interfaces (painterly control metaphor and reactive control metaphor), 2) the task motivations (experiential and utilitarian goal) and features of musicking modes (replay and edit records), 3) the abstract visual stimuli (abstract and straightforward graphical scores, participants playing with or without design information). Based on a number of empirical findings, a systematic understanding of the effects of factors that may influence novices' creative engagement and a descriptive model of creative engagement are proposed and discussed. This research has direct implications for the design of similar musical interfaces for novices in fields such as New Interfaces for Musical Expression (NIME), as well as interfaces that are aimed at engaging non-experts in creative activities in HCI. Moreover, the mixed-methods approach adopted in this thesis provides informative evidence to conclude the research questions. The empirical evidence that the correlations between participants' subjective feedback on creative engagement also suggests the potential of using the mixed-methods approach to evaluate creative engagement.

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Statement of Originality

I, Yongmeng Wu, confirm that the research included within this thesis is my own work or that where it has been carried out in collaboration with, or supported by others, that this is duly acknowledged below and my contribution indicated. Previously published material is also acknowledged below. I attest that I have exercised reasonable care to ensure that the work is original, and does not to the best of my knowledge break any UK law, infringe any third party's copyright or other Intellectual Property Right, or contain any confidential material. I accept that the College has the right to use plagiarism detection software to check the electronic version of the thesis. I confirm that this thesis has not been previously submitted for the award of a degree by this or any other university. The copyright of this thesis rests with the author and no quotation from it or information derived from it may be published without the prior written consent of the author.

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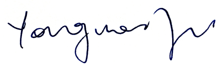

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Details of collaboration and publications: all research and contributions in this thesis and the associated publications are my own work. The research was supported by Dr Nick Bryan-Kinns within the scope of his role as my primary supervisor, and he is acknowledged as a second author in all related publications. Previous publications related to this thesis are described in Section 1.5.

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List of Abbreviations

CST	Creativity Support Tools
CFSP	Closed Frequent Sequential Pattern
DA	Disclose Analysis
DM	Data Mining
DTW	Dynamic Time Warping
GS	Graphical Score
HCI	Human-Computer Interaction
NIME	New Interfaces for Musical Expression
RQA	Recurrence Quantification Analysis
RV	Recurrence Value
TA	Thematic Analysis
TUI	Tangible User Interface
UI	User Interface

Chapter 1

Introduction

1.1 Motivation

> *It is not enough to insist upon the necessity of experience, nor even of activity in experience. Everything depends on the quality of the experience which is had. ... Just as no man lives or dies to himself, so no experience lives and ides to itself. Wholly independent of desire or intent, every experience lives on in future experience. Hence the central problem of an education based upon experience is to select the kind of present experiences that live fruitfully and creatively in subsequent experiences.*
>
> *John Dewey [Dewey, 1997, p.27]. Quoted in [Wright and McCarthy, 2010, p.12]*

Dewey's pragmatic philosophy of experience put up a starting point as well as a fundamental theoretical base for earliest researchers in Human-Computer Interaction (HCI) to propose *experience* as a central concern in designing an interactive system [Shedroff, 2001, McCarthy and Wright, 2004, Forlizzi and Ford, 2000, Forlizzi and Battarbee, 2004]. This pragmatic view of human experience led to the emphasis on the interplay of various aspects of behaviour and emotion [Wright and McCarthy, 2010, p.14], overtaking the narrow focus on the usability or utility of an interactive system [Rogers, 2012, p.69]. Experience related topics such as beauty, enjoyment, fun, entertainment, enchantment, adventure and excitement become equally valid and valuable themes in HCI research to inform and guide future design [Monk et al., 2002, Jordan, 2002, Hassenzahl and Tractinsky, 2006].

Engagement is when a user is attracted and focused on an interaction. It has been identified as one of the most desirable and essential experiences of

HCI activities [O'Brien and Toms, 2008, 2010, O'Brien, 2010, Lehmann et al., 2012]. The discussions on engagement with digital systems suggest a division of engagement from passive and sudden engagement to active and sustained engagement. Creative engagement is one of the most active and sustained form of engagement [Edmonds et al., 2006, Bilda et al., 2008]. As it is intrinsically rewarding, it engages players in autotelic and sustained activities with the system [Hansen et al., 2011]. However, as a relatively new and elusive concept in HCI, only a small number of related works studied creative engagement, many of which were situated in the domain of interactive arts [Edmonds et al., 2006, Bilda et al., 2008] and education [Reid and Solomonides, 2007, Dindler, 2014, de Abreu and Barbosa, 2017]. The challenges of studying creative engagement include a lack of agreed definition and systematic understanding in the broader context of HCI, a lack of design guidances for supporting creative engagement, and a lack of evaluation criteria. Building on the existing paradigms of HCI research on experience and engagement, as well as the related works in other domain [Bilda et al., 2008, Edmonds, 2011, Edmonds et al., 2006], this thesis defines creative engagement as when a user is engaged in an active, reflective and constructive cognitive process in pursuing a creative outcome with an interactive system. Part of the aim of this thesis is to develop a systematical understanding of creative engagement in HCI and how to design and evaluate support for the users' creative engagement.

People's creative engagement with interactive systems is closely related to their creative acts during the interaction process. Therefore, creativity is a crucial topic in this thesis. As being an everyday creative experience, creative engagement is valued at a personal level rather than a social level. Therefore, it should not be evaluated based on the quality or contribution of the creative output but should be evaluated from individual's subjective experience. However, there is a lack of assessment criteria on the creative experience as well as creative engagement. One aim of this thesis is to contribute to the evaluation of creative engagement. To facilitate people's creative engagement systems need to be designed and built to support creative acts. The domain of Creativity Support Tools (CST) has been exploring the design and evaluation of systems to technologically mediate creative process for more than a decade [Hewett, 2005, Hewett et al., 2005, Shneiderman, 2007, 2009, Carroll et al., 2009, Carroll, 2013, Davis et al., 2013a, Cherry and Latulipe, 2014]. Whilst there have been some works seeking to support creative acts in the domain of design, filmmaking and painting [Bonnardel and Marmèche, 2004, Davis et al., 2013b, Benedetti et al., 2014], most of the works were designed mainly for professional purposes and focused on how to scaffold users' creative output rather than the creative experience. Substantial works need to be done to understand users' creative process from the experiential perspective and to explore the factors that might affect their creative engagement.

As noted earlier, creative engagement can be observed in many fields, such as interactive art, education, or daily life. Music is an ideal field to study creative engagement as music making combines creativity with entertainment. It is regarded as an important activity of people's everyday life and a fundamental form of human's creative activity, and played a significant role in human intellect evolution [Small, 2011, Sawyer, 2011, Bryan-Kinns, 2013]. Due to the universality, it provides an excellent ground for studying and comparing interactions of different target users, for example, individuals and groups, amateurs and experts, children and adults [Jordà et al., 2007]. The recent designs in the field of New Interfaces for Musical Expression (NIME) [Jensenius and Lyons, 2017] has led 'musicking' [Small, 2011] to become a more accessible activity that is no longer exclusive for musicians [Robson, 2002, Kaltenbrunner et al., 2006, Jordà et al., 2007, Parson, 2009, Hansen et al., 2011, Bengler and Bryan-Kinns, 2013]. This trend has increased the number of non-musicians with all levels of skills to actively *play with* music rather than passively to listen to music [Resnick et al., 1996, Hansen et al., 2011]. The creative path which involves two or three parties in the traditional form is evolving towards a new era where the player becomes the composer, performer and listener [Deliège et al., 2006, p.4]. However, musical creativity seems to be more difficult for non-musicians to achieve, as compared to the professionals. Studies have revealed that it is difficult for non-musicians to develop their musical ideas from scratch due to their lack of conceptual and technical knowledge and skill [Weinberg and Driscoll, 2005]. Studies in the domain of creativity support also indicated that novices face barriers in engaging in creative experiences because of the lack of confidence and essential skills [Davis et al., 2013a]. Although some successful attempts has been carried out, the main goal of this thesis is to understand and systematically summarise how to help non-musicians to overcome the barriers which inhibit them toward creative engagement in better way.

In summary, the call for a systematic understanding of creative engagement in HCI, the lack of evaluation criteria on creative engagement, the need of design implications to support creative engagement, and the benefits, trends, challenges of novices' creative music making have informed the research agenda of this thesis. This background has raised questions such as how do non-musicians approach the activity of creating a piece of music? How to support their creative engagement during the process of musicking? What factors may affect non-musicians' creative engagement? More generally, how do novices behave and interact in a creative process and how to scaffold these activities? What factors influence novices' creative engagement? How to evaluate the level of creative engagement? This thesis provides answers to these questions through three empirical user studies.

1.2 Aims

This following section presents the overall research question of this thesis. Based on this overall research question, some more focused research goals are defined in detail.

1.2.1 Research Question

The overarching research question this thesis address is: *How to design and evaluate support for non-musicians' creative engagement with interactive musical systems?*

This paragraph specifies the meaning of the terminologies used, some more detail of their definition and origins are discussed in Chapter 2. The term *design* is to plan and make user interface, and to offer guidance to inform future designs based on the practices. The term *evaluate* is to measure the effectiveness of the interface based on certain criteria. The term *support* is to offer mechanisms that assist the physical activities and cognitive process related to the interaction. The term *non-musician* refers to novices and amateurs of musicking who are interested in musicking activities but with no intention to be professionals. Non-musicians need to be distinguished from the group of people who are music beginners but have an intention to become professionals later on. Unlike them, non-musicians will have less access to formal music training and lack confidence as well as conceptual and technical knowledge and skills [Weinberg and Driscoll, 2005, Davis et al., 2013a]. The term *creative engagement* is defined as when a user is engaged in an active, reflective and constructive cognitive process in pursuing a creative outcome with an interactive system. More detail of the definition will be discussed in Chapter 2. The term *interactive musical system* refers to the interface that has the ability to generate sound through a digital sound generation unit that maps the interaction input to the sound output [Tanaka, 2009]. Its design is not aimed at a professional level of music production for the benefit of audiences but is aimed at the exploratory and experiential purpose for non-expert users [Murray-Browne, 2012].

1.2.2 Research Goals

Four more specific research goals are unpacked in relation to the overarching research question.

1. Developing a descriptive model of novices' creative engagement with interactive music systems.

By means of designing the creative engagement experience in this thesis, the first goal is to form a deeper understanding of how non-musicians approach the interactive music system creatively and to develop a descriptive model of it. A central finding from the literature review, as presented in Chapter 2, is that there is a lack of systematic understanding of the process of creative engagement. Whilst the existing research mainly situating in the domain of education, management, and interactive arts (discussed in Section 2.1.4), there is also a need to expand the context of discussions on this topic. This is also to contribute to the study of creative process from an experiential perspective.

2. Examining the effects of various factors on novices' creative engagement with interactive music systems.

To develop a more in-depth understanding of creative engagement and to better inform the future design for novices' creative engagement, it is necessary to be aware of the potential factors that might affect novices' creative engagement. The review of relevant literature presented in Chapter 2 have investigated factors that influence on users' creative performance, engagement and experience. This offered a list of potential factors, i.e. control metaphor, motivation, musicking mode and visual stimuli, to be examined for the influence on novices' creative engagement. The results of whether and how these factors affect novices' creative engagement can provide valuable implications for future design.

3. Exploring the evaluation criteria for assessing the level of creative engagement.

The lack of systematic research on creative engagement results in a lack of assessing criteria for creative engagement, although substantial works have discussed on the topic of engagement and in the context of CST in Chapter 2. The lack of evaluation criteria considerably restricts the evaluation of systems that are designed for the experience of creative engagement. A better understanding of how to assess the level of creative engagement could be used to inform the evaluation of other interactive systems designed to facilitate creative engagement.

4. Providing a set of design implications that could inform other designs intended to facilitate novices' creative engagement.

Despite the trend in NIME to engage non-musicians in musicking, and the works in CST on supporting creative acts with digital systems, only a limited amount of research and guidelines were carried out on designing support to engage novices creatively with IMSs. There is a need to offer design solutions to critical issues that undermine opportunities for novices' music creation and engagement, for example, non-expert player's lack of domain knowledge and skills, and lack of confidence.

1.3 Methodological Approach

The examination into the research question adopted in this thesis followed a mixed-method approach by conducting a mixed-group study design, collecting both subjective feedback and objective behavioural data through empirical studies, and combining both qualitative and quantitative analysis methods. Questionnaires were developed to elicit participants' perceived level of creative engagement, offering a subjective assessment of the various aspects of creative engagement experience. Semi-structured interviews were conducted to gain more subjective feedback, allowing to develop a deeper understanding of how and why did the participants make these choices. Interaction logs data was collected for qualitative interpretation, activity analysis and content analysis. A further correlation comparison between the subjective feedback and the objective behaviour data provides supplementary evidence for understanding the interaction and creative engagement objectively.

The rationale and choices of measures behind this mixed-method approach are presented in Chapter 3. The practical applications and improvement for each study are described as part of the methodology in the corresponding chapter of different studies.

1.4 Contributions

The contributions of this thesis can be described mainly from two perspectives: First of all, it contributes to the field of HCI with a systematic understanding of the essence of creative engagement and potential methods for the evaluation of creative engagement. Secondly, it contributes to the domain of HCI and NIME with a systematic investigation on novices' creative engagement with musical interfaces and a set of practical implications for future designs. The primary contributions of this thesis are:

- A descriptive model of non-musicians' creative engagement with musical interfaces and a more general creative model of novices' creative engagement are described with three playing modes, i.e. experimenting, composing and performing, and with features regarding motivation, output, status, skill and activity. The models integrate interactions that involve both iterative and real-time activities, which is a novel contribution to the study of the creative process.

- A systematic understanding of the effects of control metaphors (painterly or reactive control metaphor), motivations (experiential and utilitarian goal), user interface modes of musicking (replay and edit in composition, improvisation and comprovisation) as well as the abstract visual stimuli (abstract or straightforward visual representations, playing with or without design information) on non-musicians' creative engagement with interactive music systems is developed.

- A mixed-method approach for evaluating creative engagement is explored, with a combination of both qualitative and quantitative analysis methods and a focus on both subjective feedback and objective behaviour data. The methods include a list of statements for subjective rating based on a set of creative engagement factors and potential quantitative analysis methods to assess creative engagement based on activity variation. The thesis explores an efficient and informative method for evaluating subject experience on creative engagement with objective behavioural data , which has the potential to be applied in a wider scope of research.

- For supporting novices' creative engagement, a set of design implications for musical interfaces as well as more general design guidelines for broader context are derived from the three empirical studies. These implications could inform the future design of interactive musical systems that aims to engage novices creatively.

1.5 Publications

Published

Yongmeng Wu, and Nick Bryan-Kinns. "Supporting Non-Musicians' Creative Engagement with Musical Interfaces." *Proceedings of the 2017 ACM SIGCHI Conference on Creativity and Cognition. ACM, 2017.*

This conference paper presents the related work, design and results of Study I (Chapter 2, 4).

Yongmeng Wu, and Nick Bryan-Kinns. “Musicking with an interactive musical system: The effects of task motivation and user interface mode on non-musicians’ creative engagement.” *International Journal of Human-Computer Studies 122 (2019): 61-77.*

This journal paper presents the related work, design and results of Study II (Chapter 2, 5).

Under Review

Yongmeng Wu, and Nick Bryan-Kinns. “Provoking Inspirations with Abstract Graphical Score for Non-musicians’ Creative Engagement with Interactive Musical Interfaces.” *to be submitted as a full paper to The 2019 ACM CHI Conference on Human Factors in Computing Systems*

This conference paper presents the related works, study design and results of Study III (Chapter 2, 7).

Yongmeng Wu, and Nick Bryan-Kinns. “Evaluation of Creative Engagement with quantitative approaches.” *to be submitted as a full paper to The 2019 ACM CHI Conference on Human Factors in Computing Systems*

This conference paper presents the related work, study design and results of Chapter 2, 6).

Supplementary Publications

Yongmeng Wu, Leshao Zhang, Nick Bryan-Kinns, and Mathieu Barthet. "Open symphony: Creative participation for audiences of live music performances." *IEEE MultiMedia 24, no. 1 (2017): 48-62.*

Yongmeng Wu, Nick Bryan-Kinns, Wei Wang, Jennifer G. Sheridan, and Xiang Xu. “Designing a Cross-Cultural Interactive Music Box Through Meaning Construction.” *In International Conference on Cross-Cultural Design, pp. 241-257. Springer, Cham, 2017.*

1.6 Thesis structure

Chapter 2 Chapter 2 provides a comprehensive review of research into HCI, Experience, Creativity Support Tools, New Interfaces for Musical Expression, and evaluation methods in each field. This review informs 1) the research contexts, the research questions and objectives of this thesis as presented in this chapter. 2) the related works for three studies described in later chapters. 3) the rationale and choices on the design of prototypes. 4) the evaluation methods adopted in the three studies.

Chapter 3 Chapter 3 describes the methodological approach employed in this thesis and the rationale of choices by closely reflecting on the background, trends, methods and practical issues of evaluation applied in the evaluation of experience and engagement in HCI, CST and NIME.

Chapter 4, 5, 7 Chapter 4, 5, 7 present the three empirical studies conducted in the thesis. Each study addresses a differed sub-question on the general research question, and is informed by the results from previous study. Chapter 4 looks at the effects of control metaphors (painterly or reactive control metaphor), Chapter 5 looks at the effects of motivations (experiential and utilitarian goal) and features of musicking modes (replay and edit in composition, improvisation and comprovisation), Chapter 7 examines the effects of abstract visual stimuli (abstract or straightforward visual representations, players playing with or without design information).

Chapter 6 Chapter 6 presents an exploration on the quantitative analysis of the interaction log data with a comparison between interaction log data and the subjective feedback, which provide additional evidence to reinforce the conclusions drawn from the subjective feedback. This chapter highlights the potential for the mixed-method approach to be used in evaluating creative engagement.

Chapter 8 Chapter 8 draws together the findings of the three studies and provides a structured reflective overview of the overall findings, structure and links between each study. A general descriptive model of novices' creative engagement is proposed and general design implications for supporting creative engagement are discussed and summarised based on the results from three studies. The methodological approach is also discussed reflectively and critically.

Chapter 9 Chapter 9 summarises the findings of the studies, recapitulates the contributions and limitations, and concludes the thesis with potential future works.

Chapter 2

Background

This thesis investigates how to design and evaluate support for non-musicians' creative engagement with interactive musical systems. The overarching research question is related to three research fields in particular: firstly, it is closely aligned with HCI research on experience, flow and engagement, from which the definition of creative engagement used in this thesis is developed; secondly, as creative engagement involves creative activities, the research on creative engagement is largely informed by creativity theories, e.g. definition and process of creativity, barriers to creativity, implications to support creativity; finally, as music is an ideal domain for study novices' creative engagement, the research and practices in the domain of New Interfaces for Musical Expression (NIME), the discussion on musicking modes and music creativity have contributed to the design of the research questions, study design, and prototype design. This chapter unpacks the related works in detail based on the above three important themes. These background works together to illuminate the rationale for research questions and the study design of the three empirical studies conducted in this thesis.

2.1 Creative Engagement

This section defines creative engagement based on a step-by-step introduction to experience, flow and engagement. The research on experience in HCI formed the theoretical basis for the discussion on flow and engagement in HCI. Engagement is defined as a quality of user experience [O'Brien and Toms, 2008] and is considered as a desirable and essential human response to computer-mediated activities [O'Brien and Toms, 2008, 2010, O'Brien, 2010, Lehmann et al., 2012]. Based on a division of levels of engagement and discussion on creative engagement in different domains, the definition of creative engagement in this thesis is described. The differences in the definition of creative engagement between this thesis and the domain of interactive arts are also explained.

2.1.1 Experience

The achievement of behavioural and cognitive goals and the usability of technology, e.g. ease of use and efficiency, were the fundamental concerns of early HCI research. The narrow focus on the instrumentality of a system was repeatedly challenged until a shift of focus towards the *experience* was proposed in the early 2000s [Harrison et al., 2007]. A more complete and holistic HCI was established with the focus on both instrumental and non-instrumental aspects of products. Promoting the non-instrumental aspects of technology would be beneficial for both the user and the system. Positive experience from an interaction can positively impact on one's wellbeing, help to transform and regulate a person's affective states [Hassenzahl and Tractinsky, 2006], and help to increase a product's value.

In the context of HCI, user experience (UX) is a person's perception and response that result from an interactive process with an artefact [Minge and Thüring, 2018]. UX is influenced by a unique combination of various elements, including the artefact's quality (e.g. appearance, material, functionality, usability) and internal states of the user (e.g. mood, expectation, active goal) [Hassenzahl and Tractinsky, 2006]. According to a meta-analysis of 51 publications in HCI, dimensions of UX research include generic UX, affect/emotion, enjoyment/fun, aesthetics/appeal, hedonic quality, engagement/flow, motivation, enchantment, frustration, and other constructs (e.g. values, spontaneity), among which emotions, enjoyment and aesthetics were the most frequently assessed dimensions [Bargas-Avila and Hornbæk, 2011].

Various frameworks of experience were proposed from different perspectives. Forlizzi and Battarbee described a framework of user-product interactions, including *fluent* user-product interactions that are the most automatic and well-learned ones and do not compete for attention, *cognitive* user-product interactions that focus on the product at hand and can result in knowledge, confusion or error, and *expressive* user-product interactions that help the user form a relationship to a product [Forlizzi and Battarbee, 2004]. They also distinguished three types of experience, namely *experience* that is the constant stream of self-talk that happens when conscious, *an experience* that can be articulated or named and inspires behavioural and emotional change, and *co-experience* that are created and shared between people (ibid). Norman breaks experience down into three levels: the visceral, the behavioural and the reflective [Norman, 2004]. The perceptually based visceral experience give rise to immediate judgments on products. The expectation driven behavioural experience results from the feeling of being in control and from the understanding that arises during the use of a product. The intellectual driven reflective experience is conscious of emotional feelings. Wright et al. proposed four threads of experience that interact and mutually constitute one another: emotional, sensual, compositional and spatiotemporal [Wright et al., 2008]. Desmet and Hekkert discussed three distinct components or levels of product experiences, namely aesthetic experience, experience of meaning, and emotional experience [Desmet and Hekkert, 2007]. The division of levels of experience discussed above clearly sees a progressive tendency of experience from one that relates more to sensory perception and response to one that relates more to emotional, cognitive and reflective processes.

2.1.2 Flow

The peak experience is the 'moments of highest happiness and fulfilment' [Maslow, 1964]. The experiential state of peak experience of technology use is termed as the state of *flow* [Csikszentmihalyi, 2014, p.136]. *Flow* describes a holistic sensation state when the person is acting with total involvement with clear goals and with a high degree of concentration on the task, accompanied with features such as a sense of personal control, a loss of self-consciousness, environment, and track of time (ibid).

According to theories from humanistic psychology, people seek peak experience as an approach towards self-actualisation, the 'realisation of an authentic self' [Rogers, 1954, Maslow, 1964]. Similarly, the experience of flow is also intrinsically rewarding and contribute to the growth of the self. As proposed by Csikszentmihalyi, every flow activity "provides a sense of discovery, a creative feeling of transporting the person into a new reality. It pushes the person to higher levels of performance and led to previously undreamed-of states of consciousness. In short, it transformed the self by making it more complex." [Csikszentmihalyi, 1990, p.74]. Three necessary features of activities that promote this intrinsically rewarding experience are clear goals, optimal challenges and clear, immediate feedback.

Flow state could be found in various activities such as working, playing, exercising. In terms of the flow of music, Csikszentmihalyi argued that although modern technology has made music more approachable, it is not necessarily making sure that the music experience is more enjoyable unless we pay attention to and *listen* to it. He illustrated how flow arises from listening, starting from sensory experience, followed by an analogic mode, and toward an analytic stage of listening. He also emphasised the rewards offered by *playing with* music is much greater than passively listening, as it is not only more enjoyable but can contribute to the growth of consciousness and helps strengthen the self [Csikszentmihalyi, 1990].

2.1.3 Engagement

The concept of engagement is closely related to the theory of *flow*. Flow and engagement have been identified as one of the most and essential experiences of HCI activities [O'Brien and Toms, 2008, 2010, O'Brien, 2010, Lehmann et al., 2012]. Engagement is a term that is usually adopted to describe the flow state that emerges from the computer-mediated activities [Laurel, 1993, p.112], when people are interacting with a computer system and being so focused that they lose awareness of the time and environment [Csikszentmihalyi, 1990]. Chapman stated that "something that *engages* us is something that draws us in, that attracts and holds our attention" [Chapman, 1997]. Although engagement shares a set of attributes with the flow, e.g. focused attention, feedback, interactivity, motivation, studies have argued them to be different in the aspects of control [Webster and Ho, 1997], intrinsic motivation and focus level [O'Brien and Toms, 2008]. Webster and Ho proposed engagement is conceptually similar to the state of playfulness, while the only difference is that the user's perception of control is necessary for playfulness, but not for engagement [Webster and Ho, 1997].

While previous models of engagement are concerned with interaction by an individual user, attempts are being carried out to look at multi-user context. Mutual engagement, a key feature of creative collaborations, is when people spark together, lose themselves in their joint action, and arrive together at a point of co-creation [Bryan-Kinns et al., 2007, Bryan-Kinns and Hamilton, 2012]. Several interaction features were identified to indicate points of mutual engagement, including proximal interaction, mutual modification, joint contribution, attunement, acknowledgement, mirroring and transformation [Bryan-Kinns and Hamilton, 2012]. Although the scope of this thesis is focusing on individual experience, the research on mutual engagement gives implications for this research concerning related works and evaluation methods.

Attributes of Engagement

To develop a definition of engagement that can be measured and evaluated, studies have tried to identify the key components or attributes of engagement. In the early research on engagement, the sense of control was argued to be not necessary for an engagement experience, as for passive engagement the individual is not necessarily involved in an input activity [Webster and Ho, 1997]. However, more recent studies have suggested that control and interactivity are vital attributes of engagement and whether the user can feel a sense of 'in charge' will significantly influence the degree of engagement [O'Brien and Toms, 2008, 2010]. Rozendaal et al. examined how product behaviour and appearance affect the user's experienced engagement, suggesting that experienced engagement is based upon the extent the game provided rich experiences and by the extent the game provided a sense of control [Rozendaal et al., 2007, , M.C.].

Through an extensive, critical multidisciplinary literature review and exploratory studies on users experience with Web searching, online shopping, Webcasting, and gaming applications, O'Brien and Toms proposed a set of attributes of engagement, including *challenge, positive affect, endurability, aesthetic and sensory appeal, attention, feedback, variety/novelty, interactivity, and perceived user control* [O'Brien and Toms, 2008]. In a later study, O'Brien et al. identified six attributes of engagement, including *perceived usability, aesthetics, focused attention, felt involvement, novelty, and endurability* [O'Brien and Toms, 2010].

From Passive to Active

Engagement is an experience with multiple levels. Chapman et al. proposed a classification of engagement with multimedia training system as being either passive or controlled. Passive engagement requires less effort and motivation on the person's part to be involved. Whereas controlled engagement requires the person to actively involve in higher-level cognition activities such as conscious thinking, comparing, critical thinking, reasoning [Chapman and Selvarajah, 1999]. Based on Edmonds' engagement model of attractor, sustainer and relator [Edmonds et al., 2006], three degrees of engagement were proposed by Candy and Bilda, including immediate engagement, sustained engagement, and creative engagement [Candy and Bilda, 2009]. Immediate engagement is when the system manages to draw the user's attention in the first place. Sustained engagement is when the system retains the user's attention for a short period. Creative engagement is when the system change unexpectedly, leading to a positive cognitive transformation and renewing the user's long-term interest in the system (ibid). Similarly, O'Brien proposed that engagement is a process comprised of four distinct stages: point of engagement, sustained engagement, disengagement, and reengagement [O'Brien and Toms, 2008]. Sheridan provided a framework for understanding the transitions of an individual's role during an interactive process. According to her, the audiences may start from *spectating*, then begin to develop technical abilities through *participating*, and finally reach the state of *performing* to express themselves. [Sheridan and Bryan-Kinns, 2008]. Tanaka proposed three broad levels of musical participation based on Arnstein's eight levels of citizen participation, including non-participation, when the individual is unable to influence the outcome; tokenism, when the individual has some but not full influence on the outcome; and citizen power, when the individual is able to obtain major decision-making or full creative power [Tanaka, 2011].

The above discussions on engagement with digital systems suggest a spectrum of engagement from a passive engagement that requires less initiative of a person, to an active engagement that calls for users' active participation and contribution in the interaction process and co-creation of the content or experience with the system. Compared to the passive engagement, there is an increasing need for focused attention and complex cognitive activities in active engagement. Users may shift between the different states of engagement. Active engagement transfers a user's role from consumers or spectators to contributors or co-designers [Fischer, 2002, Sanders and Stappers, 2008], and is therefore more 'sustainable and rewarding for the audience', and makes the interactive experience a 'memorable' one, rather than a 'pretty' one [Candy and Bilda, 2009].

The benefits of getting a more memorable interactive experience lead to the new goal of designing an interactive experience with active engagement in different domains. For example, the design of Open Symphony encourages audiences' active participation in live music performance to co-create music performance with musicians, which extends the traditional audiences' role in music performance from passive listening to active participating [Wu et al., 2017].

2.1.4 Creative Engagement across Domains

Creative engagement has been discussed in different domains. For example in the domain of education and management, creative engagement is to encourage students or employees' active and creative participation in the learning process so as to achieve a positive learning and working outcome [Kobus et al., 2007, Craft et al., 2008, Güldenpfennig et al., 2014, Kivunja, 2015, Hurley, 2007]. In the domain of social care, it is regarded as an approach to support the elder or disabled people's wellbeing, or to promote resilience of disease by encouraging their creative interactions and expressions [Williams, 2008, McFadden and Basting, 2010, Morris et al., 2014]. Creative engagement is also taken as an innovative method in social debate [Robinson et al., 2014], design and evaluation process [Sustar, 2008] or research contexts [Jennings et al., 2006] as it helps to form a responsible and democratised context, and also brings in interdisciplinary perspectives, knowledge and skills with broad participation of citizens, users or practitioners.

The discussion on creative engagement in the domain of new media arts or interactive arts informed the definition of creative engagement in this thesis. In the context of interactive art, creative engagement is defined as an experience to engage audience or users in a creative manner [Edmonds et al., 2006, Bilda et al., 2008, Kumpulainen et al., 2014, Dindler, 2014]. Edmonds and Bilda defined creative engagement as "when a user is engaged with the system and starts to construct meaning through the process of interacting" [Edmonds et al., 2006, Bilda et al., 2008]. It is a process of sense-making in regarding to the interactive systems [Kumpulainen et al., 2014, Dindler, 2014]. Edmonds proposed a model of creative engagement, including attractors, things that can draw attention and encourage the audience to take note of the system in the first place; sustainers, attributes that have holding power to keep the audience engaged for a period; and relaters, aspects that help the audience develop a long-term interest and grow a continuing relationship so that the audience returns to the work on future occasions [Edmonds et al., 2006].

Based on Edmonds' work, Bilda developed a more detailed framework for creative engagement with interactive arts, suggesting a sequential and temporal engagement process and defining it as a "reflective and transformative dialogue between the audience and the interactive art system"[Bilda et al., 2008]. This creative engagement model involves four interaction phases based on five interaction modes, starting with phases of *adaptation* and *learning* when participants gradually develop their expectations and understanding of how the system works. Along with this process, their intentions and expectations are set, and interactions are developed from unintended and exploratory modes into the deliberate mode, where the participants know a little of what to expect. In the following phases, *anticipation* and *deeper understanding*, the participants learn to predict the outcomes of their interaction and reaches a more complete understanding of the artwork and what their relationship is to the artwork. The interaction modes at this stage are developed from the deliberate mode into intended/in control and intended/uncertain mode, where the participants feel in control and possibly end up with creative outcomes.

2.1.5 Definition of Creative Engagement

According to the related works, *creative engagement* is a sequential and temporal engagement process for creative purpose, and a "reflective and transformative dialogue between the audience and the interactive art system" [Bilda et al., 2008]. In the context of music making, *creative engagement* is similar to the concept of 'play fluency' [Hansen et al., 2011], when the players are engaged in a constructive process for creating meaningful musical expressions or structures. Creative engagement is one of the optimal engagement experience as it is intrinsically rewarding and memorable, encouraging users' autotelic and sustained creative activities with the system [Csikszentmihalyi, 1996, Hansen et al., 2011]. Built on the theories of flow, engagement, and discussions on creative engagement in interactive art, the definition of *creative engagement* used in this thesis is as below:

> *Creative engagement is a higher level of engagement , when the user is engaged in an active, reflective and constructive cognitive process, and in pursuit of a creative outcome with the assist of the interactive system.*

Creative engagement defined in this thesis is different from its definition in the context of interactive arts. In the context of interactive arts, creative engagement is a state when the audience is in pursuit of meaning or understanding out of the system through the interactions with it. In the scope of this thesis, creative engagement is an interactive experience when the user is creatively engaged with the system in pursuit of a creative product, rather than a sense-making state in pursuit of meaning or understanding of the system.

2.1.6 Summary

This section mainly discusses the origins of the concept and the definition of creative engagement based on the related theories on experience, flow and engagement in HCI. It also discusses the related works on creative engagement in different domains, followed by the definition of creative engagement. The creative engagement is defined as when a user is involved in an active, reflective and constructive process in pursuit of a creative outcome. The definition of creative engagement in this thesis differs from that in the domain of education, management, social care and interactive arts.

2.2 Creativity

Creative engagement is an active, reflective and constructive experience in a creative process. Apart from the features of engagement discussed above, the experience of creative engagement is influenced by features of creativity as the process involves creative activities. To get a deeper understanding of creative engagement, the first three sections introduce related works on the definition of creativity and creative process and define creative engagement as little-c creativity. In the following sections, the discussion on barriers to creativity, practices and theories to creativity support and effects of motivation together give an overview of the potential issues, problems and implications for conducting research on creative engagement.

2.2.1 Definition of Creativity

Since the very early age of human history, creativity has been regarded as 'part of what makes us as human' yet stays mysterious [Sawyer, 2011]. Modern research endeavours have contributed to a profound understanding of various aspects of creativity since the 1950s. There are three waves of trends on creativity research: the first wave focused on personalities or traits of exceptionally creative people, the second wave focused on the internal mental process of creativity, e.g. how people think, perceive, learn and remember, and the third wave led the focus shift to social and cultural contexts of creative process [Sawyer, 2011]). Generally, the creativity research mainly focuses on four paradigms of subjects: the *product* of a creative process, the effects of the personality of a *person* on creative performance, the internal mental *process* of creativity and the external *process* of the social and cultural context [Rhodes, 1961, Sawyer, 2011].

As studies on creativity undertook distinctive focus, creativity has been defined from different perspectives, e.g. creativity can be a property of people, or a property of a set of cognitive processes or components. One perspective regards creativity as human capacity. For example, Boden defined creativity as "*the ability to come up with ideas or artefacts that are new, surprising and valuable*" [Boden, 2004]. Some theories define creativity as a component model. As an example, creativity has three facets: domain-relevant skills (e.g. technical skills, domain knowledge), creativity-relevant skills (e.g. appropriate cognitive style, heuristics strategy for generating novel ideas), and task motivation (e.g. attitude toward tasks, intrinsic and extrinsic motivations) [Amabile, 1990]. Another perspective takes creativity as a process of conceptualising and developing a novel product that has some value to the individual or a social group [Hewett et al., 2005]. For example, Dorin and Korb defined creativity as a generative procedure that produces representations of patterns through the use of a framework [Dorin and Korb, 2012].

The process of creative engagement is vague. In the interest of exploring the essence of creative engagement, the exploration and discussion on creative activities in this thesis will be focusing on the creative process as creative engagement is an experience of an interaction rather than the ability of people. Moreover, as the influencing factors on creative engagement are vague, the social dynamics of creativity are excluded in the scope of this thesis. The primary focus of this thesis will be on the individual's creative process.

2.2.2 Creative Process

> *Nothing is more natural than 'playing around' to gauge the potential - and the limits - of a given way of thinking... And nothing is more natural than trying, successfully or not, to modify the current thinking-style so as to make thoughts possible which were not possible before. To put it another way, nothing is more natural than the progression from exploring a given style of thinking to transforming it, in some degree.*
>
> *Margaret A. Boden [Boden, 2004, p.58]*

Boden proposed three different ways of generating the novel ideas, by combining common ideas, exploring structured conceptual spaces, and transforming some dimension of the accepted conceptual space [Boden, 1998]. The progression from *combination* to *exploration* and to *transformation* results in a progression of ideas with better novelty [Boden, 2004]. Since Graham Wallas proposed his influential four stages of a creative process, i.e. preparation, incubation, illumination and verification, various works have built upon this work and expanded it [Wallas, 1926, Sawyer, 2011]. Csikszentmihalyi indicated five mental phases in a creative process, *preparation* (become immersed in a field and a set of problematic issues), *incubation* (ideas cumulate below the threshold of consciousness), *insight* (Aha! moment when pieces of puzzle fall together), *evaluation* (deciding if an insight is valuable and worth pursuing) and finally, *elaboration* (exploring the range of outcomes that an idea suggests) [Csikszentmihalyi, 1996, p.79]. By expanding a two-stage model which addressing creative process is divergent thinking followed by convergent thinking, Sawyer proposed a framework of creative process with eight key stages [Sawyer, 2011, p88], including find and formulate the problem; acquire knowledge relevant to the problem; gather a broad range of potentially related information; take time off for incubation; generate a large variety of ideas; combine ideas in unexpected ways; select the best ideas, applying relevant criteria; externalise the idea using materials and representations.

There is a long history of debate on whether the creative process is a set of rational, analytical, incremental procedures towards an idea or a solution, or it involves emotional and random aspects toward a sudden idea or solution that has no connection to prior activities [Hewett, 2005]. These two distinctive processes are referred as non-insight process and insight process. The featured theorist for the non-insight process is Herbert Simon, whose book entitled "The Psychology of Scientific Discovery". He maintained that creativity involves rational heuristic searches for problem solutions. On reflection of his eight-stage framework for the creative process, Sawyer addressed that the moment of insight is not mysterious. He argued that the big insight is a result of numerous mini-insights, and it is an incremental process toward the big insight [Sawyer, 2011, p.139]. On the other hand, the empirical evidence suggested that the creativity can sometimes happen "outside its logical structure" [Csikszentmihalyi, 2014]. Creativity is regarded as a spontaneous process away from rationality and convention and is characterised by emotion and instinct [Sawyer, 2011, p.24]. Sternberg proposed three processes that are especially crucial to the origins of creative insights: *selective encoding*, sifting out relevant information from large amount of irrelevant information; *selective combination*, combining originally isolated pieces of information into a unified whole that may or may not resemble its parts; *selective comparison*, relating newly acquired information to old information [Sternberg and Kaufman, 2010].

In this thesis, the creative process is regarded as a rational and incremental process influenced by insight aspects that might affect an individual's state, e.g. a user's motivations and emotional states. However, insight aspects also need to be taken into account when studying creative engagement.

2.2.3 Little-c Creativity

Creativity may be divided into two main categories on the basis of the value of the creative output [Sawyer, 2011]. *Big-c creativity*, also referred as historical creativity [Boden, 2004], is conceiving novel ideas to a social group, or even to the human history. It usually leads to major contributions in a domain, which is very rare and challenging to achieve [Russ and Fiorelli, 2010]. *Little-c creativity*, also regarded as psychological creativity [Boden, 2004], is conceiving ideas new in that person's mind but not new to the world. It can be found in everyday activities such as cooking, drawing, etc. Big-c creativity is similar to the concept of 'task-focused creativity' and little-c creativity is similar to the concept of 'casual creativity' [Compton and Mateas, 2015]. As composed to the task-focused creativity that is goal-oriented, intentional and purposeful, casual creativity is an intrinsically pleasurable and autotelic, which 'privileges the enjoyable experience of explorative creativity over task-completion' (ibid).

Big-c creativity seems to be a more intriguing topic as it provides new solutions to problems and is the driving power of human progress. What's the value of little-c creativity? Richards claimed that the little-c creativity is found in everyone and highlighted the importance of everyday creativity as it is central and fundamental to human survival [Richards, 2010]. Everyday creativity can form the ground from which more valuable creative ideas can grow (ibid). In another word, the little-c become the seedbed of big-c creativity. Csikszentmihalyi proposed that the everyday creativity is good for mental health and can contribute to a happy and fulfilling life [Csikszentmihalyi, 2014]. Moreover, based on Maslow's view on creativity in his *self-actualizing* theory [Maslow, 1964], Richards suggested it is the creative process rather than the quality of the outcome that provides a potential path of personal and spiritual development, that improves physical and psychological health, and that offers greater life satisfaction and meaning to life [Richards, 2010]. Likewise, Csikszentmihalyi asserted creative acts with little-c creativity offers an autotelic experience that everyone pursues as it is the intrinsic rewarding of the everyday practice of creativity that drives people to pursuit rather than the attainment or the rare success [Csikszentmihalyi, 1996].

In the scope of this thesis, creative engagement is discussed as an experience involved with creative activities within the little-c level. Creative engagement emphasises the users' creative experience instead of their creative output. Therefore creative engagement should not be evaluated based on the quality or contribution of the output as the creative output is valued only at a personal level (little-c) rather than a social level (big-c) [Sawyer, 2011]. The evaluation of creative engagement therefore needs to be distinguished from the studies in the domain of creativity support tools (which will be discussed in more detail in later section), where the quality and value of the creative product is one of the evaluation criteria for a person's creativity or the success of a creativity support tool.

2.2.4 Barriers to Creativity

Barriers are blocks or constraints, that either inhibit creative thinking and inspiration from a person or a process or prevent innovative ideas from being accepted and implemented [Davis, 1999]. Related works have provided a comprehensive list of internal and external barriers to creativity [Davis, 1999, Sternberg and Kaufman, 2010]. External barriers are related to the context or environment, including *cultural barriers* such as rules and traditions, social influences, expectations, and conformity pressures from social and institutional norms that prevent a person from thinking of new ideas, and *resource barriers* such as shortage of people, money, time, supplies or information that are necessary for creative thinking or implementation of creative ideas [Davis, 1999].

Internal barriers are related to the individual person. For example, *learning and habits* can restrict a person from seeing and creating new possibilities (ibid). *Perceptual barriers* are the mental functional fixedness that leads a person to perceive things in certain ways, which blocks a complete and accurate picture of the world and thus lead the person to miss the 'real problem' (ibid). *Emotional barriers* can be a person's temporary states, e.g. anger, fear, hate, or chronic sources of insecurity and anxiety such as fear of failure, criticism, rejection (ibid). *Attitude barriers* are a person's willingness and ability to take a risk, to redefine existing problems in new terms, to be critical of one's own creative work, to overcome obstacles and develop expertise [Sternberg and Kaufman, 2010].

Fixation is a common cognitive problem in the creative process that is comparable to the perceptual barrier mentioned above. It is when a person gets stuck in a counterproductive mental set with an incorrect direction or solution, which obstructs the memory retrieval of the correct solutions [Smith and Blankenship, 1991, Sawyer, 2011, Kerne et al., 2014]. The occurrence of fixation is usually due to a person being misled by ambiguous or irrelevant information in the problem [Smith and Blankenship, 1991]. As an example, after being presented several example solutions in sequence, very few subjects could jump out from the previous mental set and found the simple solutions differed from the given examples when received a problem that could be solved in simple and obvious solutions (ibid). Sawyer proposed the underlying reason might be that people tend to generate things that are similar to what they already know [Sawyer, 2011, p.111]. Therefore the experience and knowledge prohibit the generation of unusual and original solutions (ibid). Similar cases were reported in the design domain that designers become attached to existing solutions and examples they encounter and start to repeat key attributes or features of the examples unconsciously and excessively in the design process [Cardoso and Badke-Schaub, 2011].

2.2.5 Creativity Support

The studies of creativity development support the idea that creativity could be developed through appropriate training [Sawyer, 2011] or be fostered with appropriate techniques [Hewett, 2005]. For example, two important cognitive processes in creativity, divergent thinking and transformation, are demonstrated to be improved through divergent play and improvisational play [Russ and Fiorelli, 2010]. Although creativity differs across domains and involves domain-specific characteristics, there are domain-independent features of creativity [Kaufman et al., 2005, p. xiv]. Similarly, Hewett argued whilst the associated constraints and resulting products differ widely from domain to domain, the fundamental processes and conditions required to make creative works possible are domain independent [Hewett, 2005]. Also, these domain-independent factors are some of the most fundamental basis for generating creative output (ibid). This argument is coherent with the earlier study on creative cognition, suggesting that there are commonalities between domains to produce creative ideas and discoveries [Finke et al., 1992]. These commonalities lie in the aspects of the cognitive process such as ideation, convergent or divergent thinking (ibid).

Based on the notion that creativity can be enhanced and fostered [Hewett, 2005, Sawyer, 2011], and that there are shared features across different domains of creative activities [Finke et al., 1992, Hewett, 2005], the domain of Creativity Support Tools (CST) has been exploring the design and evaluation of systems to mediate the creative process with technologies for more than a decade. A four categories classification on creativity support tools was proposed, indicating that computers may facilitate (a) the management of creative work, (b) communication between individuals collaborating on creative projects, (c) the use of creativity enhancement techniques, (d) the creative act through integrated human-computer cooperation during idea production [Lubart, 2005]. The main approach to support creativity is through facilitating the task-related activities involved in creative processes, including *collect* and *learn* from previous works; *relate* by consulting with peers and mentors at early, middle, and late stages; *create, explore, compose*, and *evaluate* possible solutions; *donate* and *disseminate* the results and contribute to libraries [Shneiderman, 2000]. Some approaches seek to support creativity through influencing individual's cognitive essentials or variables, e.g. interests, attitudes, motivation, intelligence, knowledge, skills, beliefs, values and cognitive styles [Hewett et al., 2005]. Davis et al. used cognitive theories of embodiment, situated activity, and distributed cognition to identify the unique needs of novices [Davis et al., 2013a]. They presented three concepts to support the cognitive aspects in a creative process, including 1) embodied creativity to increase novices' creative ideas, 2) situated creativity to support tools become an extension of the body, and 3) distributed creativity to offload some of the conceptual and technical tasks to the tools.

A set of practical design guidelines derived from the research and studies into supporting activities involved in creative processes and improving the potential of creative output are summarised below. The ultimate goal embedded in these implications is to allow a quick capture on the related knowledge, possible ideas or insights, and provide a low cost to trial and error, without being disrupted from the main workflow.

- Encouraging users' confidence and willingness to take risks by providing easy mistake correction [Nickerson, 1998].

- Designing the system with low thresholds, high ceilings, and wide walls with a wide range of functionalities but easy for novices to begin using [Shneiderman, 2007].

- Supporting exploratory search for rapid incremental and reversible exploration [Candy and Edmonds, 1997, Nickerson, 1998, Shneiderman, 2007].

- Providing multiple access routes into archives or relevant data [Hewett, 2005].
- Providing rich history-keeping mechanisms including recording different alternatives [Shneiderman, 2007, Carroll et al., 2009].
- Supporting the management of creative work [Lubart, 2005].
- Enable collaboration and social evaluation with peers and mentors [Shneiderman, 2000].
- Supporting communication between individuals in collaborative creative projects [Lubart, 2005].
- Allowing the users to quickly produce and experiment with variations on alternative ideas with algorithmic techniques [Sarwate and Fiebrink, 2013].
- Allowing quick implementation of interaction design with machine learning algorithms [Fiebrink and Caramiaux, 2016].

The above design guidelines are mostly derived to support the professional task-focused creativity, focusing on efficient task completion by supporting a broad range of possible actions. Compton and Mateas proposed another paradigm of creativity support tools, which support the autotelic, intrinsically-rewarded casual creativity and value pleasurable user experience over productivity [Compton and Mateas, 2015]. Therefore, this design paradigm usually reduces the possibility space of the tools as the users are more flexible with the results, offers instant, simulation and approximating feedback, provides entertaining evaluations and optional direction, as well as limiting actions to encourage exploration, allows saving and sharing in communities (ibid).

Serendipity Strategies

Serendipity is a phenomenon when an 'aha' moment of insight occurs under unexpected circumstances and results in a valuable, unanticipated outcome [Makri et al., 2014, McCay-Peet and Toms, 2017]. The experience of serendipity is beneficial as it provides users with new knowledge, propels them in a direction they would never think of, and encourages them to integrate these strategies into future work and everyday life (ibid).

Suggestions to support or to foster serendipity in digital information environments are mainly from two perspectives. One perspective focuses on supporting peoples' attitude. For example, a prepared, curious and open mind is argued to be helpful for a subject to achieve serendipity [McBirnie, 2008, e Cunha et al., 2010, Makri and Blandford, 2012]. Another perspective seeks to support serendipity by providing users with unexpected and valuable content that they might not have otherwise thought of or come across on the digital environment [Makri et al., 2014]. There are three distinct suggestions for doing so, including a) recommend digital content, b) make location-based recommendations, c) facilitate information visualisation (ibid).

Visual stimuli

Insight problems such as fixation, as discussed earlier in Section 2.2.4, are difficult to be resolved by normal associations unless via a cognitive reinterpreting or restructuring the problem [Sawyer, 2011, p.110]. This reinterpreting and restructuring the problem could be achieved by supporting *incubation* [Smith and Blankenship, 1991] or *provocative stimuli* [Kerne et al., 2014]. Incubation is when a person temporarily puts aside the problem and gets away from the mindset of previous solutions [Smith and Blankenship, 1991, Vul and Pashler, 2007, Kohn and Smith, 2009]. Provocative stimuli is new materials or aspects that could provide clues for solutions, or provoke insights [Kerne et al., 2014]. The source for stimuli could come from external environment [Seifert et al., 1994], or from internal divergent thinking through creative imagery [Finke, 1990] or sketch [Shah et al., 2001].

There is plenty of empirical evidence suggesting that visual stimuli in the working environment can positively prompt the performance of a creative process by providing 'potential cues, analogy-sources or other similes' for inspirations [Eckert and Stacey, 2000, Cardoso et al., 2009, Cardoso and Badke-Schaub, 2011, Goldschmidt and Smolkov, 2006, Goldschmidt, 2015]. Practical solutions such as mood boards or ideation metrics that collect sketches or pictures together [Shah et al., 2001, Cheng et al., 2014, Kerne et al., 2014] are broadly used in various creative ideation process, especially in the domain of design.

2.2.6 Effects of Motivation on Creativity, Experience, Engagement

Motivation is regarded as an essential factor and an essential component for creativity, without which creative innovations are unlikely to occur [Selker, 2005, Csikszentmihalyi and Sawyer, 2014, Amabile, 1990, Hewett, 2005]. The discussions about creativity have been intertwined with the discussions about task motivation [Hennessey, 2010]. The recent HCI designs encourage users to take an active role in content production during the interaction process, rather than passively receiving content or knowledge [Simon, 2010, Dindler, 2014, Wu et al., 2017]. The shift of users' role and motivation have influenced the users' interaction strategies, as well as their creative experience. Given the goal to behave more creatively, people tend to produce more creative responses, compared to what they would usually do without an assigned goal [Ironson and Davis, 1979]. Shalley found that when setting a difficult productivity goal, high levels of creativity and productivity were attained by employees, while low levels of creativity were obtained with no creativity goal [Shalley, 1991]. The result might be caused by the different cognitive styles triggered by different motivations. A study has suggested that risky and exploratory processing style would facilitate creative thought, relative to the risk-averse and perseverant processing style [Friedman and Förster, 2001].

Motivation has a profound impact on product evaluation and user experience, according to a long list of related works in HCI [Novak et al., 2003, Hassenzahl and Ullrich, 2007, Hassenzahl et al., 2008, Rozendaal et al., 2007, , M.C., Soleimani and Law, 2015]. Research suggested that a user's motivational orientation, whether an experiential goal or a utilitarian goal, will strongly affect their choice and preference of a product [Hassenzahl et al., 2008], emotional experiences of an e-commerce website [Soleimani and Law, 2015], experience of control and engagement in voice mail browsing [, M.C.], and also subsequent retrospective judgment of an interactive product [Hassenzahl and Ullrich, 2007]. An experiential motivation usually aims for hedonic experience whereas a utilitarian motivation usually aims at a concrete result or output [Rozendaal et al., 2007].

The experiential and utilitarian motivation might have different effects on the user's flow, engagement, and experience. For example, online flow experience was more likely to be observed when the users were engaged in task-oriented rather than experiential activities [Novak et al., 2003]. Furthermore, among the three necessary preconditions of a *flow* state, i.e. clear goals, optimal challenges, and immediate feedback, a set of clear goals are suggested to be helpful to add direction and purpose to behaviours, thus serving to structure the experience [Csikszentmihalyi, 2014]. Contrarily, Rozendaal et al.'s study indicated that there might be a positive link between the increased engagement and experiential motivation [Rozendaal et al., 2007]. They reported that when assigned with an experiential goal users' experience of engagement gradually increased with increased levels of richness in product appearance, which is not the case when assigned goal-directed tasks. Hassenzahl and Ullrich suggested that to have an active instrumental goal negatively impact on the experience of an interactive product, and also subsequent retrospective judgment, making barriers by increasing mental effort [Hassenzahl and Ullrich, 2007]. A more neutral view on the effects of different motivations was proposed as well. By examining the relationships between motivations and factors of user engagement in the context of an e-commerce environment, O'Brien provided predictive connections between hedonic and utilitarian motivations and aspects of engagement [O'Brien, 2010]. She suggested an interconnection between utilitarian and hedonic motivations as both of them have certain central effects on some aspects of engagement.

The above pieces of literature suggest that a clearly defined utilitarian motivation contributes to more optimal creative performance, compared to an uncertain, vague, or experiential goal. The effects of different motivations on experience and engagement, however, is not so obvious. Some studies suggested a positive influence of a clear utilitarian goal on engagement and experience whereas some studies suggested an experiential goal contribute to user engagement and experience. Whether having a positive influence or not, the above related works reveal that there is a relation between different motivations and the users' creative performance or engagement experience.

2.2.7 Summary

To summarise, creativity is an autotelic human activity that every human being is instinctually pursuing as it is rewarding and beneficial, no matter the value or the quality of the creative acts. Creative engagement is little-c creativity that does not emphasise on the creative outcome but the creative experience. There are internal and external barriers to creativity. Creativity could be developed through training and be supported by technologies. Studies have been exploring methods to support creativity and have offered a list of implications for designing CSTs. Motivation orientations will strongly affect a user's creative performance, experience and engagement.

2.3 Musicking

As discussed in Chapter 1, music is an ideal domain to study creative engagement as music making is regarded as a fundamental form of human creative activities. It plays a major role in human intellect evolution and has common and unique features as compared to the creative activities in other domains [Small, 2011, Sawyer, 2011, Bryan-Kinns, 2013]. With the use of digital technology, the notion of music has been adapted and improved. This section summarises the main trends and features of design in the domain of NIME, and the barriers for novices to be creatively engaged in the activity of musicking.

2.3.1 New Interfaces for Musical Expression

> *"To music is to take part, in any capacity, in a musical performance".*
>
> *Christopher Small, [Small, 2011]*

Small proposed the term *musicking*, to suggest that music is not a thing but rather an activity [Small, 2011]. This term has extended the traditional notion of music as a content or a product to a more advanced notion of music as an activity, and as a process. The shift in the notion of music is coherent with the trends in the domain of New Interfaces for Musical Expression (NIME). Various new interfaces for musical expressions are being designed and are aiming at breaking the barriers of traditional instruments, allowing broader and more active participation in musicking from a wide range of users with all levels of skills. *Musicking* is becoming a more accessible activity that is no longer exclusive for musicians [Robson, 2002, Kaltenbrunner et al., 2006, Jordà et al., 2007, Parson, 2009, Hansen et al., 2011, Bengler and Bryan-Kinns, 2013]. This trend has encouraged more and more people with all levels of skills to actively *play with* music as opposed to passively *listen to* music [Resnick et al., 1996, Hansen et al., 2011].

The experience of creating and enjoying music through playing is often rewarding, offering "an affirmation of life" because of its exploratory, engaging, intuitive and enjoyable qualities [Cage, 1961, Hansen et al., 2011]. Being able to create the sound and listen to it simultaneously, a person's role is transformed from a mere consumer towards a creator of music [Resnick et al., 1996, Hansen et al., 2011]. The gap between performers and audiences has been merged [Tanaka, 2011]. Moreover, research on music creativity suggested that creating music can contribute to the cognitive ability, e.g. learning to compose music enables a person to think in ways that might be helpful in other contexts [Byrne et al., 2001].

Instead of producing sound through physical acoustic mechanisms like traditional instruments do, a NIME generates its sound through a sound generation unit that maps the input to the sound output [Wanderley, 2001, Miranda and Wanderley, 2006, Tanaka, 2009]. Generally, it has components such as an input device or a controller, a mapping algorithm between the input and output, a sound production unit such as a sound synthesis engine, and an output system [Miranda and Wanderley, 2006, Tanaka, 2009]. The benefits of NIMEs as compared to traditional acoustic instruments are that they can enhance and extend the sound produced by traditional instruments [Tanaka, 2009].

Novel forms of interaction methods are being designed and implemented on NIMEs. Keyboards or knobs were substituted by gestural controls for real-time synthesis [Miranda and Wanderley, 2006]. For example, body gestures and movements of singers were captured by custom-built technologies and transformed for creating synthesised accompaniment in real-time so as to extend the singers' vocal performance [Elblaus et al., 2014]. Wearable instruments were designed to capture movement to allow dancers to play music by dancing [Fujimoto et al., 2009]. Tangible interfaces, e.g. *Reactable*, allow multiple musicians to interact with sound by placing and manipulating marked physical objects on a round translucent table [Kaltenbranner et al., 2006]. Each object acts as a part of a modular synthesiser to transmit or control audio data (ibid).

2.3.2 Interactive Music Systems

There are many paradigms of musical interfaces identified in the NIME field. For example, *intelligent musical instrument* was utilised to describe interactive composing systems that automatically generated music based on the performer's input [Chadabe, 1997]. *Interconnected musical networks* were proposed to describe the musical systems that support collaborative group music making [Weinberg, 2003].*Interactive music system (IMS)* was initially described as a system 'whose behaviour changes in response to musical input' [Rowe, 1992]. Jordà defined IMS as computer-based interactive system that generates a musical output at performance time, under the control of one or several performers [Jordà, 2005, p.58]. Later on, IMS was proposed as a system that 'responds with music to input from a non-expert human participant', as composed to *digital musical instrument (DMI)*, which is designed for professional musicians to perform delicate and expressive music [Murray-Browne, 2012].

Among the various paradigms within NIME field, the interactive Music System (IMS) proposed in [Murray-Browne, 2012] is most relevant to this thesis. As it explicitly makes a distinction between the experts and novices, and is focusing particularly on novices' music making, its description is in line with the focus of this thesis, targeting at non-musicians' music making. Based on the previous research, in this thesis the notion of IMS is described as *a computer-based interactive system that produces music or sound from the input of non-expert users*. It should be noted that the notion of IMS in this thesis is not *prescriptive* but *descriptive* as it's based on 'observations and generalisations rather than a requirement analysis'(ibid). It has similar components to DMI, i.e. an input device or a controller, a mapping algorithm, a sound production unit and an output system [Tanaka, 2009], usually presented in the form of musical application or installation [Murray-Browne, 2012]. Jordà proposed an important feature of IMS, that it should be able to engage the player by behaving in somewhat unpredictable ways so as to 'provoke an ongoing dialog between the performer and the system' [Jordà, 2005, p.59]. Based on related works on IMSs, three typical features of IMSs are summarised below:

I: Emphasise the experience. Compared to the design of DMIs that emphasise the system's expressiveness, responsiveness and the final sound output, IMSs emphasise the player's experience during the interaction process. Such designs are less likely to be driven by musical goals but are more likely to be driven by the aim to foster an engaging experience that is rewarding to participants [Weinberg, 2003]. For example, they may be designed to support improvisation with coordinated actions between participants [Zamorano, 2012], or to provide a rich music learning experience [Resnick et al., 1996].

Collaborative creative experience is an prominent direction of IMSs design. By facilitating the elaborate social dynamics between a group of players [Blaine and Fels, 2003, Weinberg, 2003, Bryan-Kinns, 2004, Weinberg and Driscoll, 2005, Tanaka et al., 2005, Zamorano, 2012, Bryan-Kinns, 2013, Bengler and Bryan-Kinns, 2013], collaborative music making based on collective knowledge and creativity allows a sustained musical creative engagement. As process and experience become the priority in these systems, the chances are that the keystone of the design is not facilitating the music creation, but facilitating the elaborate social dynamics such as communication, mutual awareness, the rules of interaction.

II: Emphasise the intuitiveness As non-musicians usually have little or no physical skills and domain knowledge of music, the interfaces are designed with low entry fee to enable users to understand and learn easily, and intuitively interact with them [Wessel and Wright, 2002, Fels, 2004]. Simplified mapping strategies between the input and sound, limited sound parameters, pre-recorded samples or pre-composed materials [D'Arcangelo, 2001] and generative algorithms to control all or part of the sound generation [Weinberg and Driscoll, 2005, Schacher et al., 2015] are often utilised to reduce the complexity of the sound. Intuitive control mechanisms such as tangible interactions [Jordà et al., 2007, Bengler and Bryan-Kinns, 2013], mobile interactions [Bryan-Kinns, 2004], wearable interactions, spatial or gestural interactions [Beyer and Meier, 2011, Zamorano, 2012, McAlpine, 2017] and laptop-based interaction are widely adopted to provide intuitive interaction with low or little barriers to use [Xambó, 2017].

A challenge here is that with *simplified interaction* or with *constrained musical complexity* ISMs might be able to 'hook' novice in the first place, however, they might also fail to encourage 'deeper exploration and continued discovery and creativity'[Machover, 2002], as they present limited musical possibilities and potential [Jordà, 2004]. Players could quickly lose interest after all the various sounds and the musical mappings had been explored [Feldmeier, 2002]. Thus they may engage with the interface for a limited amount of time [Overholt, 2009]. Gelineck and Serafin argued that for an environment to encourage exploratory behaviour, it must be 'rich, complex, and somewhat mysterious' but remains intuitive in order to give the user confidence to continue [Gelineck and Serafin, 2010].

III: Emphasise the liveness. As discussed in [Overholt, 2009]'s framework for the design of expressive musical interfaces, the faster the real-time sound processing and generation in response to the interaction, the higher level of control will the player experience. The majority of IMSs employ a dynamic real-time design paradigm by offering immediate sound output in response to a player's interaction [Levin, 2000, Jordà et al., 2007, Bryan-Kinns, 2004, 2013, Bengler and Bryan-Kinns, 2013]. Only limited ISMs have embedded history keeping mechanisms to enable players to revisit, reuse or revise previous creations, usually following a step sequencer design [Bryan-Kinns, 2004, Arellano and McPherson, 2014].

2.3.3 Commercial Applications for Novice Musicking

IMSs design is often in the context of commercial applications. Most of these commercial applications are designed on personal touch devices or game console. Below is a discussion of two common types of applications that influenced the design of the prototypes used in this thesis.

The first type of applications implements the idea of a sequencer. The user can control the rhythm and create loops with single tone. A typical example is *Beatwave* [1], a sequencer allows the user to create beats, chords, rhythm and layered melodies easily on touch screen. It also allows user to perform with real-time sound effects. With *Poly* [2], a generative sequencer, the user can create sound loops and rhythm patterns by adding different coloured nodes to a circular area. A node repeats automatically and rhythmically according to the distance the node is to the middle. The closer it is to the middle, the faster it repeats. Similarly, *Figure* [3] lets the user set a rhythmic pattern of the chosen instrument by changing the scale steps. It also allows the user to tweak the instrument's sonic qualities in real-time. *Musyc* [4] simulates the real world gravity and physics to make music. It allows the user to place symbols and lines on a canvas. A symbol goes into free fall once being placed on the canvas. A sound is generated when a symbol touches a line. The line gives a reactive force to the symbol. The symbol then naturally bounces and moves based on the reactive force and the gravity.

A second type of designs utilise the idea of remixing, using pre-recorded sound samples to play loops and one-shots. *Launchpad* [5], for example, allows the user to perform with samples in real-time. The users can also change tempo

[1] http://beatwave.co/
[2] http://ipadloops.com/poly-generative-sequencer-for-ipad/
[3] https://allihoopa.com/apps/figure
[4] http://fingerlab.net/portfolio/musyc
[5] https://ampifymusic.com/launchpad

at any time, with real-time audio stretching and synchronising. *NOIZ* [6] allows the user to create dynamic drops and build ups in real-time. On the interface there are different shapes of cells representing different sound loops, effects, or beats. By holding, touching or dragging the cells on the interface the users are able to trigger beats, fills and effects. Similarly, the *Jammer* [7] application allows the user to perform a piece of pop music in their desired way by tapping out the separated vocal, instrumental, and percussion grooves, as well as the short musical elements.

The designs of the above applications address the three features of IMSs summarised in the previous section, i.e. emphasising the experience, the intuitiveness, and the liveness. The applications utilise the simple gestures, e.g. tapping, holding, sliding and dragging on the touch screen, providing intuitive interaction mode for non-musicians. *Musyc* transfers the complex rhythm control into the more obvious distance control. The design emphasise the intuitiveness of interaction as it uses the users knowledge of natural world, i.e. gravity and physics, to create music. The idea of mashup and jamming in *Launchpad, NOIZ, and Jammer* emphasise the liveness of music playing. Tweaking the sonic qualities in real-time also adds more dynamics to the music playing, for example, the sound effects in *Beatwave* and *Figure*. The real-time sound processing and generation in response to the intuitive interaction also produces a lot of fun.

Although some of the IMSs successfully achieved the goal to engage non-musicians to play with music, there is a lack of academic work to look into the failure and success of IMSs systematically. Therefore, there is a lack of understanding on how to design a successful IMS and how to improve them for the benefit of non-musicians. The aim of this thesis is to provide design implications by looking into the design systematically from an academic perspective, hoping this academic work can concretely benefit the industry and the practitioners.

2.3.4 Musicking Mode: Composition and Improvisation

Composition and improvisation are the two most commonly discussed creative modes in traditional Western music theories [Sawyer, 2011]. These two musicking modes have distinct features and require different creative strategies, mental and physical skills. Composition is regarded as an iterative process of putting together musical elements, revising and storing them, whereas as improvisation is defined as a real-time performance process [Larson, 2005, Sawyer, 2011].

Compared to composition, the real-time pressure of improvisation requires

[6] http://studioamplify.com/noiz
[7] https://jammerapp.com

more reliance on automated activities without conscious attention, highly constrained music structures, and pre-existing familiar patterns in order to reduce decision-making tasks due to the limitations of conscious attention (ibid). Apart from the distinct creative strategies employed by the two musicking modes, another distinction is whether the creative process involves rational reflection and revision (composition) or instantaneous innovation (improvisation). There is no tolerance of mistakes in the output of composition. Therefore, revision of mistakes is indispensable for composition but not necessary for improvisation [Larson, 2005]. Consider the representative activities of improvising with an instrument in performance, and composing with audio software such as Logic Pro. When improvising with an instrument it is not possible to replay or to edit the previous creation. However, with software such as Logic Pro, users can replay and edit previous creations.

With the emergence of electronic and experimental musical techniques, the boundary between composition and improvisation began to blend [Holmes and Holmes, 2002]. In the context of electronic music, a more common form of performance is now regarded as *comprovisation*, a creative process of 'plan of action', in which improvisation is used as a precursor to composition in terms of generating musical ideas, extending existing structures, and the composed structures or instruments are widely used in an improvisational setting [Dudas, 2010]. The emerging musicking activities tend to incorporate composed material within an improvisational setting (ibid), allowing a compositional structure as well as the expressiveness of improvisation. An example would be live coding performances, which encourage improvisational creation using pre-composed sound materials and structures. It also involves activities such as reuse and revision of the previous records as a live production. Another slightly different example would be live performance using a launchpad or Ableton Push, with which a player can play and record the music ideas such as rhythms, patterns and combinations to one button, and replay or restore them when necessary. However, in this setting, there is no chance to edit the previous ideas.

The above literature discussed typical features of composition, improvisation, and comprovisation, for example, whether the process is in real-time or not, and whether the process allows to revisit or revise records. Although most of the current IMSs are designed with the real-time features of the mode of improvisation and comprovisation, it is not clear how the features of composition mode will affect non-musicians' approach to creative endeavours, especially when the study of CST suggest a mechanism of rich history keeping.

2.3.5 Music Creativity for Non-musicians

In this thesis, the term non-musicians is defined as *the group of people who are amateurs of musicking, taking part in music making for pleasure, not as a job* [8]*.* Compared to musicians, non-musicians may be interested in learning music but are inexperienced and with no intention to become professionals. Non-musicians are similar to novices, who are beginners to learn a job or an activity and have little or no experience or skill in it'[9]. Novices are opposed to the professionals, who are trained and skilled people with expertise to accomplish a job or an activity. In this thesis, the term novice is used to refer to beginners and amateurs who are inexperienced but with interest in an activity, not confined to the field of music.

Despite the fact that musicking has become an activity that is no longer monopolised by expert musicians, creating music seems to be an exclusive skill of professionals. Webster suggested four skills are essential for musical creativity to happen, most of which are developed in the early years and through years of practices: *musical aptitudes*, the ability to recognise tonal and rhythmic patterns and musical syntax; *conceptual understanding*, the knowledge facts that constitute the substance of music understanding; *craftsmanship*, the ability to apply factual knowledge in the service of the musical task; *aesthetic sensitivity*, the shaping of sound structures to capture the deepest levels of personal feeling [Webster, 1990]. He also proposed a model of creative thinking in music, starting from the productive intentions, followed by a thinking process of divergent thinking on the conditions of enabling skills discussed above and enabling conditions toward convergent thinking, and finally generate the creative product (ibid).

More studies have suggested the insufficiency of skills of non-musicians to achieve music creativity. For example, by drawing an expert-novice comparison in musical composition, Colley et al. suggested that the novices tended to concentrate on solving basic technical problems and were unable to pay much attention to the shape of the composition when they are creating [Colley et al., 1992]. Smith's work demonstrates that novices failed to perceive octave equivalence, and their ability to identify intervals and hierarchy is significantly weaker than experts do [Smith, 1997]. Weinburg's studies indicate that it is conceptually and technically difficult for them to create and develop their own musical ideas from scratch [Weinberg, 2003, Weinberg and Driscoll, 2005]. The above literature indicates that non-musicians are not capable of being creative while musicking in terms of taking care of the overall music structure, conceiving music ideas, or implementing ideas. These skills could be summarised as cognitive

[8] Amateur. In Cambridge dictionary. Retrieved from https://dictionary.cambridge.org
[9] Novice. In Cambridge dictionary. Retrieved from https://dictionary.cambridge.org

and physical skills. Here the cognitive skills refer to a set of cognitive skills in order to develop mental representations of music, which allow a person to plan and to reason about the potential outcome of actions, and thus to monitor the performance and learn from it [Ericsson, 1998, Davidson and Coulam, 2006]. The physical skills refer to the ability to articulate the music in mind and to express it onto the instrument (ibid).

Research in CSTs has suggested the potential of novices to be creative when they are supported appropriately to deal with the issues such as their lack of domain knowledge and expertise, lack of self-motivation and time commitment, as well as their fear of failures [Hewett, 2005, Reilly, 2008, Davis et al., 2013b]. Studies have found that novices might make fewer errors when they are given information about rule violations in digital filmmaking [Davis et al., 2013b], and novices will be better engaged when given the support to kick-start in digital painting [Benedetti et al., 2014]. Kim et al. argued that the current creativity tools intimidate novices with the risky experiments and lack of opportunities for novices to use failures for growth. They proposed designing for failure in creativity support tools by promoting the value of failure [Kim et al., 2015]. Based on the precursory works to support novices' creative acts in the other domains, this thesis set out to look at how to scaffold non-musicians' creative engagement on musicking activities.

2.3.6 Summary

There are three typical features for IMSs in the context of NIME, experience oriented, intuitive, and in real-time. Music creativity is difficult for non-musicians to achieve due to their lack of essential skills and confidence. However, it could be potentially achieved with appropriate support. Features of musicking modes might affect non-musicians' musicking process.

2.4 Design IMSs for Non-musicians

Through the various IMSs designed to facilitate non-musicians creative experience, a set of design implications have arisen from the evaluation and usage of them. These design implications include visual music interfaces, control metaphor, tangible user interface, and graphical score, which have informed the design of music interfaces used in this thesis.

2.4.1 Visual Music Interfaces

Integration of visual and audio is an inevitable trend in NIME designs. The attempts to relate sound and image has a long history since the pre-computational era. Levin offered an extensive introduction to this history by introducing the works from early practitioners such as Thomas Wilfred, Oskar Fischinger, or Charles Dockum [Levin, 2000], who produced abstract visual representations to visualise sound or to directly or physically generate and control sound since the 1920s.

Most recent IMSs that explore the correspondence between visual and music can be classified as music-to-visual, visual-to-music, or concurrent generation of visual and music [Momeni and Henry, 2006]. In the music-to-visual applications, parameters of music are analysed and extracted to synthesise or to manipulate visual. Examples could be real-time visualisation on sound [Ng, 2008]. In the visual-to-music applications, parameters of visual representations, e.g. position, size, are mapped to synthesise and manipulate music. Most of the screen-based interfaces belong to this category [Bryan-Kinns, 2004]. In the applications with a concurrent generation of visual and music, data collected from sources such as gestural-control, body motion, emotion from live audio, is mapped to synthesise visual and music simultaneously [Momeni and Henry, 2006, Johnston, 2013, van't Klooster and Collins, 2014]. Unlike the first two categories of works that represent a unidirectional relationship between visual and music, the final category of works represent a two-way relationship between visual and music [Momeni and Henry, 2006].

Accompanying music with visual representations, no matter in which form, can reinforce physical interaction by offering supplementary information and feedback on the player's interactions, as well as the system states and the audio output [Zadel and Scavone, 2006, Gómez et al., 2007, Wang, 2014]. The player's performance and engagement can also be reinforced with the concurrent visual and sound feedback. Improved performance when using a congruent visual mapping and higher engagement levels with congruent displays were observed for a memory task [Metatla et al., 2016]. Moreover, by offering an 'intrinsic link' between music and visuals, the system became dynamic and rich with potential to engage users more deeply [Momeni and Henry, 2006].

2.4.2 Graphical Score

One of the 'oldest and most common' means of relating sound to a graphical representation is musical scores [Levin, 2000]. Staff notation is one of the most traditional musical scores, with a long history which could be traced back to medieval times (ibid). Since the early decades of the twentieth century, the practice of experimental music has been encouraging new ways of producing sounds with non-pitched instruments. This has lead a growing interest on the design of *graphical score* as it can represent various new sound, music structure,

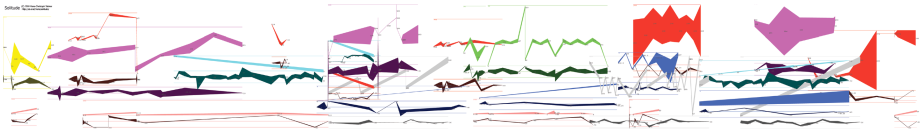

Figure 2.1: Christoph Steiner's Solitude (2004)

techniques, which can not be fully represented by the traditional staff notation [Walters, 1997, Auh and Walker, 2002, Rebelo, 2010].

In graphical scores, a series of 'idiosyncratic' or 'personal' visual representations are drawn to convey various dimensions of sound information needed for the piece to be performed [Levin, 2000]. There are generally two strategies to associate the graphics and music in the graphical score. One is *mapping* elements of graphics (e.g. position, colour, length, shape, size) to the music language (e.g. timbre, tonal, pitch, duration, or amplitude) over time. For example, dense graphics are mapped to dense musical texture, and graphical weight is mapped to musical dynamics [Rebelo, 2015]. Hans-Christoph Steiner's score for Solitude[10], see Figure 2.1, illustrated different lines in correspondence to different samples. The relative changes of the illustration shape was mapped to the intermixing and interplay of the sample melody and timbre. Another strategy is a more formalised and codified strategy that uses abstract symbols *coded* in a specific way to signify a series of musical events or written chords [Rebelo, 2015]. In Karlheinz Stockhausen's score for Plus-Minus (1963)[11], see Figure 2.2, each square represented a musical event, with a circle in the middle corresponding to one of the eight chords written separately [Walters, 1997].

Apart from the static graphical score, real-time graphical scores that change dynamically according to environment, algorithms, and audiences are designed for live music performances [Miyashita and Nishimoto, 2004, Magnusson, 2011, Lee and Freeman, 2013, Magnusson, 2014, Wu et al., 2017]. Unlike the traditional notations that are instructional and determine performers to recreate the composer's conceptualisation, graphical scores are often non-instructional and open for alternative improvisations during a performance [Rebelo, 2015]. A non-instructional graphical score conveys a relative change with an approximate value rather than specific or determined actions. Performers are encouraged to decide the actual music elements to be played while performing. Therefore most performers working with graphics consider themselves as improvisers (ibid). This dynamic feature of the graphical score is widely utilised in live music performances as a complementary support tool for improvisational play.

[10]https://at.or.at/hans/solitude/
[11]http://stockhausenspace.blogspot.com/2015/06/plus-minus.html

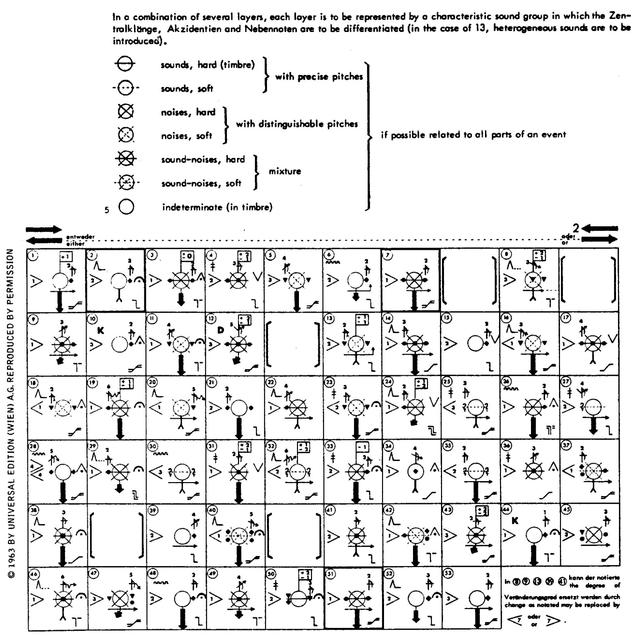

Figure 2.2: Karlheinz Stockhausen's Plus-Minus (1963)

Similar to the discussion that visual stimuli can help to overcome the fixation problem in the creative process, discussed in Section 2.2.5, the graphical score also has the potential to inspire people while creating music. Walker suggested that the graphical notation is a unrestricted tool for both musically trained and inexperienced people to create and to compose music, with superior effect in subjects who have limited formal musical training and experience [Walker, 1987]. Early in 1944, Willmann's experiment indicated that the creation of musical themes is influenced by the visual stimuli used by the composers, with both abstract graphics and other visual objects [Willmann, 1944]. Studies exploring the effect of graphical notations and staff notations on music creativity suggested that the use of graphic notations would make a significant difference in students' creativity when composing [Auh and Walker, 1999, Auh, 2000]. Graphical notations have the potential to promote more diverse compositional strategies, which result in higher musical creativity when composing (ibid). A later study conducted by the same authors found that students scored significantly higher in creativity when they were using graphical scores that focused on structure than when using graphical scores that focused on sonic elements [Auh and Walker, 2002]. This implied that structural graphical score has more potential to trigger creativity (ibid).

2.4.3 Benefits of Metaphor

The metaphor is an important and common visual communication tool in user interface design, through which the abstract operations or functionalities of an interface are represented by widely understood frameworks of concepts [Neale and Carroll, 1997]. Some classical examples of the usage of metaphors are the concept of ‘desktop’, ‘windows’, ‘folder’, and ‘menu’ in computer operating systems. There are three general types of metaphors in HCI design: *activity metaphors* refers to the user’s highest level of goals, for example, the user’s goal is playing a game or communicating with others; *mode of interaction metaphors* has four sub-categories, conversation, declaration, model-world, and collaborative manipulation. They determine the understanding of the fundamental nature of the interaction with the computer, i.e. a conversational partner or a toolbox; *task domain metaphors* define the object and its operations, providing the user with a structure for understanding the nature of the tasks presented by the computer. For example people can add, delete, remove on a ‘file’ metaphor [Hutchins, 1987]. This thesis is mostly concerned with task domain metaphors because the activity metaphors and mode of interaction metaphors for IMSs are quite obvious. Whereas in terms of task domain metaphors, its effects on users’ creative engagement remain unclear.

By linking the technical and complex software concepts with the user’s everyday world concepts, a metaphor helps users by using their prior knowledge and experience to understand computers and to build an appropriate mental model. It helps to control the complexity of an interface and thus provides a direct and intuitive interface for users to complete tasks [Neale and Carroll, 1997, Blackwell, 2006]. Apart from the practical benefits, Blackwell maintained that a metaphor has the potential to offer creative experience to the users as it can initiate users’ creative sense-making and interpretation [Blackwell, 2006]. Waite proposed the use of real-world metaphors in music systems to increase audience engagement and summarised several advantages [Waite, 2016]:

- Offering a shared mental model of the system between system designer, performer and audience.
- Facilitating simple, intuitive mappings between input interactions and system sound output.
- Promoting audience perceptions of liveness.
- Increasing audience engagement.

2.4.4 Control Metaphors

Control metaphors are the task domain metaphors that define operations and interactions of an interface mentioned in the previous section. Levin summarised three existing principal control metaphors in the field of visually-orchestrated computer music and added another one based on his own practices [Levin, 2000, Franco et al., 2004]. These four control metaphors that are closely related to computer graphics and electronic music, i.e. timelines and diagrams, control-panel displays, reactive widgets and painterly interface, are described in the following.

Timelines and diagrams

Timelines and diagrams display musical information with visual representations on a two-dimensional timeline, following the form that is similar to the standard music notation score display or digitised sound waveforms [Franco et al., 2004]. These are the most traditional and common forms of music representations. In timeline and diagram systems, the visual is generated as a real-time representation of the sound rather than directing how the music should be produced.

Control-panel displays

The control panel displays mimic the physical controllers in analogue synthesisers [Franco et al., 2004]. However, the direct replication of the complex synthesiser interface fails to bring the superiority of visual into full play and carries the problems of physical synthesisers into the graphical user interface (ibid). For example, the mappings from knobs to underlying sound parameters are far too complex for users to learn and remember [Levin, 2000].

Reactive widgets

In interfaces that follow the metaphor of reactive widgets, virtual objects are designed to manipulate or to modify sound parameters [Franco et al., 2004]. Compared to the control-panel displays, the reactive widgets are more flexible and intuitive. However, due to the limited granularity of control, such systems might easily restrict users from performing exhaustible music [Levin, 2000].

Painterly Interfaces

The painterly interfaces use drawings or free-form images from gestural interactions to generate or control sound [Levin, 2000]. They propose to employ a multimodal interface to create and perform dynamic visuals and sounds simultaneously in real-time [Jordà, 2003]. They usually map the parameter of the input drawing or gestures, i.e. length, colour or curves, with the sound parameters such as the pitch, volume or beat. Practices in NIME have presented a spectrum of intuitive interfaces that employ the freehand drawing as an input method, and at the same time the visual outcome of the drawing as an output of actions [Levin, 2000, Ryokai et al., 2004, Franco et al., 2004, Zadel and Scavone, 2006, Knörig et al., 2007, Garcia et al., 2011, Thiebaut et al., 2008, Diao et al., 2014, Barbosa et al., 2013, Houix et al., 2016].

Drawing is an intuitive and dynamic interaction that everyone is capable of learning and practising, and is regarded as 'instantly knowable, indefinitely masterable' [Levin, 2000]. Compared to the reactive widgets, the painterly interfaces have richer and more dynamic interaction, which combines visual and sound in a structured way (ibid). Moreover, from the perspective of creativity, sketching is an important tool for creative activities in different domains as it offers a way for pictorial reasoning [Goldschmidt, 1991]. Previous researches on composers' creative process have shown that sketch is commonly used to formulate initial music ideas as well [Thiebaut et al., 2008]. Moreover, sketches in music programs offer a certain degree of ambiguity or vagueness that supports the exploration of musical structures (ibid). Therefore the painterly interfaces have the potential to support non-musicians to explore sounds creatively and expressively [Knörig et al., 2007], and may offer them the chance to experience creative flow [Levin, 2000].

2.4.5 Tangible Musical Interfaces

Unlike Graphic User Interfaces (GUIs) that represent information in the form of pixels on two-dimensional displays, Tangible User Interfaces (TUIs) give 'physical forms to digital information' [Ishii, 2008]. Built upon the theories of embodiment, that peoples' being, living, feeling, bodily entities are situated in a physical world, TUIs are proposed as a promising approach to better engage users by utilising haptic interaction skills, as opposed to GUIs that place little emphasis on the differential abilities of the human body (ibid). TUIs have been widely explored in the various domains [Shaer et al., 2010], e.g. education and learning [Fjeld et al., 2007], problem-solving and planning, information visualisation, tangible programming, entertainment, play and edutainment, music and performance, social communication [Farr et al., 2010], tangible reminders and tags.

Music applications are one of the oldest and most popular areas for applying TUIs [Shaer et al., 2010]. In NIME, TUIs have been applied to control or to represent music parameters. Ways to achieve these designs include using portable devices to detect continuous motion or gestural data [Weinberg and

Gan, 2001, Sheridan and Bryan-Kinns, 2008], using tabletop systems for players to arrange and to manipulate a set of musical objects [Jordà et al., 2007, Xambó et al., 2013a], or using an instrument metaphor for players to control the music parameters directly with the interface [Bengler and Bryan-Kinns, 2013, Zappi and McPherson, 2014]. Shaer and Hornecker summarised four high-level approaches for TUI music applications, namely *instruments* that generate or synthesise sound, *sequencer* that mix and play audio samples, *sound toys* that are with limited user control, and *controllers* that remotely control an arbitrary synthesiser [Shaer et al., 2010].

For music performance, TUI has its superiority as compared to GUI support in supporting collaboration and sharing of control, in supporting continuous, real-time interaction with multidimensional data, and in supporting complex, skilled, expressive, and explorative interaction [Shaer et al., 2010]. It is a paradigm of design that can better engage non-musicians intuitively and creatively as it provides direct interaction with physical objects [Xambó, 2017], it offers haptic feedback and is easy to learn for everyone by utilising people's 'sophisticated skills for sensing and manipulating physical environment' [Ishii, 2008].

2.4.6 Summary

To summarise, combining visual and sound in NIME reinforces interaction feedback and provides dynamic and rich interfaces. The graphical score has the potential to offer inspirations in a creative process. Embedding metaphors in interfaces is beneficial in supporting creative experience and deeper engagement. Among the four control metaphors in the design of IMSs, the painterly interface is the potential design paradigm to support non-musicians' creative engagement with musical interfaces. Tangible music interfaces are intuitive for engaging non-musicians.

Chapter 3

Methodology Approach for Evaluation

This chapter describes the methodology approach for evaluation. It starts with a reflective review of the background, trends and methods of evaluation in HCI in relation to the topics discussed in the previous chapter, e.g. experience, engagement, CST, and NIME. Practical issues of these methods and implications for evaluation are discussed. Drawing on this background, the rationales of the evaluation approaches used in this thesis are presented, followed by a description of the methods applied.

3.1 Evaluating Experience

Evaluation is vital in the field of HCI as it offers feedback on the quality of an interface and informs later improvement on it. Traditional evaluation research has been concerned with use-case scenarios that focus on the usability, efficiency and effectiveness of the system for users to perform tasks. Various theories and methods were produced from this perspective. For instance, task analysis model was proposed for evaluating the usability of a systems [Hackos and Redish, 1998], and the GOMS models were proposed for evaluating the efficiency of a system by predicting the time a user needs to complete a task [John and Kieras, 1996].

Recently, there is a shift in the focus of HCI studies from task-oriented towards experience oriented, described as the third wave or paradigm of HCI, as discussed in Section 2.1.1. Evaluation of the user experience with the interactive system has become a prominent topic within HCI [Lubart, 2005]. The focus of the evaluation is therefore related to experience aspects such as fun, pleasure, goodness, beauty, social dynamics. For example, the focus of evaluation in interactive arts has shifted from determining whether an author's intention was successfully communicated to the audiences, to identifying, coordinating, simulating, and analysing the process of interpretation and experience in practice [Johnston, 2014].

Methodologies for the evaluation of the experience are well established. A comprehensive review of the methodologies used to collect data regarding the user experience with an interactive system was provided by [Bargas-Avila and Hornbæk, 2011]. The list includes questionnaires, open or semi-structured interviews, live user observation, video recordings, focus groups, diaries and probes, collage or drawings photographs, body movements, psychophysiological measures, and other methods (e.g. think aloud, personal meaning maps) (ibid). The questionnaire, interview or focus group are usually used to collect users' retrospective self-report data on their experience [Consolvo and Walker, 2003, Jennett et al., 2008, Koeffel et al., 2010]. Physical interactions data (e.g. mouse clicks, eye tracking [Jennett et al., 2008]) and physiological data (e.g. galvanic skin response, heart rate, EMG [Mandryk and Inkpen, 2004, Yao et al., 2014]) are collected as concurrent objective behavioural data during the interaction. Diaries and probes, collage or drawings photographs, contextual inquiry and observations [Blandford, 2013] are typical methods used to understand the user experience from an objective perspective.

Data collected in qualitative format (e.g. text, graphs) are usually analysed with qualitative analytic methods, e.g. grounded theory, discourse analysis, and thematic analysis. These methods seek to organise and reduce the gathered data and to construct a systematic understanding of it [Walker and Myrick, 2006]. The methods usually involve iterative, inductive or reductive coding processes in which the data are broken down, compared and categorised based on similarity [Walker and Myrick, 2006, Stowell et al., 2008, Braun and Clarke, 2006]. With the categories and themes, essences can be extracted and constructed, from which descriptions, models, and theories can be built (ibid). Quantitative data are usually analysed with statistical analytic methods to compare the difference between conditions and find the correlation between variables. A common problem in applying qualitative methods to evaluate experience is that some are developed and applied with unclear validity, for example using self-developed questionnaires without providing items or statistical validations [Bargas-Avila and Hornbæk, 2011].

3.2 Evaluating Engagement

User engagement is an important indicator of the quality of experience provided by an interactive system [Jacques, 1995]. However, there is a difficulty to measure engagement directly as it is a subjective, abstract, multi-level and intangible experience [O'brien and MacLean, 2009, Hung and Parsons, 2017]. The approaches to evaluate or measure engagement are mainly distributed into two categories (qualitative approach and quantitative approach) as discussed below.

3.2.1 Qualitative Approach

In papers on evaluating engagement [Rozendaal et al., 2007, Bilda et al., 2008, Brockmyer et al., 2009, O'Brien, 2010, Bengler and Bryan-Kinns, 2013, Bryan-Kinns, 2013, Radbourne et al., 2013, Hung and Parsons, 2017], retrospective self-report on the interaction process is the mostly adopted approach to collect the users' subjective feedback on their engagement experience. There are mainly two approaches to collect the users' retrospective self-report, questionnaire and interview.

Questionnaire

Questionnaires are widely used in the evaluation of different interactive systems, e.g. websites, games, interactive arts and performing arts [Brockmyer et al., 2009, O'Brien and Toms, 2010, Bryan-Kinns, 2013, Radbourne et al., 2013]. Within these questionnaires, the questions are usually designed based on the attributes of engagement. Chapman proposed to measure engagement according to the attributes of engagement such as attention focus, curiosity and intrinsic interest [Chapman, 1997, Chapman et al., 1999]. Brockmyer et al. developed the game engagement questionnaire based on the factors of absorption, flow attributes, presence, and immersion [Brockmyer et al., 2009]. Later on, O'Brien et al. identified six attributes of engagement and proposed a set of statements [O'Brien and Toms, 2010]. The six attributes include perceived usability, aesthetics, focused attention, felt involvement, novelty, and endurability. Bryan-Kinns developed a mutual engagement questionnaire based on four factors: satisfaction with the product; feelings of enjoyment or flow; sense of collaboration; usability [Bryan-Kinns, 2013]. Radbourne et al. suggested to measure arts audience engagement based on four indicators: knowledge transfer or learning, risk management, authenticity and collective engagement [Radbourne et al., 2013]. The attributes of engagement provide an instrumental tool for developing questionnaires to evaluate engagement with all aspects of engagement considered and measured.

In terms of the form of questionnaires, the index-based questionnaire is commonly used [Brockmyer et al., 2009, Radbourne et al., 2013, Hung and Parsons, 2017]. It involves a set of statements for users to rate their agreement based on a

Likert Scale from 1 to 7, where 1 is low agreement and 7 is high agreement. The rating from the users is used to quantify the score for the interactive engagement experience. The benefits of such an index-based questionnaire are that with the rating data from participants it is easy to conduct a quantitative statistical analysis. Therefore the questionnaire helps to generate comparative conclusions in relation to the features of the system design. However, one possible pitfall of using Likert scale is that participants' choices might not be explicitly different between compared conditions. Thus there might not be enough findings from the questionnaire.

A comparable questionnaire, forcing participants to choose one from the comparable conditions that is most suitable to the question, is optimal to solve the problem of index-based questionnaire [Bryan-Kinns, 2013]. The possible disadvantage of this questionnaire is that it needs to be done after all conditions finished and the results will be strongly influenced by the sequence of playing. Moreover, the questions might be too constrained for participants to answer as it compels participants to choose from the limited choices.

Interview

Post-task interviews are commonly used to obtain user's subjective feedback on engagement with an interactive system [Haywood and Cairns, 2006]. Unlike text-based questionnaires, interviews take the form of a conversation where the investigator asks questions and the participant replies orally [Blandford, 2013]. There are structured, semi-structured and open interviews. The difference between the three forms of interviews depends on whether the interview follows a schedule of pre-prepared questions. However, the more structured an interview is, the less likely that a participant will be flexible to reveal important and relevant issues, the easier for analysis afterwards [Adams and Cox, 2008]. Therefore it is a tradeoff to consider whether to employ a structured interview for collecting data. Due to the flexibility of oral communication, the data collected from interviews is more detailed, thorough and informative compared to questionnaire [Adams and Cox, 2008]. However, it is also more time-consuming in terms of the preparation and the analysis process for transcribing and coding the data (ibid). Qualitative analysis methods such as discourse analysis, thematic analysis and grounded theory can be used to build a structured understanding based on the qualitative interview data [Stowell et al., 2009].

Ethnographic Approach

Apart from the retrospective self-report data, ethnographic approaches such as observation and video analysis are also used to understand the user's interaction. The ethnographic approaches help to extract an overview of the forms of interaction and the structures of an interaction process, especially when the study is conducted in a natural context and involves social dynamics of multiple users [Heath and Vom Lehn, 2008, Hornecker, 2008, Bengler and Bryan-Kinns, 2013]. Candy summarised the main current qualitative approaches for evaluating interactive art on account of three scenarios: ethnographic methods in a real-world setting, video-cued recall method in eliciting audience response to experience, and post-experience interviews as a strategy for reflective practice [Candy, 2014]. For example, the observation helped to understand how participants acknowledge, mirror, transform or complement each other's contribution or actions in collaborative music making [Bryan-Kinns et al., 2007]. However, the drawback of this method is that it takes tremendous time for analysis [Block et al., 2015].

3.2.2 Quantitative Approach

Early attempts measured engagement solely on the basis of physical interactions, for example, the occurrences of touch gestures or the time spent watching the screen [Fisher et al., 1975], or the frequency of physical and verbal behaviours [Leinhardt and Crowley, 1998]. To quantify group engagement in real scenarios, methods such as counting the dwell time or holding time of visitors [Horn et al., 2012], analysing the group factors that might influence the group engagement in museums, e.g. group size and age composition [Diamond, 1986, Borun et al., 1997] are developed. Block et al. compared the effect of observational techniques on visitors' engagement, and argued that consented video analysis do not necessarily reflect visitor behaviour in a natural context such as public museums [Block et al., 2015]. They developed a coding scheme for social engagement based on a set of nine social engagement behaviours, based on which they are able to use algorithms to identify natural groups of visitors and to quantify their engagement with the interactive system. Such attempts have illuminated the potential of using objective measures to quantify the user's engagement.

Recent practices have shown the benefits of using a combination of qualitative and quantitative approaches for the evaluation of engagement. For example Bryan-Kinns examined the effect of shared representations on mutual engagement by analysing participants' interaction log data as well as interview and questionnaire feedback [Bryan-Kinns, 2013]. Objective measures of individual activity (e.g. musical activity and collaborative activity) were developed to find evidence with statistical analysis with the interaction log data. The subjective data collected from the questionnaire and open interview helped to explain the reasons behind the behaviours (ibid).

The benefit of quantitative approaches is that they have the potential to analyse data in large scale while manual in-depth qualitative analysis by researchers are incredibly time-consuming [Bryan-Kinns et al., 2007, Block et al., 2015]. More importantly, such approaches offer potential objective evidence to evaluate engagement rather than merely subjective self-reporting (ibid).

3.3 Evaluating Creativity Support Tools

It is challenging to measure how well a tool supports creativity because there were no obvious metrics to quantify creativity [Shneiderman, 2007, Cherry and Latulipe, 2014], unlike the evaluation of productivity support tools, in which performance, time, and error rate could be used as standardised measures.

A frequently used approach to evaluate CST was to invite a third party, either experts or crowdsourced raters, to rate the creative output mediated by the CST according to a set of criteria, which were usually drawn from factors of creativity [Kerne et al., 2014]. These criteria include *fluency*, the total number of ideas generated, *flexibility/variety*, the number of categories of ideas generated, *novelty*, the rareness of an idea, and the *quality* of an idea (ibid). For example, Dow et al. measured the variety of graphics created by study participants by posting them as web ads and measure click-through by the crowdsourced workers [Dow et al., 2012]. Kerne et al. suggested a combination of two metrics to evaluate information-based ideation. One of the two metrics was an elemental ideation metrics that evaluate creativity within the objects that people find and curate, based on the criteria discussed above. The other metrics was a holistic ideation metrics that evaluate how elements are put together based on four criteria, including *emergence, relevance, visual presentation and exposition* [Kerne et al., 2014]. However, the risk of having a third party to evaluate the creative output is the lack of consistency among judges. To justify the validity of the result, the inter-rater reliability needs to be calculated to measure the consistency of the ratings (ibid).

Another approach to evaluate CST followed a self-assessment tradition from the user's perspective. For example, Creativity Support Index (CSI) was proposed as a psychometric questionnaire to quantify the ability of a CST in assisting a user's creative process [Carroll et al., 2009, Carroll, 2013, Cherry and Latulipe, 2014]. Users rate their agreement on the statements developed based on some of the factors that are essential to a successful creative process, including collaboration, enjoyment, exploration, expressiveness, immersion and results worth effort (ibid). The advantages and disadvantages of the index-based questionnaire have been discussed in Section 3.2.1.

Some evaluation approaches were based on the user's behavioural data, offering objective metrics of measurement. For example, to compare the effect of a tangible and graphical user interface on creative collaboration, Kim and Maher conducted observations on designers' behaviour to look for behaviour patterns [Kim and Maher, 2005]. Similarly, Tripathi and Burleson used sensors and electronic to collect data of team members' movement and face-to-face interactions to report and to predict team creativity in the wild [Tripathi and Burleson, 2012]. Based on a critical overview on the strengths and weaknesses of the variety of behavioural science research methods used to study creativity, including psychometric methods, experimental methods, biographical methods, biological methods, computational methods and contextual methods, Mayer highlighted the importance of employing mixed methods for evaluating and studying CST, e.g. combining qualitative and quantitative methods, and argued for a richer suite of evaluation instruments [Mayer, 1999, Hewett et al., 2005]. According to him, whilst quantitative methods form the basis of evaluation on CST in terms of the performance and efficiency, qualitative methods reveal the user's needs and help explain *why* they do what they do.

3.4 Evaluating NIME

Evaluation has been a key topic in NIME research [Barbosa et al., 2015]. Early attempts applied simple quantifiable tests to evaluate the performance of musical input devices, following a task-oriented approach in HCI [Wanderley and Orio, 2002]. The narrow focus on task was gradually broadened over time. Recently richer and more open methods were adopted to evaluate the interactive music systems, which is similar to the trend of evaluation on CSTs as discussed in Section 3.3. According to a meta-analysis of NIME proceedings from 2012 to 2014, there is a mixture of subjective and objective evaluation criteria and a mixture of qualitative and quantitative approaches to evaluation [Barbosa et al., 2015]. Quantitative methods were more commonly used to test the system from the designer's perspective, for example, whether the task is performed effectively. Qualitative methods (e.g. questionnaire and interviews) were more commonly used to evaluate the system from the user's perspective to understand the users' experience (ibid).

Similar to practices presented in Section 3.3, evaluation of NIME also combine qualitative and quantitative analysis methods because qualitative methods help to extract participants' subjective feedback, and quantitative methods help to address the objective analysis of participants' behaviour [Stowell et al., 2009, Bryan-Kinns, 2013, Bengler and Bryan-Kinns, 2013]. Stowell et al. compared and contrasted a qualitative method based on discourse analysis, and a quantitative method based on the Turing Test to evaluate the music-making interaction [Stowell et al., 2009]. According to them, discourse analysis helped to extract a detailed reconstruction of the users' understanding of a system, and a turning test offered quantitative results on whether a system provides an interactive experience similar to that provided by a human. To identify the unique design challenges and opportunities, Tanaka et al. used a survey method combined with qualitative thematic analysis to investigate how people use mobiles musically [Tanaka et al., 2012].

Factors such as timing for data collection also need to be considered when evaluating NIME. Stowell and Alex proposed *retrospective protocols* is better than *concurrent protocols* because real-time data collection (e.g. think-aloud approach) could take the risk of distracting the creative process and may also be disrupted by the movement of music-making activities [Stowell and McLean, 2013]. Discourse analysis was proposed for a detailed analysis of the retrospective interview transcripts to extract a structured understanding (ibid).

Moreover, the scenario is another prominent factor in the choice of the evaluation methods in NIME. Whether the system is intended for solo interactions or group interactions [Bryan-Kinns et al., 2007], or whether the context of the interaction is in the lab, in the wild [Block et al., 2015], or in telepresence [Bryan-Kinns, 2004] will influence the interactive experience and the choice of data collection. As discussed earlier in Section 3.2.1, for interactions that involve social dynamics or for studies that are conducted in the wild, the ethnographic approach are considered most suitable. Anna et al. applied video analysis for evaluating musical tabletops in collaborative settings because they found current lab-based methods failed to take social aspects into consideration, which are fundamental for a successful music performance [Xambó et al., 2013b].

3.5 Evaluating Creative Engagement

Based on the broader perspective of evaluation, the framework for evaluating creative engagement in this thesis is introduced in the following sections. The first section discusses the rationale for conducting a controlled lab-based experiment with a mixed-methods approach, and the rationale for conducting an exploratory oriented interaction log analysis. The second section discusses in more details on the data collection methods and analysis methods used in this thesis.

3.5.1 Rationale for Controlled Lab Experiment

Some studies have proposed to conduct the evaluation of interactive systems in the real-world context as users' interactions are notably influenced by the accompanying social dynamics [Marshall et al., 2011, Rogers et al., 2013, Bengler and Bryan-Kinns, 2013]. For example, new ways of collaborative working with multi-touch tabletops discovered from an in-the-wild study, were different from previous discoveries in lab settings [Marshall et al., 2011]. Most of these works were targeting multiple users in a single interaction, in which social interaction took place. Therefore evaluation in-the-wild is appropriate for studies that involve multi-users as in lab it is difficult to replicate the social dynamics from a real context. As the focus of this thesis is on individual non-musician's creative process and experience, the influence of social dynamics is not the primary concern on the creative engagement.

The decision to conduct controlled lab experiments is also motivated by the research goal to explore the effects of different factors on novices' creative engagement as discussed in Chapter 1. Although it is beneficial to get a large number of users to interact in a short period, data collected in the real-environment is less informative as the users are easily distracted by the environment, and are less prepared to give in-depth feedback. Questionnaires used in these studies are usually designed to be short and easy to fill in. Moreover, it is also more challenging to conduct comparative studies in the real-environment context. Contrary to this, lab-based experimental methods can ensure a systematic data collection process and enable researchers to effectively draw conclusions from the result of a manipulation [Mayer, 1999, Hewett et al., 2005]. Therefore for the research goal, the studies in this thesis follow a convention of controlled lab experiments.

3.5.2 Rationale for Mixed-Method Approach

As discussed in the previous sections, there is a trend of using the mixed-methods approach to evaluate engagement, CST, and NIME. The mixed-method approach adopted in this thesis involves a mixed data collection. Three types of data were collected in the studies, namely questionnaire data, interview data and interaction log data. These data covered a spectrum of subjective data and objective data, retrospective data and concurrent data, qualitative data and quantitative data. The mixed data collection led to the choice of mixed analysis methods, including both qualitative analysis and quantitative analysis methods. Below explains the choice of the data collection.

Candy and Bilda proposed two indicators for assessing creative engagement in the context of interactive art [Candy and Bilda, 2009]. One is the conceptual change when there is a shift in the participant's intentionality and expectation with the system. The other is the behavioural change, which is often observed before and after an unexpected change in the system (ibid). According to them, the observed behavioural change needs to be confirmed with the participant's retrospective reports. Observation on participant's behaviour and analysis of participant's feedback are necessary to find the confirmation between the two sets of data. However, the analysis demands a considerable amount of works on data interpretation, and also bring a risk of missing points due to the not all-inclusive interview, especially when the interaction process is lengthy. Moreover, differed from the context of interactive art, where the audience's behavioural change is usually caused by the unexpected change of the system, in the context of playing with musical interfaces the participants' behavioural change is usually initiated by the participants themselves. Therefore it is difficult to distinguish the participant's behaviour change via observation. In order to provide evidence on the research goal to investigate the effects of various factors on novices' creative engagement, questionnaire approach was chosen to probe participants' perceived level of creative engagement. By comparing the ratings on subjective experience in the manipulated conditions, the results can offer direct evidence to support or reject the hypothesis on the effects of the compared conditions on novices' creative engagement.

Apart from the questionnaire data, there is a need for a more in-depth subjective data due to two reasons. Firstly, the drawback of controlled lab experiments is that the control of the comparison variables reduces the generalisability of one's conclusions [Hewett et al., 2005]. It is not easy to reflect the reason for the results, and thus it is difficult to expand the conclusions into a broader context of research. Secondly, the research goal to develop a descriptive understanding of novices' creative engagement also requires more informative data on the interactive process as well as the subjective experience. Qualitative methods such as in-situ observations and semi-structured interviews enable researchers to gain a deep understanding of the needs, making it possible to draw explanations to the results [Stowell et al., 2009]. Moreover, they allow researchers to collect a rich data set in a relatively short period (ibid).

Whilst retrospective data collection is good without distracting participant from the creative process [Stowell et al., 2009], it might be difficult to relate the retrospective feedback to the interaction process as it is not collected concurrently during the process. The analysis of interaction log data is capable of providing a complementary objective data to inform the study of the interaction process and to improve the validity of findings [Hornecker and Stifter, 2006, Crabtree et al., 2012].

3.5.3 Rationale for Interaction Log Analysis

Some practices utilise the interaction log data to inform the qualitative interpretation of the interaction process by visualising user interactions [Bryan-Kinns, 2013, Brown et al., 2014, Wang et al., 2016]. For example, the visualisation of interaction shows a visual trace of the entire pointer movements for each group [Bryan-Kinns, 2013]. Visually inspecting this figure confirms the quantitative analysis of the interaction (ibid). By visualising the transitions between viewpoints seen by participants, it is possible to detect strategies employed by different groups of participants and infer aspects of their personality factors [Brown et al., 2014].

The behavioural data, i.e. eye tracking, click stream, text, are used to identify significant surfing paths of websites in order to predict the usability of websites design [Chi et al., 2000], to predict user's task performance and the difficulty of the task, and to infer some user cognitive traits such as personality, perceptual speed and visual working memory [Brown et al., 2014], or to cluster user behaviours or interests to understand the dominating user behaviours of system [Wang et al., 2016]. The mere quantitative analysis of behavioural data such as activity counts, task accuracy, completion time, etc, does not give enough validity to evaluate the connections between actions and the rationale behind, especially when the research question comes to the topics that are not suitable to be evaluated purely based on quantitative measures, e.g. strategies, participation, exploring and reasoning process, insights.

The analysis of behavioural data provides informative and objective evidence to help researchers and designers to understand the user's interaction as well as to evaluate the design of the systems [Jennett et al., 2008, Wang et al., 2016]. This behavioural data-driven approach can overcome the limitations of the user-centred approach, e.g. user studies are limited in scale, questionnaires rely on known questions or hypotheses, and participants are not able to self-identify their experience [Wang et al., 2016].

Studies have combined the analysis of qualitative data with quantitative interaction log data in order to better inform more complicated or more abstract topics of an interaction process. For example, methods such as Complementary Explorative Data analysis were proposed to combine quantitative methods to extract reliable behavioural patterns and evidence with qualitative methods to understand the essence of phenomena [Sudweeks and Simoff, 1999, Simoff and Maher, 2000]. Dou et al. collected users' interaction video, think-aloud data as well as self-reported reasoning and thinking process data to evaluate the accuracy of analysis of their interaction log data [Dou et al., 2009]. Reda et al. used codings for interactions and mental process to explore the differences of exploratory behaviours of users with comparable interfaces [Reda et al., 2014]. They instructed and trained participants with the think-aloud approach to gain real-time subjective descriptions on their cognitive process and applied coding schemes on verbal protocol. An extended interaction process could be developed based on the analysis of the interaction data and user-reported cognitive process, and based on analysis of the transitions between cognitive and interaction states. Guo et al. applied a similar approach, combining both qualitative and quantitative data to explore how analysts arrive at insights with visualisation system [Guo et al., 2016]. They extracted sequences of consecutive actions patterns that occur frequently and developed the transition matrix for patterns based on qualitative analysis. This study demonstrated a method of correlating self-reported insights and usage histories in a systematic way (ibid). The combination of qualitative data and interaction data can significantly inform the study of technology-mediated activities by providing additional insights into participants' interactions and improving the validity of findings [Hornecker and Stifter, 2006, Crabtree et al., 2012].

Apart from combining the different methods, some studies analysed the interaction log data from two perspectives. Simoff and Maher analysed levels of participation in collaborative interactions by analysing the text transcripts from the seminar discussions [Simoff and Maher, 2000]. Their analysis combined the *activity analysis* on the count of different activities with the *content analysis* on the thematic keywords and their co-occurrence. With the two parts of the analysis, they were able to reveal the level of the users' participation through the quantitative activity analysis, as well as the relations of the topics through the qualitative content analysis. Likewise, to identify the role of shared annotation on mutual engagement in collaborative music making, the analysis was carried out on both participants' *activities* with the user interface (i.e. mouse pointer movement, click, and drag) and *content* analysis with a coding scheme to categorise the topics of textual and graphical communication between participants (i.e. system related, presence and identity, quality judgement, task organisation, social) [Bryan-Kinns, 2013]. The above practices offered potential directions for the analysis of interaction log data in this thesis.

Because not much work has been done before on creative engagement, this thesis conducted an exploratory analysis of interaction log data to find potential objective evidence to inform the essence of non-musicians' creative engagement. Correlation analysis to connect the interactive log analysis and the subjective feedback were conducted to explore potential evaluation methods to be used on creative engagement.

3.5.4 Description of Methods Used

The main approaches for data collection and the corresponding analysis methods used in this thesis are introduced in the following sections.

Questionnaire

The choice of questionnaire was motivated by the existing practices to extract subjective experience, as discussed in Section 3.2.1 and 3.3. Questionnaires used in this thesis were improved and modified according to the research question of each study. The questionnaire in Study I asked questions only about learnability and creativity. The narrow focus did not provide enough information on the user's creative engagement.

To investigate participants' feedback on more specific aspects of creative engagement, a set of potential factors were extracted based on the attributes for user engagement [O'Brien and Toms, 2008, 2010] and the factors that were used to evaluate CST [Carroll et al., 2009, Carroll, 2013]. These two sets of factors were chosen because creative engagement possesses features of both engagement and creative activities, specifically it indicates when the participant is engaged in a creative process and activities. Engagement was defined as a quality of user experience that is comprised of factors such as *focused attention, perceived usability, endurability, novelty, aesthetics, and felt involvement* [O'Brien and Toms, 2010]. The factors to evaluate CST include *results worth effort, expressiveness, exploration, immersion, enjoyment, and collaboration* [Carroll et al., 2009].

The above factors were combined and merged into a single set of factors, from which the statements in the index-based questionnaires used for Study II and III were designed to evaluate the level of creative engagement, as discussed in Section 3.2.1 and 3.3. By giving a set of statements in relation to the factors of creative engagement and by asking participants to rate their agreement on a 7 points Likert scale, the questionnaire was able to collect more precise data on the subjects' perceived level of creative engagement. The factors for creative engagement included *Interest, Aesthetics, Learnability, Feedback, Structure Composition, Plan Ahead, Enjoyment, Exploration, Expressiveness, Challenge, Control, Focused Attention, Results Worth Effort.* As this thesis is focusing on the individual creative process rather than on the collaborative process, the list excluded the factor that addresses collaboration. Table 3.1 illustrates the factors, definition and source of the factor.

In order to extract more explicit preference between the conditions, a comparable questionnaire is developed based on a set of factors of creative engagement, as discussed in Section 3.2.1. Participants were forced to choose one from the

Factors	Definition	Source
Interest	User's interest in the prototype or task	Engagement
Aesthetics	Perceived visual beauty	Engagement
Feedback	System response according to interaction	Engagement
Challenge	The amount of effort put in interaction	Engagement
Control	How in charge user feels in interaction	Engagement
Focused Attention	The concentration on the task	Both E&C
Enjoyment	Perceived pleasingness	Creativity
Exploration	The easiness of explore new ideas	Creativity
Expressiveness	The ability to perform various outcomes	Creativity
Results Worth Effort	Perceive value of the result	Creativity

Table 3.1: Factors of Creative Engagement

Please choose an appropriate condition to the following statements:
(1)Enjoyment: I enjoyed my self most;
(2)Exploration: I explored more music ideas;
(3)Expressiveness: I felt I was more expressive;
(4)Challenge: The interface was frustrating;
(5)Creativity: I felt more creative with;
(6)Results worth effort: I felt more satisfied with the result.

Table 3.2: Questionnaire for Comparable Conditions

two conditions that are most appropriate to the statements. The compulsive choice between the conditions avoids the possible pitfall of the Likert scale questionnaire that the participants may not give explicit choices on their preference as they may not be able to self-identify their preference [Wang et al., 2016]. To control the volume of the questionnaire, the six most important factors of creative engagement were chosen for this questionnaire, see Table 3.2.

The questionnaire data is analysed statistically to find significant differences between the manipulated conditions.

Interview and Thematic Analysis

To develop a descriptive model of creative engagement, semi-structured interviews were conducted to extract more in-depth subjective feedback. The reason to conduct a semi-structured interview instead of a structured or open interview was that of its flexibility in allowing researchers to encourage participants to give more relevant information.

Thematic analysis was used to analyse the semi-structured interview data in this thesis. Thematic analysis is a wildly used qualitative analytic method for identifying, analysing and reporting themes within qualitative data in relation to the research question [Braun and Clarke, 2006]. Compared to other qualitative analytic methods, e.g. grounded theory and discourse analysis, thematic analysis is a more accessible form of analysis for research novices as it does not require pre-existing theoretical and technological knowledge (ibid). There are two approaches for extracting themes from the data, inductive ('top-down') and deductive ('bottom-up') thematic analysis. The difference is whether the process of coding the data follows a pre-existing coding frame [Fereday and Muir-Cochrane, 2006]. Inductive ('top-down') thematic analysis follows a pre-existing coding frame and deductive ('bottom-up') thematic analysis does not. As the coding frame is developed prior to the analysis based on the research question or researcher's theoretical or analytic interest, the deductive analysis is analyst driven [Braun and Clarke, 2006]. On the contrary, the inductive thematic analysis is data driven and is suitable when the exploration is open-ended with no prior hypothesis or research question (ibid).

In this thesis, inductive (bottom-up) thematic analysis was used to explore the interview data for all three studies. The choice of a data-driven approach is to avoid any preliminary assumptions on novices' creative engagement. Following the step-by-step guide with six phases of analysis, the analysis process started from getting familiar with the feedback data, followed by generating initial codes, then searching and reviewing themes, and finally defining and naming themes [Braun and Clarke, 2006, Fereday and Muir-Cochrane, 2006].

Interaction Log Data Analysis

The analysis of the interaction log data was conducted with a different methodology in each study with close relation to the research question. In Study I visualisations of the interaction log data were created based on a timeline. Then a qualitative interpretation of the interaction strategies for exploration and creation was drawn based on the visualisations.

In Study II the analysis of the interaction log data was conducted with a particular focus on the users' activities, especially the repetition of the frequent actions. The variety of the interactions was assumed to be able to indicate the level of creative engagement during the interaction process. Techniques such as Closed Frequent Sequential Pattern Mining and Recurrence Quantification Analysis were conducted on the interaction log data to examine the level of behaviour repetition. This level of repetition was later compared with the subjective questionnaire feedback to explore the correlation between subjective feedback and objective behaviours. More details of the analysis procedure will be illustrated in Chapter 6.

3.6 Summary

This section discussed the evaluation theories, methods and trends in the domain of HCI, in relation to the topics discussed in Chapter 2, e.g. experience, engagement, CST and NIME. The reflection on the benefits and drawbacks of these practices inform the choices of the methodology for evaluation used in this thesis: the design of the questionnaire, the mixed-method approach and the exploration on the interaction log data.

Chapter 4

Study I: Effects of Control Metaphors

This chapter describes the motivation, research question, study design, evaluation and results of the first study. As the first major study of this thesis, the focus is not only to answer the research question, but also to explore the feasibility and the practical applications of the methodological framework discussed in Chapter 3. Based on the reflection on the practical issues, the evaluation approach applied in this study is adapted and progressively developed in the two subsequent studies.

4.1 Motivation

Section 2.4.3 introduced how metaphors contribute to the visual communication of an interface and help the user to build an appropriate mental model of an interactive system. Section 2.4.4 introduced the trend of integrating visual and sound in IMSs designs and its benefits, as well as the four control metaphors of visual-music system summarised by Levin [Levin, 2000]. Among the four control metaphors, the painterly interface has richer and more dynamic interaction compared to the other three, and has the potential to support non-musicians to explore sounds creatively and expressively due to its intuitiveness and cognitive benefits on creative activities (ibid). However, whether the control metaphor of the painterly interface supports non-musicians' creative engagement with musical interface remained unclear. This ambiguity motivated the research question of this study: *does the control metaphor of the painterly interface have advantages on supporting non-musicians' creative engagement?* The hypothesis in this study was that *the painterly control metaphor have advantages on support-*

ing non-musicians' creative engagement.

This study was also motivated by the research goal to understand the interaction process of non-musicians and to develop a descriptive model of non-musicians' creative engagement with interactive music systems. As discussed in Section 1.2.2, there was not much work done on novices' creative engagement, and what has beed discussed was not in the context of interactive music system. This study set out to explore the general process of how non-musicians approach an IMS and their subjective experience on creative engagement.

Moreover, as the first major study of this thesis, particular attention was paid to explore the feasibility of the research methods, i.e. controlled lab experiment and mixed data collection, discussed in Chapter 3, and to reflect on their practical applications in order to improve and adapt them to further studies.

Therefore, this study mainly focused on three topics: investigating the effects of the control metaphor on non-musicians' creative engagement, exploring the process of creative engagement, and testing the feasibility of the research methods.

4.2 User Interface

To investigate the research question, two visual-music IMSs addressing different control metaphors were designed in comparison with each other. To compare the control metaphors, the basic conceptual models of the two interfaces were designed to be the same. On the contrary, the control metaphor and its corresponding graphical representations, interaction models and mappings, were designed distinctly. The following sections give more details on the design of the two interfaces and on the comparison of the interface attributes between prototypes.

4.2.1 Unified Conceptual Model

The two interfaces share the same conceptual model, of which the idea came from the step sequencer interfaces that loop through steps of sound at certain rhythm [Hayes, 2010, Harriman, 2012, Arellano and McPherson, 2014]. Such interfaces usually employ eight or sixteen steps, each step represents a note or a beat. It allows the control of rhythmic patterns by turning on or off the step buttons and by adjusting the speed for looping through each step. It is an accessible and intuitive interaction for non-musicians to create complex rhythmic patterns without any need for skill dexterity. This concept offers a low entry fee for non-musicians, while maintaining enough complexity.

Generators were designed to automatically and rhythmically generate graphical elements once they are activated. When the generated graphical elements touched the *effectors* on the canvas placed by the player, a corresponding sound would be triggered. The sound parameters were mapped to the features of the *effectors*. To add more diversity, a *sequencer* was designed to generate continuous background sound to accompany the sound generated by the objects.

In summary, there are three main categories of virtual objects on both interfaces:

- The *generator* continuously generates graphical elements rhythmically once activated. The frequency of its generation can be adjusted.
- The *effector* produces a sound when triggered by a graphical element from the generator. There are four types of effectors with four different sound effects. The volume and the note of the effectors can be adjusted based on the parameters of the visual representations.
- The *sequencer* offers a continuous background sound. There are three sound effects to choose from and only one can be played at a time. The rhythm of the sequencer sample can be adjusted.

The interface layout is unified across the two prototypes to minimise the difference. The main operational space is a canvas for user to create and to place the generators and effectors. There is a sidebar on the left where user can switch between different function modes, i.e. adding or deleting four types of effectors, adjusting effector parameters, switching between sequencers or adjusting sequencer parameters.

4.2.2 Separate Control Metaphor

The two control metaphors were designed based on the four control metaphors of visual-music systems proposed by Levin [Levin, 2000]. One follows the painterly interface control metaphor to generate visual representation from gestural interactions to control sound parameters. The other follows the reactive widgets control metaphor that uses virtual objects to control sound parameters. Supplementary videos are created in support of explaining how the prototypes work. To download the videos please see link in the footnote [1].

Painterly Prototype

In the painterly prototype ($\mathrm{P}_{\mathrm{paint}}$), see Figure 4.2, a *generator* is represented by a circle. When it was placed on the canvas by touching the screen, it regularly

[1]https://doi.org/10.17636/01049923

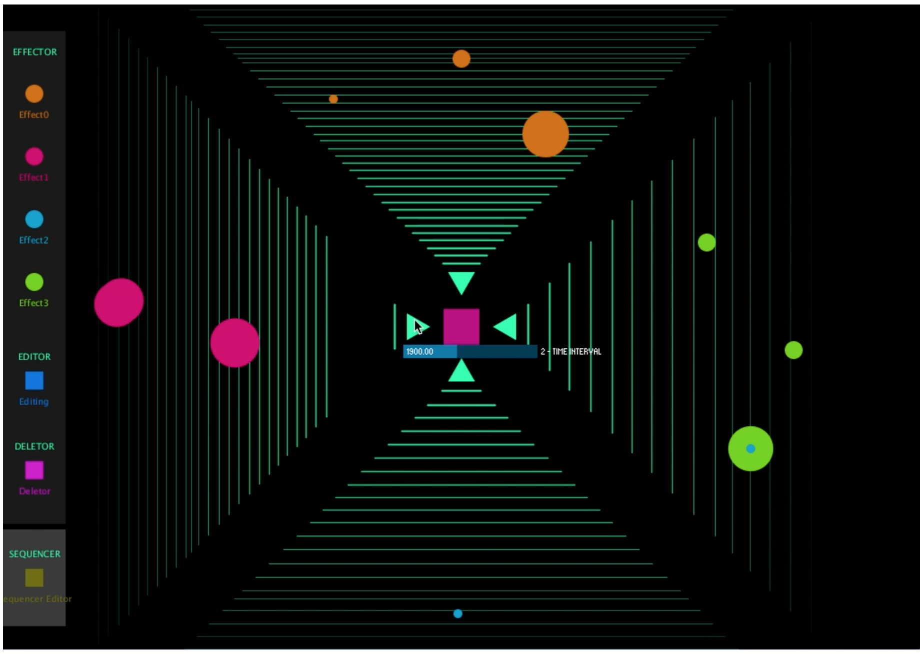

Figure 4.1: Reactive Prototype (P_{react})

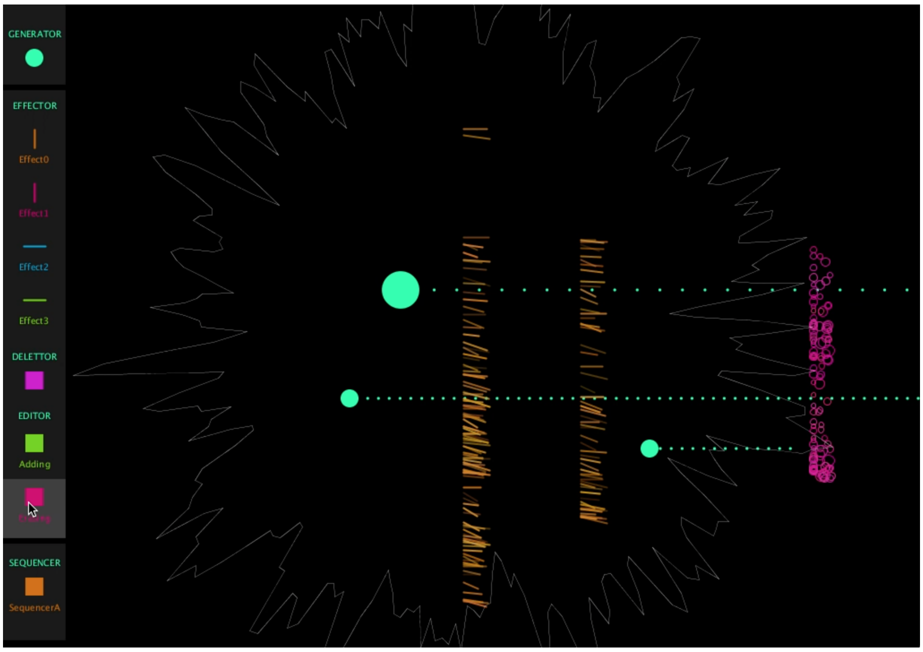

Figure 4.2: Painterly Prototype (P_{paint})

generated a set of dots moving linearly towards the right. The size of the generator object is adjustable, which is associate with the speed (rhythm) it generates the dots. The bigger the size, the slower the speed. To add an *effector*, a user needs to select the effector type from the side bar and draw it on the canvas. Different colours indicate different sounds. The red and orange ones produce melodic sounds. The green and blue ones produce rhythmic sounds. Sound would be generated when the effector was touched by a dot from the generator. The speed of drawing would affect the density of the effector which determines the volume of the sound. The faster the drawing, the less the density, thus the lower the volume. The length of the effector was mapped with the sound note for the red and orange effectors, and with the decay of the sound for the blue and green effectors. To adjust the sound variables of an effector, a user can select the adding or erasing mode from the sidebar to add or delete elements inside that effector. The *sequencer* can be triggered to generate a background sound by pressing the sequencer button in the side bar. Adjusting the size of its radius was to control its tempo and volume.

Reactive Prototype

In the reactive prototype (P_{react}), see Figure 4.1. There were four *generators* fixed in the centre of the canvas, represented by four triangles. Each of them can be turned on or off to regularly generate lines moving from the centre towards the edge of the canvas. The speed (rhythm) for generating the lines is controllable via a control bar, which appeared when the triangle is pressed. When a line from the sequencer touches an effector object, the effector would make a sound according to its type. *Effectors* are represented with circles. Similar to the P_{paint}, different colours indicate different sounds. Different effectors can be selected from the side bar and placed on the canvas with a simple click. The effectors can be dragged around, which cause the volume of the sound to change according to its distance from the centre in real-time. The closer the circle is to the centre, the louder the sound would be. The size of the circle effector is adjustable by dragging from the centre of the object when creating it or in the edit mode. For the red and orange effectors, which produce melodic sound, the size of the circle object is associate with its sound note. The bigger the size, the higher the note of the sound. For the blue and green effectors, which generate rhythmic sounds, the size is associated with the decay of the sound. The bigger the size, the longer the sound (the decay) would be played for. A user can also trigger the *sequencer* to generate background sound by pressing the rectangle in the middle. Its tempo is adjustable by dragging to adjust its radius.

The mappings between sound variables and effector variables are different

Attributes	$\mathbf{P_{react}}$	$\mathbf{P_{paint}}$
Generator		
Graphic	Triangle & Line	Circle & Dot
Variables	Rhythm, limited quantity	Rhythm, position, quantity, size
Interaction	Adjust slide bar	Adjust circle size
Effector		
Sound	Same	
Graphic	Circle	Linear Bar
Variables	Volume-Position Note-Size	Volume-Density Note-Length
Interaction	Drag-Position Drag-Size	Draw-Density Draw-Length
Sequencer		
Sound	Same	
Graphic	Same - Centric	
Variables	Same - Rhythm	
Interaction	Drag to switch, click rect in centre;	Drag to switch, click rect in control bar;

Table 4.1: Comparison on Attributes of P_{react} and P_{paint}

based on the different interaction model. P_{paint} uses drawing as the interaction concept. The length and the density of the effectors are associated with the note and the volume. P_{react}, however, uses dragging as the interaction concept. Adjusting the size of the effectors is to adjust the note, and adjusting the position is to adjust the volume. For the summary of the similarities and differences between the two prototypes please see Table 4.1.

The canvas of P_{paint} was designed to be blank and ready for 'drawing'. It is totally up to the user to plan and place both the generators and the effectors on the canvas which in the end would influence the sound. However, P_{react} was designed with some elements already present on the canvas. For example, the sequencer button was placed at the sidebar in P_{paint} rather than in the middle of canvas in P_{react}.

4.2.3 Implementation

The prototypes were programmed in *Processing*[2], a flexible software sketchbook and a programming language based on Java with a focus on visually oriented applications. The sounds in prototypes were generated using an open source Processing library for real-time audio - Beads[3] [Bown, 2011]. Table 4.2 gives an

[2]https://processing.org
[3]http://www.beadsproject.net

Effectors	Sound Type	Sound Parameter
Instrument 1	Piano Note	Pitch, Volume
Instrument 2	Bass Note	Pitch, Volume
Instrument 3	High Hat	Decay phase, Volume
Instrument 4	Low Tom	Decay phase, Volume

Table 4.2: Sound Sets of MTBox

$\mathrm{P_{react}}$	$\mathrm{P_{paint}}$

Table 4.3: Design of Study I

overview of the sound set and its adjustable sound parameters programmed in the prototypes. Electronic music inspired the design of the sound sets.

In the experiment, the prototypes were running from Processing on a MacBook Pro. An iPad was connected and used as a display extension for the screen of the MacBook Pro via *Splashtop*[4]. The participants interacted with the prototypes through the iPad with its touch screen. Prototypes were in the full-screen mode with no other user interface visible or accessible.

4.3 User Study

As mentioned earlier, this study aimed at not only comparing the effects of control metaphor on participants' creative experience, but also to understand the creative engagement with musical interfaces from an exploratory perspective. Therefore, apart from asking participants to play with both prototypes and to give feedback accordingly, different sessions were designed to understand the experience at different stages.

4.3.1 Procedure

The study involved four sessions: *introduction (5 minutes)*, *interaction with one of two prototypes (35 minutes)*, *interaction with the other prototype (35 minutes)*, *final interview (5 minutes)*. During the study, the participants were informed that they are free to opt out at any point. In the first part of the introduction, the researcher sat together with the participants to introduce the process of the study and the purpose of this study, which is to understand how different user interfaces will affect the interaction on the learning process and the creative process.

In the second part of the introduction, the basic concept of the interface and the three types of virtual objects were introduced. The introduction script

[4]https://www.splashtop.com/

is listed below. "There are three main categories of objects in both of the prototypes. The effectors make sound when triggered. The generator, which generate graphical elements rhythmically to trigger the sound controlled by the effectors. The sequencer offers a background sound. There are three sound effects to choose from. Only one of them is available at each time. Some variables of the sound can be changed by resizing the objects added on the canvas. These different functions can be chose from the left sidebar. In the Effector mode, different effectors can be added on the canvas; in the Editor mode the effector can be adjusted; in the Deleter mode effector can be deleted. In the Sequencer mode, the Sequencer can be changed or adjusted. The sound design of the two prototypes is the same while the interface design is different, and the ways to manipulate the sound variable are different."

After the introduction, the participants were asked to interact with the prototype by themselves. The researcher sat in the corner of the room in case the participants needed any help. To eliminate the influence of the sequence of exposure to prototypes, the order of the prototypes were randomly sorted for participants. For each prototype, the interaction was divided into five subsessions. This segmentation of the exploration and the creation session was based on the previous study in which solo sessions were structured to explore individuals' responses to the interface [Stowell et al., 2009]. Moreover, in the creation session, the participants were asked to improvise a piece of music based on the sequencer music. This requirement was designed to unify the task across participants. Instead of introducing a confounding variable, the sequencer samples offered a consistent standard for every participant and allowed a certain degree of freedom for improvisation.

- *i) Free Exploration.* Participants were encouraged to try out the interface for a while and explore it in his own way. The participants were asked to interact with the prototypes and explore how to interact with the different functions and element of the interface. The researcher asked participants to explore by themselves which sound variables could be adjusted and how to adjust them. Apart from the information offered in the introduction phase, no further information was offered to the participant.

- *ii) Semi-Structured interview.* The participants were asked questions about their learning process and experience.

- *iii) Guided Learning.* The participants were guided to learn the prototype systematically. Especially, the researcher demonstrated how to use the interface according to the participants' questions. The purpose was to make sure that the participants have a full understanding of the system before starting the creative task.

- *iv) Creative Improvisation.* The participants were encouraged to improvise a piece of music with the prototype. The researcher asked them to create their music alongwith one of the samples from the sequencer or to combine different ones. They were told that they are free to control the prototype as they wished.
- *v) Semi-Structured interview.* The participants were then asked about their creative process and their experience with the interface.

A more detailed description of the study procedure and interview questions please see Appendix A.1.

4.3.2 Setup

The set-up of the experiment is illustrated in figure 4.3. The participant was seated in front of the iPad, and the researcher was seated next to the table to conduct the introduction and interview, and set up the computer for interaction. When the participant was interacting with the prototype, the researcher was seated in the corner of the room (away from the participant) to not give pressure on their creation but be available to offer help at any point when the participants needed.

There was a camera placed on the right to record the participants' interaction. A sound recorder was used to record the interview. All participants were informed about the recordings.

4.3.3 Data Collection

Questionnaire

The questions in the questionnaire aimed at identifying whether participants understood the design concepts and control mechanisms of the prototypes in the learning session, as well as their overall subjective perception on the creative experience in the creative session. Table 4.4 lists the questions. The questions Q9 and Q14 provided five choices, which were listed below the question in bracket. Apart from that, all the other questions had only two choices, i.e. yes and no. With each prototype, participants were asked to fill in the questionnaire with a pen. A full list of questionnaire please see Appendix A.2.

Interview

A range of open-ended questions addressing how participants interacted with the prototypes were asked in a semi-structured interview after the participant finished the questionnaire. Finally, after the participants finished playing with

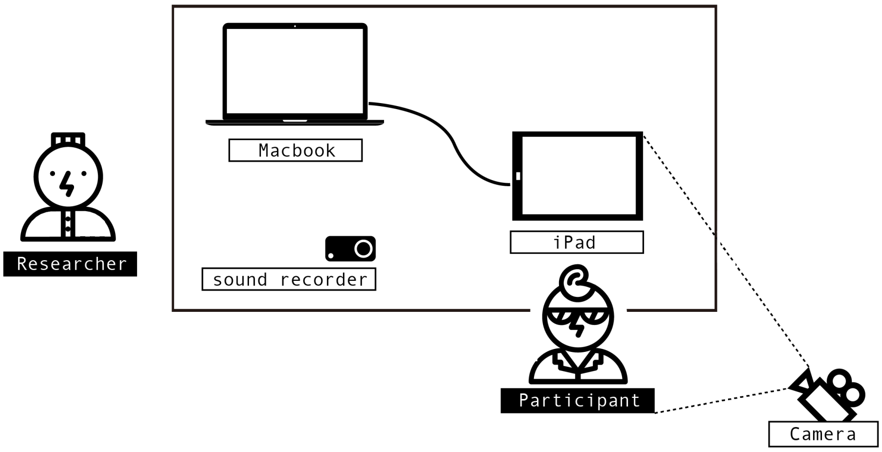

Figure 4.3: Set Up of Study I *(Researcher was seated next to participants during the introduction, guided learning and interview. Researcher left participants alone and sat in the corner of the room when participants were exploring and creating.)*

Explore Session (Yes or No)
Q1. Do you understand how the generator works?
Q2. Do you understand how to adjust the generator?
Q3. Do you understand how effectors work?
Q4. Do you understand how to control the note of the effectors?
Q5. Do you understand how to control the volume of the effectors?
Q6. Do you understand how to the sequencer works?
Q7. Are you satisfied with the work you've created?
Q8. Is this prototype easy to learn?
Q9. How would you rate your learning experience in this session? (not at all easy/ not really easy/ neutral/ easy/ very easy to learn)
Creative Session (Yes or No)
Q10. Do you like the interaction model of this prototype?
Q11. Do you think you were creative during the process?
Q12. Do you enjoy the graphic design of this interface?
Q13. Do you think the outcome is with good?
Q14. How would you rate your creative experience in this session? (not at all creative/ not really creative/ neutral/ creative/ very creative)

Table 4.4: Questionnaire for Study I

How did you go about exploring to use this application?
Do you think the interface helps you learn this prototype? If yes, what features of the interface helps you to learn?
Do you find it is difficult to create a piece of sound with this prototype? Why?
Do you think the interface helps you to create your piece of music? If yes, What features of the interface helps you to create?
What features of the prototype would you improve so that you can be more creative with this prototype?

Table 4.5: Interview Questions for Study I

both prototypes, participants completed a final semi-structured interview at the end of the session. Participants were asked to compare the two prototypes in terms of the satisfaction of the outcome, the interaction model, as well as the graphic design and the reason for given that choice, and to give feedback on their their learning experience, and creative experience. A full list of questions please see 4.5.

Interaction Log

The prototypes were programmed with the ability to log each user interaction. In order to simplify the data, interaction activities recorded in the interaction log were categorised into seven interaction types and coded in numbers: 0 - Change Mode, 1- Adjust Generator, 2 - Add Effector, 3 - Adjust Generator, 4- Adjust Effector R/ Edit Effector-add, 5 - Adjust Effector Position / Adjust Effector-erase, 6 - Delete Effector/ Delete Generator, 7 - Adjust Sequencer. Therefore, when a participant interacts with the system, the interaction type, its time and detail data (e.g. effector position, effector size, generator size) are recorded into a CSV file.

4.4 Study Results

Ten participants took part in the experiment(4 male & 6 female), the average age of the participants was 29, five said that they do not have any experience on making music or playing instruments, four said that they are amateur players on one or more instruments, and one claimed to be more fluent with instruments. The following section details the results of ten participants.

4.4.1 Questionnaire Feedback

The Pearson Chi-squared test was used to analyse the choices of the questionnaire data according to the two prototypes. There was no statistically significant

Q9 (Learnability)	Not at all	Not really	Neutral	Easy	Very easy
P_{react}	0	2	2	4	2
P_{paint}	0	1	3	6	0
Q14 (Creativity)	Not at all	Not really	Neutral	Creative	Very creative
P_{react}	0	1	1	6	2
P_{paint}	0	3	1	5	1

Table 4.6: Results of Questionnaire Feedback in Study I

association between prototype and preferred choices on learning experience (Q9) and creative experience (Q14), see Table 4.6; that is, both P_{react} and P_{paint} were equally preferred in terms of exploring experience and creative experience. The Fleiss' kappa test was used to assess the reliability of agreement between participants [Gwet, 2008]. The results showed a fair agreement ($k = 0.37$) between participants.

In the questionnaire about the explore session, there was a statistically significant difference ($\chi(1)$=5.495, p=.019) on participants' choices of Q4 (Effector note), with significantly more people (9 out of 10) not understand how to control the note of effectors for P_{paint}, as compared to P_{react} (4 out of 10). Interestingly, although there was no statistically significant difference for Q5. Participants could not understand how to control the volume of effectors both for P_{react} (8 out of 10) and P_{paint} (9 of 10). Moreover, there was a statistically significant difference ($\chi(1)$=5.495, p=.019) on participants' choices of Q8 (Easiness to learn), with significantly more people (9 of 10) found P_{paint} more difficult to learn, compared to P_{react} (4 out of 10).

In the questionnaire about the creative session, there was a statistically significant difference ($\chi(1)$=5.051, p=.025) on participants' choices of Q10 (Control model), with significantly more people (8 out of 10) not liking the interaction concept of P_{paint}, compared to P_{react} (3 out of 10). Moreover, there was a statistically significant difference ($\chi(1)$=5.051, p=.025) on participants' choices of Q13 (Creative outcome), with significantly more people (7 out of 10) not liking the outcome with P_{paint}, compared to P_{react} (2 out of 10).

4.4.2 Interaction Log Analysis

A Wilcoxon signed-ranks test was used to test the statistical significance of the data, because the data came from different settings within the same participants [Kerby, 2014]. There was no significance on the total time length spent in the exploration session and the creation session between P_{react} and P_{paint}.

Figure 4.4 shows the average percentage of time spent on each interaction type by participants. The time participants spent on each interaction type was added together, and its percentage was calculated out of the total time

Question	P_{react}		P_{paint}	
Choice	No	Yes	No	Yes
Q1 (Understand generator)	0	10	3	7
Q2 (Generator adjustment)	3	7	7	3
Q3 (Understand effector)	6	4	9	1
Q4 (Effector note)	**4**	**6**	**9**	**1**
Q5 (Effector volume)	8	2	9	1
Q6 (Understand sequencer)	0	10	1	9
Q7 (Result satisfaction)	4	6	4	6
Q8 (Easiness to learn)	**4**	**6**	**9**	**1**
Q10 (Control model)	**3**	**7**	**8**	**2**
Q11 (Creativity)	4	6	7	3
Q12 (Graphic design)	4	6	5	5
Q13 (Creative outcome)	**2**	**8**	**7**	**3**

Table 4.7: Results of Questionnaire Feedback in Study I

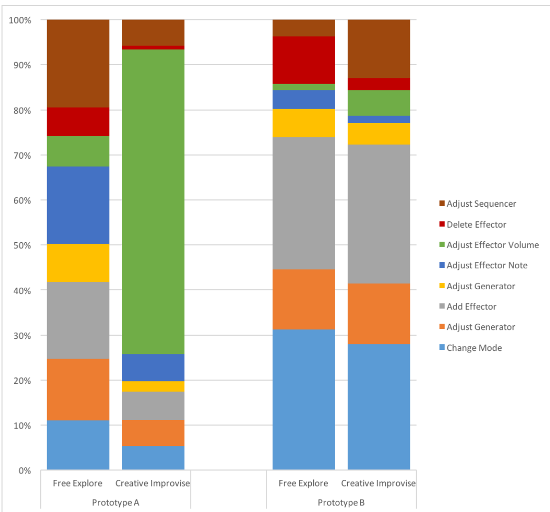

Figure 4.4: Duration of Each Interaction Type

participants spent on each session. Compared to the exploration session, the time for most of the interaction behaviours stayed the same or decreased in the creative session. The only three that increased were *adjust effector position* with P_{react}, and *adjust effector - erase* and *adjust sequencer* with P_{paint}. A Wilcoxon signed-ranks test was used to test the difference. For P_{react}, participants spent significantly more time (p = 0.0135, W = -49, Z = -2.47) on adjusting the position of effector in the creation session compared to the exploration session.

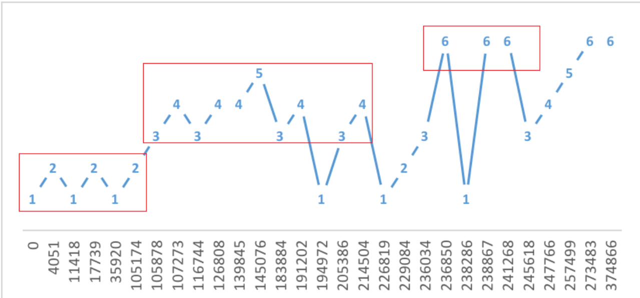

Figure 4.5: Explore Strategy A - One by One

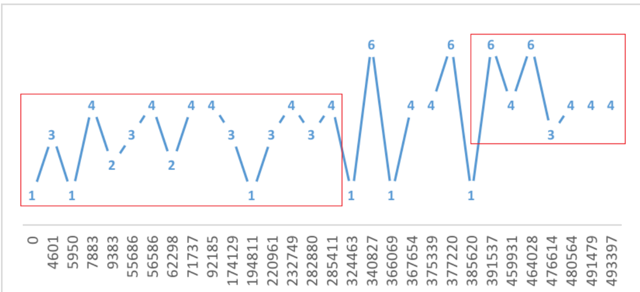

Figure 4.6: Explore Strategy B - Combination of Two

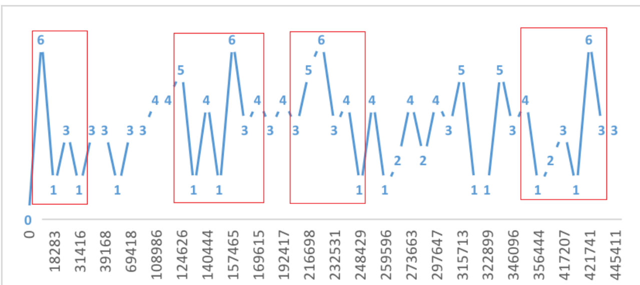

Figure 4.7: Explore Strategy C - Combination of Three

4.4.3 Patterns of Behaviour

Beyond the statistical analysis of the log data, visualisation and qualitative interpretation were undertaken to explore how a user's interaction developed and changed through the interaction process. The data was filtered by getting the first point when users switched from one interaction type to another. A graph of the interaction process over time was generated by plotting the trimmed data on timeline for each interaction. In the figures, numbers represent interaction types (1 - add generator, 2 - adjust generator, 3 - add effector, 4 - adjust effector, 5 - delete effector, 6 - adjust sequencer). The patterns of activity in the exploration session and creation session were quite different. The graphs of interaction process were annotated manually and categorised as different interaction styles based on how did the participants learn the different objects and the time when participants introduce the sequencer. The standard of classification was created based on observation of all the graphs. The categories are reported in details in the following sections.

Free Exploration

There were three basic styles of interaction to explore the prototypes. Style A was *One-by-One*, see figure 4.5, that participants tried to learn all the possible operations and adjustable parameters of one object before moving on to learn another object. Two participants' interaction process can be categorised in this style on P_{react}, four on P_{paint}. Style B was *Combination of Two*, see figure 4.6, that participants firstly explored two types of objects by switching between them alternately to learn their interaction attributes, and then moved on to explore other two types of objects. This process was a combinational strategy that integrated two types of objects to learn interactions and parameters together. Five participants adopted this interaction style on P_{react}, four on P_{paint}. Style C was *Combination of Three*, see figure 4.7, that participant interacted with three objects from the very beginning until the end of the interaction process. They started interacting with the generator and moved on interacting with the sequencer in a continuous process. Three participants used this interaction style on P_{react}, two on P_{paint}.

There were also two cases when participants mixed different interaction styles within one interaction process. For example, participants started with style A and end up with style C at the end of the interaction, or started with style C, but during the interaction process they also used style B or A for a period of time. In terms of the learning style across prototypes within the individual participant, six participants conducted the same style of interaction for both P_{react} and P_{paint}, three started with P_{react} in the first place and three started with P_{paint}. For the four who changed their learning style, two started with P_{react} and two started with P_{paint}. Three among them switched from style A to C, and one switched from A to B.

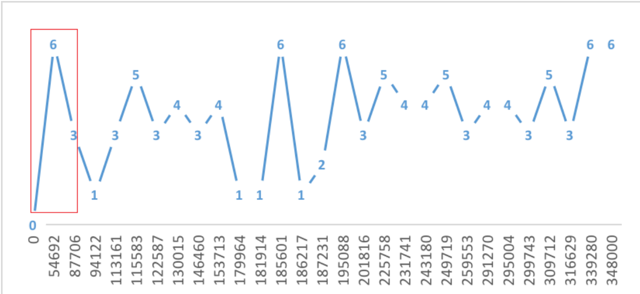

Figure 4.8: Create Strategy A - Begin with Sequencer

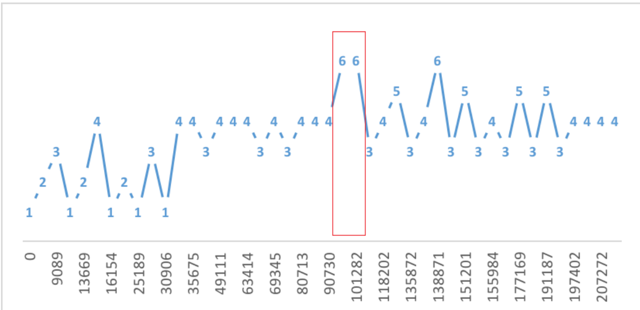

Figure 4.9: Create Strategy B - Start Sequencer in Middle

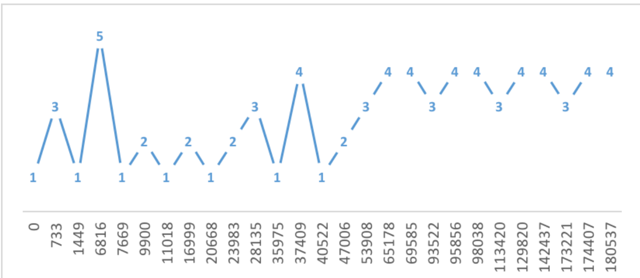

Figure 4.10: Create Strategy C - No Sequencer

Creative Improvisation

For this session, the task for the participant was to improvise a piece of music based on a background sound chosen from the sequencer. Three strategies for improvising a piece of music under this requirement were summarised based on the time when participants introduced the sequencer sound.

Strategy A was starting with the sequencer sound at the beginning of creation, figure 4.8. Among the six participants who adopted this strategy on P_{react} and seven on P_{paint}, only one of them never went back to the sequencer in later interactions. The others adjusted the sequencer or switched between the sequencer samples quite often all along the improvisation process. In strategy B, figure 4.9, participants started without a sequencer sound. They often played with the sequencer and effectors for the first half of the total interaction time, and then introduced the sequencer in the second half of the interaction process. Three participants adopted this strategy with P_{react}, two with P_{paint}. For strategy C, figure 4.10, participants did not select any sequencer to play with across the interaction process. There was one of them for both P_{react} and P_{paint}. Both of them did not use the sequencer in the second prototype.

Six participants adopted the same strategy to improvise music across prototypes. Four participants changed their improvisation strategy, two of which started with P_{react} in the first place while Two started with P_{paint}. However, no matter which prototype they started with, two of them changed their strategy from A to B, one from A to C, and one from B to C.

4.4.4 Interview Feedback

Informed by the theories of creative process, as discussed in Section 2.2.2, three stages of participants' interaction process with a musical interface were identified. They can be described as *Learn*, learning the basic concepts, interaction and sound of the system, which is a process of collect [Shneiderman, 2007] and preparation [Csikszentmihalyi, 1996]; *Exploration*, exploring the possible music ideas and approaches of making through trial and error, which is a process of relate [Shneiderman, 2007] and incubation; *Create*, improvising a structured piece with ideas, techniques and strategies from previous stages, which is a process of insight and create [Shneiderman, 2007, Csikszentmihalyi, 1996]. It is necessary to note that these stages of interaction can be interlocking and overlay with each other. For example, after participants learnt one basic function of the prototype, they might start to explore making possible music ideas with that specific function and go back to learn other functions. They might also explore mini music ideas during the process of creating as well. The extracted themes from the interview transcripts are reported below, categorised according to the three stages of the interaction process. The numbers in brackets express the count of participants who mentioned the theme in the interview.

Learn

The themes listed in this session were mainly concerned with exploring sounds in the learning process.

- *Solo listen (5).* For novice users, it was difficult to remember the different timbres of sound and the mapping between sound variables and interactions in the prototype. Participants described their strategy for learning the sound were to listen to them 'one by one'. With more elements added on the canvas, the context became complex as different sounds mixed. It then became difficult to differentiate the sound timbres, and to figure out the links of mapping while they were making adjustments, e.g. "I think I had too much happening, didn't I? I had a lot of stuff going on."

- *Affordance (7).* Some interface features were found to be helpful for organising the sounds. For example, participants commented positively about the layout of the interface, e.g. the grid design in $\mathrm{P}_{\mathrm{react}}$, and the linear design in $\mathrm{P}_{\mathrm{paint}}$, because they suggested a clear idea on how to arrange the objects, e.g. "I understand how I can create a piece of sound with this."

- *Simplicity (6).* The control of the sound should be simple in the way that the action is easy to achieve, and with a one-to-one mapping to the sound. For example, in $\mathrm{P}_{\mathrm{paint}}$, participants reported that the drawing interaction controlling the density(volume) and the length(tone) of the effector at the same time is demanding for their skills.

- *Consistency (3).* The requirement for consistent interaction emerged from results. A consistent interaction helps to build the link between functions and sound. Thus it is easier for novice users to learn and remember. For example, participants commented the concentric layout of $\mathrm{P}_{\mathrm{react}}$ is more consistent between objects, "makes more sense to include the sequencer".

Explore

There were two different approaches for participants' exploration of the music ideas - random exploration and precise exploration. Random exploration was when a participant was trying different functions without having any particular goal, usually involved combining sound elements and exploring extremity of a sound parameter. For example, one participant described the process as "So I just play around it to see what else I could do". Precise exploration was when a participant had a music idea in mind and looked for possible implementing methods. With these two distinct approach, three themes emerged in this stage.

- *Serendipity (5).* When participants generated music ideas that they liked or encountered functions that they did not expect, they were surprised and excited. e.g. "you play around with it, so yeah, I like it", "when discovered that I can drag them, I was really happy." Participants' interest in the system was triggered. They were more willing and confident to look for further knowledge, and were more engaged in the exploration process, e.g. "you were like yeah I want to find out if anything else has got new stuff, show me more".

- *Expressiveness (7).* Various controllable parameters helped the participants to achieve satisfaction on music ideas, e.g. "Some nice music, interesting music, because you've got a lot of control". Moreover, for the given parameter, participants expected a bigger range of control so as to achieve a more dynamic effect, e.g. "I find the ranges weren't large enough for what I need to do".

- *Precision (5).* When participants had music ideas in mind, they expected more precise control on timing or sound parameters to implement their ideas, e.g. "that very difficult is to timing things as I expected".

- *Repeatability (3).* After trying out the possibilities, participants may find some musical phrases interesting and would like to re-use them repeatedly, e.g. "Fair enough you might fancy sound you like, but how would you do something again". In this case, the ability to repeat previous interaction easily is a key point to transfer a participant to conceive the whole piece, a more in-depth creative process.

Create

- *Structure Composition (6).* There were three main sub-themes for non-musician users to structure a piece of music. Namely, *record history, plan ahead of time, and anticipate future events.* Participants found it is hard for them to remember what they played before, as well as to plan what is going to be played in the future. One participant reported that she had "a bad memory to remember what did I played before", and therefore find it is hard to organise a consistent piece. Some participants enjoyed to plan ahead of time with both prototypes, e.g. "compose what's gonna happen latter". As the interface allowed generators to be adjusted accordingly, there were possibilities to have a "pre-designed structure", and to trigger the sound after the objects were placed as they designed. The ability to "anticipate when that is gonna happen" was helpful for novice's improvisation in a way they were able to anticipate future sound events to plan next step of interactions.

- *Readiness Time (4).* There was a delay between the management of the objects and the feedback of the sound. For example, when adding an effector on the screen before triggering the generator, the effector would not play until the generator's dots or lines reach the effector. This time lag caused two adverse experiences in this situation. On one hand, it allowed non-musicians to prepare and to implement their conception of the sound before actually affecting the current composition, e.g. "you can press on and off but it's not affect something at that moment because you see there will be some time." On the other hand, without the instant feedback from the sound, it caused barriers for users to know the outcome of their interaction, e.g. "Because I don't know what it would sound like when I draw it."

- *Manage Sound (4).* With the interface to help to manage sound objects and parameters, e.g. rhythm, timbres, non-musicians felt easier to create their piece. In $\mathrm{P}_{\mathrm{react}}$, particularly, lines emitted by four sequencers towards different directions construct four separate spaces. These spaces allowed participants to manage their sound separately. Some participants used different space to manage different timbre effectors, e.g. "You have four different bits to control different sound elements". Some participants utilised them to manage both timbre and rhythm, e.g. "you can control different rate so maybe for one you can control beat and for the other one you can control tone".

- *Play Live (7).* Another representative strategy in the creating process was playing with objects to get a dynamic and live sound effect with the interaction. Two behaviours for playing live were summarised: one was *re-arranging objects*, when user re-arrange the previous sound objects to get some new effects, for example by adjusting the tempo or sequence of the notes. Another was *manipulating objects* when the participant kept moving the effectors around to hit the lines generated from the generator to create a live sound effect that would not happen without this interaction. One participant reported "it's quite fun to move the things around while it is playing".

- *Starting Base (2).* For novice users, it was conceptually and technically difficult for them to develop their musical ideas from scratch [Weinberg et al., 2002, Weinberg and Driscoll, 2005]. The role of the starting base was to give an idea of creating in the first place. For example, sequencers offered pre-designed sound sequences, which is a good starting point for novice users to play with. One participant reported "it was useful to have a starting sound. Like, not starting from zero completely." One suggestion from the participant was to provide an example sketch with preset effectors to begin with. Besides, in P_{react}, the preset generators on the interface were reported helpful by offering a clear strategy on how to organise the sound from the beginning. Although one participant criticised the preset layout in P_{react} had less freedom and was less creative because it 'predetermined' or 'indicated' what user should do, the other participants reported the preset layout gave confidence for them to start.

4.5 Discussion

This section discusses the comparison of the two prototypes based on results presented in the previous section. A three-step framework of creative engagement is presented, followed by design implications summarised based on the thematic analysis.

4.5.1 Comparions on Prototypes

The hypothesis is not supported by the results of this study. Significantly more participants understood how to adjust the effector's note with P_{react} and agreed on the easiness to learn on P_{react} than P_{paint}. Significantly more participants preferred the control model and satisfied with the creative outcome of P_{react} but not P_{paint}. The results indicate that the participants had a better experience when playing with P_{react} than playing P_{paint} on the aspects of learnability and satisfaction.

The reasons why P_{paint} failed to engage non-musicians while P_{react} has a superior effect could be inferred from the combination of the interview feedback and related literature. Firstly, according to Stowell and McLean, a rich open task such as music-making requires a rich open interface, and the use of design metaphors can lead to interfaces which constrain interactions and militate against reinterpretation [Stowell and McLean, 2013]. Due to the comparison design of the study, the control model and sound mapping mechanism designed for the interfaces were constrained to two parameters, i.e. pitch and volume. The limited parameters and the design of mapping between sound parameters and feature of effector might have restricted the design of gestural interactions of the P_{paint} interface, thus constrained the expressiveness of the painterly interface. Although the design of the mappings was similar in P_{react}, it did not show that much limitation. In fact, the conceptual model seemed to be more consistent in its control metaphor in P_{react} than in P_{paint}, which enabled participants to efficiently interpret and to play with it. Therefore the painterly control metaphor failed to show its an advantage over the reactive control metaphor.

Secondly, the interface mechanism of P_{react} accidentally functioned as a distributed cognitive tool to scaffold non-musicians' creative process [Davis et al., 2013a]. For example, the preset effectors on the canvas worked as a starting base that helped non-musicians to start building their ideas from scratch. The four conceptual spaces created by the generators helped non-musicians to manage the sound objects, sound parameters separately.

Finally, due to the implementation of the P_{react}, the effectors can be moved around to adjust the volume according to their distance to the centre. Participants found the movement was fun to play as it accompanied with instant real-time sound feedback. This function offered a great experience to the participants as it supports live playing. However, the function of movement was not designed in the P_{paint}. Therefore, due to the fact that the prototypes were designed inconsistently, it is difficult to make the conclusion that either painterly control metaphor or reactive control metaphor has superior effects in supporting non-musicians' creative engagement.

4.5.2 A Three-step Framework of Creative Engagement

The three-step framework ('learn', 'exploration','creation') of creative engagement was identified based on both the results of thematic analysis and the literature review of creative process [Csikszentmihalyi, 1996, Shneiderman, 2000, Sawyer, 2011]. It is similar to the Geneplore Model, which describes creative activities as a combination of generative and exploratory processes [Finke et al., 1992]. Complementary to this two-stage model, the framework suggested the learning process as part of the creative process and highlighted its importance for novices as it was a key process to accumulate knowledge and ideas for creation.

In the learning session, four participants switched their learning style from A to C and from A to B. In the creative session, four participants switch their creative style from A to B, A to C and B to C. These two observations indicate: *i)* Participants started with more complex learning styles when they interact with the second prototype, informing learning with fewer objects are more straightforward to start with compared to learning with a combination of three different objects. *ii)* Participants started to introduce the sequencer later in their creation process, which means participants had more variation in their composition when using the second prototype. Together with the qualitative data, it is possible to infer that in the learning phase, participants spent more effort to learn the sound and its interaction. The sound became a primary subject to learn in the musical interface in order to be able to easily figure out music strategy. The interaction and interface became a secondary subject to learn, and served for better interaction with the sound. This finding is similar to Bengler's findings that some participants strive for sonic identity and clear separation of sounds [Bengler and Bryan-Kinns, 2013].

The average satisfaction on both the learning and creating experience for P_{react} was higher. The results of the thematic analysis indicate P_{react} has some features that can cognitively scaffold participants' composition [Clark, 1998, Davis et al., 2013b]. For instance, *structure composition*, *manage sound*, and *starting base* are the themes that affected the participants' creation. These observations lead us toward another key component for supporting non-musician's creative engagement - *scaffold composition*. Due to the limits of musical skills, non-musicians need support to arrange sound elements and to plan music in a structured way, in order to generate musical ideas, to achieve their musical goals and to engage with the system creatively.

Participants spent significantly more time on adjusting the position of the effector in the improvisation session compared to the learning session in P_{react}. Also in the qualitative data, participants reported that they enjoyed P_{react} more than P_{paint} because of the feature of being able to move effectors around to create a live sound effect. These observations indicate that *playing live*- being able to manipulate live sound effect - it helped to engage participants creatively by means of encouraging participants to explore more possible interactions and various combinations of objects and sound.

4.5.3 Design Implications

Four design implications for designing musical interfaces were identified in this study to support novices' creative engagement:

- Providing mechanisms to enable the player to *learn the sound*, for example, enable solo listening for users to learn and explore the sound in a separate context other than on the main interface. By doing this the player can learn the basic sounds and the concepts of the system quickly in the exploration process, and to check if the sound combination works as expected in the creation process.

- Providing mechanisms to support *playing live* by enabling dynamic sound feedback on the interaction, e.g. P_{react} provides the ability to generate dynamic sound by dragging effectors around. With such kind of an intuitive and responsive instrument, novices will be encouraged to explore different possibilities of the interface. This can help to keep the players and audiences engaged.

- Providing mechanisms to *catalyze insights* to lead novices to a more in-depth creative process, e.g. conceiving the structure of the whole piece, or exploring music variations. For example, providing easy access to re-use the previous musical ideas is a possible approach to encourage in-depth explorations on musical ideas. By doing this the relationship between player and systems is catalysed to grow. [Edmonds et al., 2006].

- Providing mechanisms to *scaffold composition*, which involves three aspects: firstly, the interface needs to provide a starting base to give a clear guidance for creating, and also to spark new music ideas, this is addresses the critique that it is conceptually and technically difficult for novices to create and develop their own musical ideas from scratch [Weinberg and Driscoll, 2005]; secondly, it is vital to support novices to structure their composition, by recording the history of composition, enabling players to play ahead of time (to buy some readiness time), and to anticipate future events; finally, it is necessary to help managing sound objects and parameters so as to release the cognitive load by distributing the cognition to the interface [Hollan et al., 2000]. As as example, $\mathrm{P}_{\mathrm{react}}$ provided four virtual spaces for users to plan ahead of time and to manage the sound elements.

Apart from the above ones, some points that can be linked to previous research are also interesting. Providing enough *visual affordance* to increase the chance of finding new functions and playing strategies is prominent for creative engagement. Visual clue is also helpful for beginners to interpret and to remember the sound. For example, participants reported that the graphic design of effectors in $\mathrm{P}_{\mathrm{paint}}$ helped them to distinguish the sound. Besides, providing mechanisms to facilitate *serendipity* is good for generating new music ideas and finding functions, which helps to 'catalyse human activity' [Tanaka et al., 2005] for creative engagement.

4.6 Reflective Summary

This chapter presents an overview of the first study undertaken to investigate the second research goal of this thesis: whether the control metaphor of an interactive music system is affecting non-musicians' creative engagement? According to the questionnaire data, the hypothesis that the painterly interface can better support non-musicians' creative engagement is not supported by the findings.

Results of this study informed the design of the IMS used in Study II. For instance, as the study was based on the prototypes designed in the context of screen-based applications, the results were bounded in the limited scope of screen-based IMSs. Future studies will need to expand into a broader context of IMSs, such as tangible interfaces and installations, to test whether the results are generally applicable to different forms of IMSs. Moreover, the results indicate to assist better creative engagement there is a need to support the composition structure and the management of the sound objects when creating, which informed the design of the timeline interface in the prototypes for further studies.

The findings of Study I also informed the design of research question of Study II. As described in the interview feedback, in the stage of *exploration*, there were two distinct approaches for participants' exploration on the music ideas - random exploration and precise exploration. Random exploration was adopted when the participants did not have a clear goal of creating. While precise exploration was adopted when the participants have a clear music goal to create. This finding indicated that whether the participants have a goal in mind influenced their creative engagement as well as their strategy of playing. The effects of goal on non-musicians' creative engagement would be an interesting topic to investigate. Moreover, in the stage of *creation*, the participants reported a representative strategy in the creating process - *play live*. The dynamic and live sound effects of playing live contributed to the participants' creative engagement with the prototypes. It is a musicking strategy similar to the mode of improvisation, as described in Section 2.3.4. However, this is a conflict with some of the feedback was addressing the features of composition, e.g. the theme *structure composition* that addresses music structure and the theme *repeatability* that addresses to reuse interesting ideas. This conflict motivated the investigation of the effects of musicking mode on non-musicians' creative engagement in Study II.

There were some limitations on the data collection in this study. Although it managed to provide a comparison between the two prototypes, the questions designed for this study provided insufficient information about participants' subjective experience concerning creative engagement. One problem was that the questions were designed with a narrow focus on the factors such as learnability, preference, enjoyment, and satisfaction, which restricted the possibility to get a deeper understanding of other factors. Another problem was that the answers were mainly with two options, i.e. yes and no. The binary choices did not allow to quantify the preference of the participants to a fine grain to get deeper understanding of their creative engagement. Therefore, in further studies, the questionnaire design needed to be adapted and improved. Besides, the current experiment was carried out with a limited amount of participants in a controlled environment. By recruiting more participants the findings could be more appropriately validated and generalised.

Regarding the analysis, there were also implications that could be improved in future studies. The analysis of the timeline activities offered information to infer how participants interact with different types of objects. The visualisation of the interaction log data has informed the qualitative interpretation of participants' patterns of interaction. The evidence supported the use of interaction log data to inform the evaluation of IMSs and creative engagement. However, the qualitative approach did not offer evidence that could be used to drawn conclusions to the research question. Moreover, the qualitative interpretation was too subjective and was not applicable when there are more data. There are more potential methods to analyse the interaction log data, for example, the activity analysis and content analysis discussed in Section 3.5.3. In the Chapter 6 and 7, more attempts to evaluate creative engagement and IMSs through interactive log data will be explored.

The three-step framework was developed based on the division of the stages, i.e. learn, explore and create, which was strongly influenced by the preliminary structure of the study procedures. In further studies, the study procedures need to be adjusted so as to eliminate its influence on the results.

Chapter 5

Study II: Effects of Task Motivations and User Interface Modes

This chapter presents the study to explore the effects of task motivations (experiential task vs utilitarian task) and user interface (UI) features (whether content can be replayed and whether the content is editable) on non-musicians' creative engagement with novel musical interfaces. The chapter shows through an empirical study of twenty-four participants that an experiential exploratory task encouraged participants' creative engagement compared to a utilitarian creative task. Being able to replay records was less critical when the participant had an experiential exploratory task than had a utilitarian creative task. Allowing people to replay their musical ideas increased some aspects of their creative engagement which was further increased when they were able to edit their creations. Results also indicated that creative engagement increased when the interface supported users in planning ahead. A descriptive model of non-musician's creative engagement with musical interfaces is described including three modes of musicking. An optimal trajectory of creative engagement through these modes is proposed, and a description of inferred motivations, output, status and activities during the creative process is discussed. Design implications are proposed for supporting novices' creative engagement based on facets of motivation, cognitive skills, insights and real-time activities. A journal paper accepted by *International Journal of Human-Computer Studies* was written based on this study.

5.1 Motivation

The thematic analysis of Study I indicated two approaches for non-musicians to explore the musical interface - random exploration without any particular task and precise exploration with some specific task. Section 2.2.6 introduced the studies on the effects of different motivations on creativity, experience and engagement. The clearly defined utilitarian motivation, e.g. asking for concrete output or performance, showed more positive effects on creative performance compared to a vague experiential task that emphasising user experience or exploration without requirement on the output. However, the effects of different motivations on experience and engagement are not as apparent as on creative performance. Some studies suggested that a positive influence of a clear utilitarian task on user engagement and experience whereas some studies suggested an experiential task contribute to user engagement and experience. Whether a utilitarian task or an experiential task has different impacts on non-musicians' creative engagement is worth looking at for the purpose of designing support for creative engagement.

The two musicking modes, composition and improvisation outlined in Section 2.3.4 employ different activities of playing. The composition is an iterative creative process whereas the improvisation is a real-time creative process. Both require different sets of skills and user interface features (e.g. editing and replay versus real-time sound manipulation) in order to produce the creative output. Most of the NIME practices for non-musicians follow the dynamic real-time conventions of conventional instrument design such as a guitar or a flute, inherently offering an improvisational musicking mode of interaction, as discussed in Section 2.3.1. In this case, music is produced in real-time in direct response to the users' input, much as it might be with a traditional acoustic instrument. However, the improvisation need the player to plan and implement music ideas in real-time. As discussed in Section 2.2.4, the cognitive and physical skills required in an improvisation process are exactly what the non-musicians lack of. According to studies of Creativity Support Tools outlined in Section 2.2.5, *rich history keeping* is a fundamental mechanism for supporting creative process because having a record of what alternatives have been explored makes modification and improvement on creative output easier to achieve. There is a conflict between the implications of CSTs that calls for the rich-history keeping for the creative process and the current NIME practices that employed the improvisational paradigm of musicking. These two different user interface features can be linked to the two different musicking modes of creation. The iterative creative process of composition needs accessible records whereas the real-time music making process of improvisation that emphasise on real-time activities rather than history keeping. Moreover, the thematic analysis of Study I indicated that the participants enjoyed the function of playing live with sounds generated according to input in real-time (features of improvisation) and the function of scaffolding the structure of composition (features of composition). Which of the two musicking modes and its corresponding user interface features has more advantage in supporting non-musicians' creative engagement is necessary to be investigated.

According to the above discussions on related literature and findings of Study I, factors that might affect non-musicians' creative engagement with musical interfaces can be summarised as: 1) The motivation orientations of players, whether they are playing with the interface with an experiential or a utilitarian task. 2) The distinct user interface features of musicking modes (composition and improvisation), whether it allows to replay records or revise records. Based on this the research questions in this chapter are described as below:

1. *Whether with different motivation orientations, either an experiential task or a utilitarian task, will affect non-musicians' creative engagement. Also, if they will affect, how?*
2. *Whether the activities of replaying and revising records, which are two representative features of the different musicking modes, will affect non-musicians' creative engagement. Also, if they will affect, how?*

5.2 MTBox

In order to investigate these research questions an intuitive musical interface, MTBox was designed. With MTBox, a player can compose or improvise music with pre-recorded musical samples by pressing the buttons. The following sections introduce the MTBox design, rationale of design choices, and its implementation in detail. Supplementary videos are created in support of explaining how the prototypes work. To download the videos please see link in the footnote [1].

5.2.1 Tangible Interaction

MTBox was designed as a tangible musical interface, following the TUI paradigm [Weinberg and Gan, 2001, Sheridan and Bryan-Kinns, 2008, Jordà et al., 2007, Xambó et al., 2013a, Bengler and Bryan-Kinns, 2013, Zappi and McPherson, 2014] of music applications for users to manipulate and control sound directly and intuitively through buttons and rotary knobs. To remove preconceptions

[1] https://doi.org/10.17636/01049923

of instruments and to reduce non-musicians typical nervousness about playing with conventional instruments, MTBox was purposefully designed to *not* look or function like a conventional instrument such as a keyboard or a guitar [Overholt, 2009]. As presented in results of Study I, with interface to help to *manage sound* objects and parameters, non-musicians felt easier to create music. Therefore, MTBox was designed as a cube because the form of a cube which does not look like a conventional musical instrument, is easy to pick up, and offers six separate surfaces that could be used for different functions, see Figure 5.1. Offering different sounds on different surfaces responded to the results from a previous study which suggested utilising separate spaces to help non-musicians to manage different sound objects [Wu and Bryan-Kinns, 2017].

Each vertical of the side of MTBox holds four buttons. Each button corresponds to one pre-recorded sample that belongs to one sound genre. As each side has buttons, MTBox can be used by left-handed and right-handed people. Participants pressed a button to choose a sound sample. In terms of the sound design, there were melodic samples and beat samples. Each group contained long samples (more than three notes/beats) and short samples (less than three notes/beats). Therefore four types of samples (melodic/long, melodic/short, beat/long, beat/short) were distributed on four sides of the MTBox. An iPod screen, a rotary knob and operational buttons (On and Off buttons, Play/Pause button, Back button) were embedded on the top surface. The iPod screen was for displaying the timeline interface. The rotary knob was for controlling the movement of the timeline interface. Both would be discussed in detail in section 3.2. When the ON button is pressed, the chosen sample is triggered and started looping until the OFF button is pressed. The Pause/Play button is to pause the box or start play again. The back button is to reset the timeline interface to the current playback position after being scrolled. There is a LED embedded at the back of each button. The LED is illuminated when the its corresponding sample is playing. The choice of buttons instead of touchscreen controls was made to reduce the need for visual attention to the controls with the help of physical feedback and affordances from buttons and knobs. For a similar reason, the choice of semi-transparent material was designed to allow the LED light to be seen from different angles giving additional visual feedback on the button state and to hide the complex electronic components to avoid distraction. The MTBox is 15cm wide, 15cm height, and 15 cm deep. The size of the screen is 9cm width and 5cm height.

5.2.2 Timeline Interface

The timeline interface was displayed on an iPod screen embedded on top of MTBox, see Figure 5.2. The timeline provides a visual *record* of the sound events created by participants, see Figure 5.2. It was designed to respond to the CST design guideline of providing history keeping [Shneiderman, 2007] and the call for providing support for compositional structures and events organisation and modification [Franco et al., 2004]. The timeline moves from right to left as time progresses. There are sixteen tracks on the timeline to record the activity of each sample individually. Once triggered, a sample starts looping and be stopped when turned off. The state of the sample is represented as a line recorded from its starting point to its stopping point on its corresponding track on the timeline. Real-time animation is simultaneously drawn in the middle of the track while the sound is active.

As the results of Study I suggested that non-musicians need readiness time in the creative process, MTBox was designed to allow players to plan musical events in the future by using the timeline. In the middle of the timeline, a red vertical line divides the timeline into two parts. The left side of the timeline records the previous musical events, and the right of the timeline records the future musical events, whilst the middle indicates the current playing point. Using the rotary knob, the timeline can be scrolled into the future (clockwise turn of the rotary knob). In this situation, a player can start or stop samples ahead of current playing point, which would be recorded on the future timeline. The future records would not take effect until it reached the vertical line in the middle.

5.2.3 User Interface Features of Musicking Modes

As discussed above, the primary user interface features of different musicking modes are whether the system allows to i) replay and ii) revise the previous and future records. In order to examine the effect of these features, the timeline was designed with two key user interface features beyond sound production:

- Changeable playing point that allows a player start to play from any point of the previous or the future records by pressing the Play button.

- Editable records that allows a player to edit (add, cut off, or extend) any record that has been created by pressing the On/Off buttons.

Figure 5.3 shows an example of the timeline interface when the timeline is in the current status. The yellow and red line are placed in the middle. In Figure 5.2 the timeline is scrolled to the future time zone. The yellow line indicates

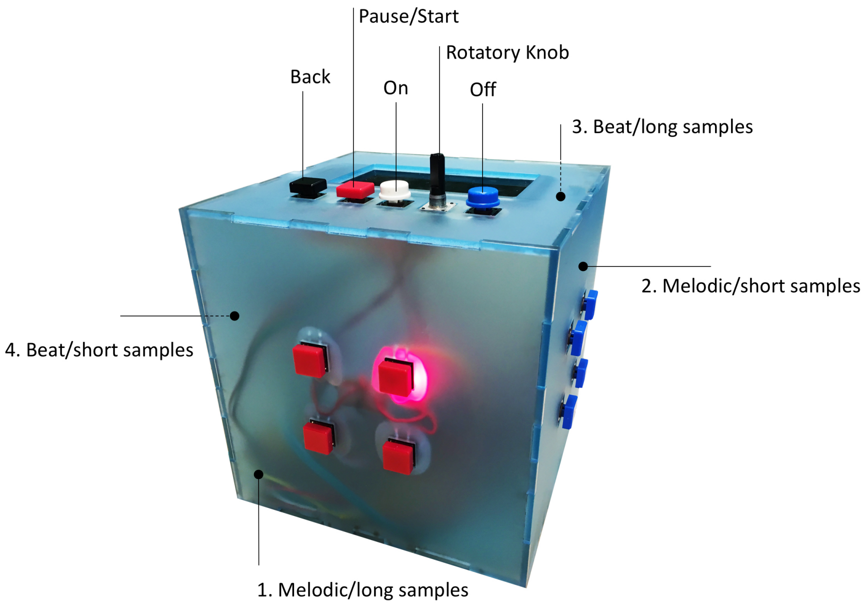

Figure 5.1: MTBox

where the current playing point is. If the Play button on MTBox is pressed, the yellow line would jump to the point where the red line is. Therefore the system would start playing from the point where the red line is.

To allow for comparison between the features of the two user interfaces, four user interface modes were designed for MTBox. Each mode was designed with or without the two functions so as to trigger different modes of musicking. Table 5.1 lists all MTBox modes and their functions. $\mathrm{M_{nn}}$ was designed with non-changeable playing point and non-editable records, aimed at triggering the musicking mode that is similar to improvising with an instrument. $\mathrm{M_{ne}}$ was designed with non-changeable playing point and editable records, aimed at triggering the music mode of comprovising that allows editing on previous records, such as live coding. $\mathrm{M_{cn}}$ was designed with changeable playing point and non-editable records, aimed at triggering the music mode of comprovising that allows replaying previous creation, such as playing with a Launchpad. $\mathrm{M_{ce}}$ was designed with changeable playing point and editable records, aimed at triggering the music mode that is similar to composing with Logic.

5.2.4 Implementation

The MTBox has three main components. First, the hardware interface such as buttons, a rotary knob and LEDs were integrated with a microcontroller board,

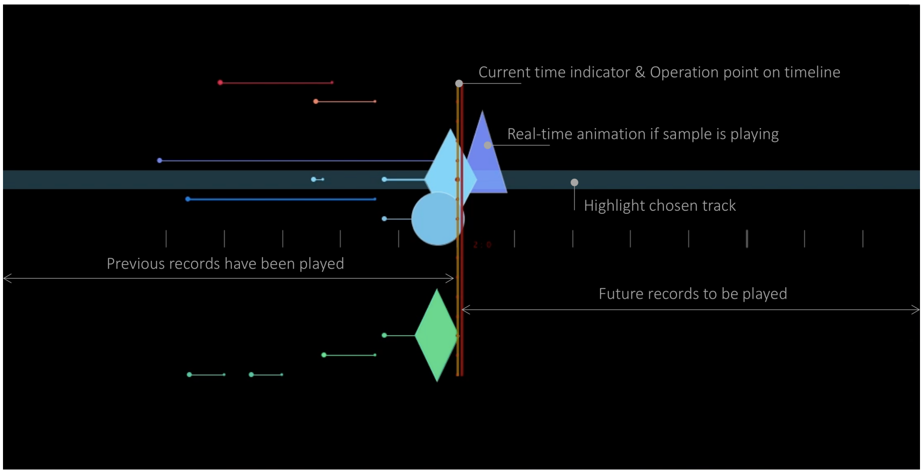

Figure 5.2: Timeline Interface: Normal View

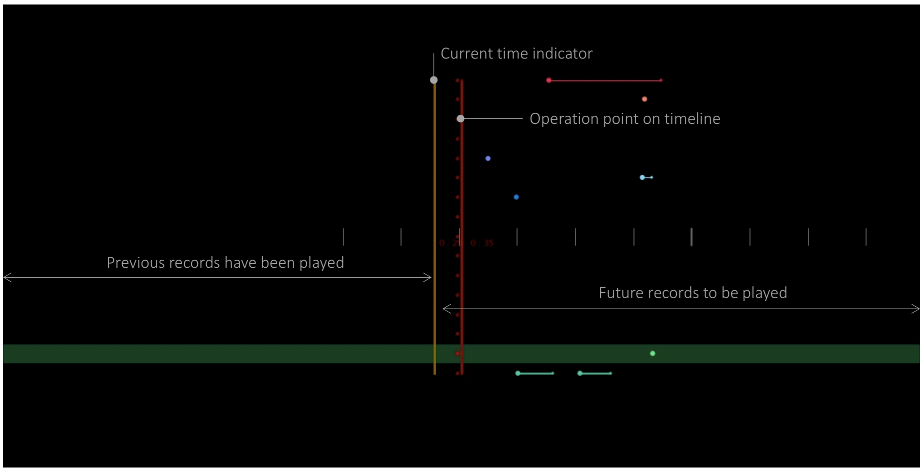

Figure 5.3: Timeline Interface: Scrolled and Started to Play from Previous

Arduino Mega[2]. Second, the timeline interface was programmed in *Processing*[3] and displayed on an iPod embedded in MTBox. Third, the sound interface was built in *Pure Data*[4].

A working setup of MTBox included a MacBook Pro. The Processing and Pure Data were running on the MacBook Pro. The iPod embedded in MTBox was connected with it via USB and was used as a screen extension to display the timeline interface via *Splashtop*[5], which was set in full-screen mode with no other user interface objects visible or accessible. Arduino Mega was also

[2]https://www.arduino.cc/en/Main/arduinoBoardMega/
[3]https://processing.org/
[4]https://puredata.info/
[5]https://www.splashtop.com/

	Non-Editable records	Editable records
Non-changeable playing point	M_{nn}	M_{ne}
Changeable playing point	M_{cn}	M_{ce}
Participant Group	Group 1	Group 2

Table 5.1: Prototype Versions

connected with the MacBook Pro for power supply and data transfer. The user interaction data was transferred from Arduino Mega to Processing. After processing, the data was then transferred to Pure Data to control the state of the samples, and also back to Arduino Mega to control the state of LED lights. A technical set up of MTBox, please see Figure 4.3.

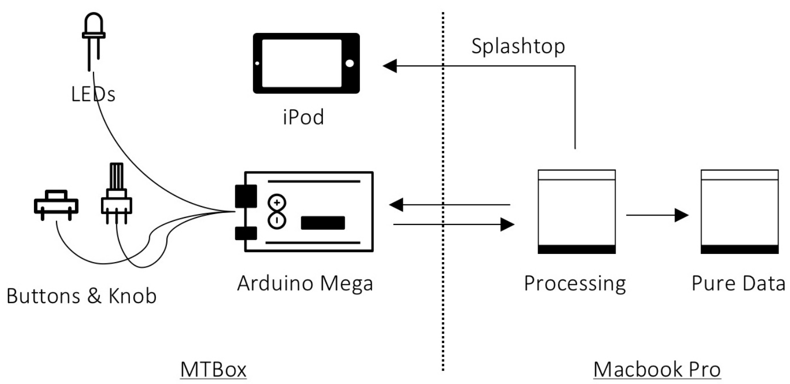

Figure 5.4: Technical Set Up of Study II

5.3 Study Design

The following sections introduce the design of the experiment with detail description of the design of independent variables, hypothesis, dependent variables, study procedure, and description on the rationale for choices.

5.3.1 Independent variables

With the four modes of prototype addressing different musicking features, it was possible to examine their effects by conducting a cross comparison between two groups of participants. In addition, to explore how the different motivations, affect creative engagement, the study designed different tasks to trigger the users experiential and utilitarian motivation of playing with the prototype. The study design utilised the two tasks built to examine the effect of task motivation on online users' flow and engagement in [Rozendaal et al., 2007, O'Brien, 2010], which are exploration task and creation task. The experiential motivation was fostered with an exploratory task to give participants an experiential task that aimed for a hedonic experience. Under this exploratory task, participants were encouraged to explore the MTBox in their way. The utilitarian motivation was fostered with a creative task to give participants an explicit utilitarian motivation that aimed for a concrete creative result. Under this creative task, participants were encouraged to create a piece of music with MTBox. With these two tasks fostering two different motivations, the study was able to examine the effects of motivations on non-musician's creative engagement.

Therefore three independent variables were manipulated in the experiment, how they were related to two groups of participants, please see Table 5.1:

- A within-subjects factor (repeated) of two task sessions (exploration and creation) - whether or not the participant was asked to play the prototype with a utilitarian task for creative output.
- A within-subjects factor (repeated) of changeable playing point - whether or not the participant was able to start playing from the previous or the future records on the timeline.
- A between-subjects factor (non-repeated) of editable records - whether or not the participant was able to edit (to cut off or extend) the previous and the future records on the timeline.

5.3.2 Hypothesis

According to Sawyer, expert musicians were usually motivated by a utilitarian task for creative output, and most of the great music was created after engaged in long periods of preparation and frequent revision [Sawyer, 2011]. The study hypothesed that the creative engagement would be greater when non-musicians are involved in the composition mode with the ability to replay (with changeable playing point) and revise records (with editable records), and when participants are given an explicit utilitarian task to create a piece of music. Therefore three hypotheses were developed according to the independent variables:

- *H1:* Creative engagement would be greater with an explicit utilitarian task for the creative output. This hypothesis will be tested with two tasks given to the participants in the experiment, i.e. the exploration task and the creative task. If this hypothesis is supported, greater creative engagement will be indicated by the higher agreement on one or more statements in the questionnaire when playing with creative task, as compared to the agreement when when playing with exploratory task.

- *H2:* Creative engagement would be greater with the prototypes with changeable playing point. This hypothesis will be tested with the comparison of the prototypes with non-changeable playing point and the prototype with changeable playing point. If this hypothesis is supported, greater creative engagement will be indicated by the higher agreement on one or more statements in the questionnaire when playing with $\mathrm{M_{cn}}$ & $\mathrm{M_{ce}}$ as compared to the agreement when playing with $\mathrm{M_{nn}}$ & $\mathrm{M_{ne}}$.

- *H3:* Creative engagement would be greater with prototypes with editable records. This hypothesis will be tested with the comparison of the prototype with non-editable records and the prototype with editable records. If this hypothesis is supported, greater creative engagement will be indicated by the higher agreement on one or more statements in the questionnaire when playing with $\mathrm{M_{nn}}$ & $\mathrm{M_{cn}}$ as compared to the agreement when playing with $\mathrm{M_{ne}}$ & $\mathrm{M_{ce}}$.

5.3.3 Dependent variables

This section presents the design of the dependent variables, which were mostly designed based on the discussion in Chapter 3.

Candy and Bilda proposed two indicators for assessing creative engagement in the context of interactive art: i) the conceptual change, when there is a shift in the audience's intentionality and expectation with the system; and ii) the behavioral change, which is often observed before and after an unexpected change in the system [Candy and Bilda, 2009]. According to them, the observed behavioural change needs to be confirmed by audiences' retrospective reports. To achieve the confirmation, both observation of participants' behaviour and analysis of participants' feedback are necessary, demanding a massive amount of work on data interpretation, and also bringing with it a risk of missing points due to superficial interviews, especially when the interaction process is lengthy. However, in contrast to the context of interactive art, where the audience's behaviour change is usually caused by unexpected changes in the system, the behaviour change in the scope of this study is usually initiated by the audiences. Therefore it is difficult to determine audiences' behaviour change via video recordings in the context of this thesis. Therefore questionnaire methods were proposed as the main method to assess the conceptual change based on a set of creative engagement factors, and collecting interaction logs as a comple-

Factors	Definition	Questionnaire
Interest	User's interest in the prototype or task	ES1, CS1
Aesthetics	Perceived visual beauty	ES2
Learnability*	The easiness of learning	ES3
Feedback	System response according to interaction	ES4, CS5
Composition*	Support on structuring the composition	CS2
Readiness Time*	Support on planning future events	CS3
Enjoyment	Perceived pleasingness	CS8
Exploration	The easiness of explore new ideas	ES5, CS6
Expressiveness	The ability to perform various outcomes	ES6, CS10
Challenge	The amount of effort put in interaction	ES7, CS4
Control	How in charge user feels in interaction	ES8, CS7
Focused Attention	The concentration on the task	ES9, CS9
Results Worth Effort	Perceive value of the result	ES10, CS11

Table 5.2: Factors of Creative Engagement Assessed in Study II

mentary source for analysing behaviour change during the interaction process. Two categories of dependent measures were developed to assess participants' creative engagement: i) participant feedback (agreement on statements) and ii) activity assessment (what participants did).

Participant feedback

The questionnaire to access participants' creative engagement has three parts:

There was a pre-question designed before the experiment to get an initial self-assessment of participants' music creativity. The pre-question was designed to compare with the perceived creativity after playing with the prototypes.

As discussed in Chapter 3, a set of factors for creative engagement listed in Table 3.1 were extracted based on the attributes of engagement [O'Brien and Toms, 2008, 2010] and the factors that were used to evaluate CST [Carroll et al., 2009, Carroll, 2013]. The results in Study I indicated that the factors such as the *learnability* of systems, whether or not the system helps to *structure composition* and leaves enough *readiness time* to plan events were crucial for non-musicians' creative engagement. Therefore the second part of the questionnaire was developed based on the factors listed in Table 3.1 combined with the three factors above.

To evaluate participants' creative engagement when given different task motivations, the questionnaire was designed separately for each task session: statements for exploration session (ES) and statements for creation session(CS). There were eight paired statements in ES and CS addressing the same factors: interest(ES1, CS1), feedback(ES4, CS5), exploration(ES5, CS6), expressiveness(ES6, CS10), challenge (ES7, CS4), control(ES8, CS7), focused attention(ES9, CS9), results worth effort (ES10, CS11). The paired statements addressing the same factors aimed at offering comparisons between the task sessions.

Table 5.2 illustrates the factors, the definition of the factor, and corresponding questionnaire statements. Factors marked with the symbol * were extracted from the results of Study I. Table 5.3 lists the statements of the first and second part of the questionnaire. The statements marked with the symbol * were coded negatively. Participants were asked to rate their agreement on each statement on a seven-point Likert scale from 1 (Strongly disagree) to 7 (Strongly agree).

The third part of the questionnaire was designed based on Table 3.2 introduced in Chapter 3. Participants were asked to choose that was the most appropriate to a set of statements from the two given prototype modes they have played with. With the comparisons between prototype modes, it was possible to capture participants' preference of the prototypes on the six factors of creative engagement.

Semi-structured Interview

Apart from the questionnaire, a semi-structured interview was conducted for each prototype to collect additional feedback, in order to understand the participants' subjective experience with the prototypes. Interview questions were designed based on the task sessions. Table 5.4 lists all the interview questions. The questions were not posed in a systematic way, meaning not all participants were asked all the questions and in the same order. The choice was done on the spot, trying to build on the interesting insights that were emerging during the conversation. Interviews were transcribed and analysed with thematic analysis.

5.3.4 Procedure

Twenty four participants (12 male, 12 female) who considered themselves to be non-musicians were recruited to take part. The average age of the participants was 25 (SD=5.247). Participants were a mixture of undergraduate students, graduate students, and non-students. Participants signed a consent form and were informed that they could leave at any time. Each participant received £10 as compensation.

Before starting to play with the MTBox, the participants were asked to complete a pre-questionnaire to self-assess their musical creativity. Participants were divided into two groups: group 1 and group 2. In the study, they interacted with two UI modes separately. Group 1 interacted with $\mathrm{M_{nn}}$ & $\mathrm{M_{cn}}$, and group 2 interacted with $\mathrm{M_{ne}}$ & $\mathrm{M_{ce}}$, see Table 5.5. To eliminate the influence of the

ES0. I am very creative to create a piece of music.
Questionnaire Statements for Exploration Session (ES)
ES1. I was curious about the prototype.
ES2. This prototype was aesthetically appealing.
ES3. I found this prototype confusing to learn.
ES4. The timeline helped me to understand my interaction.
ES5. I have found different ways of playing with the prototype.
ES6. It was easy for me to explore many different music ideas, possibilities, or outcomes, using this musical box.
ES7. I felt frustrated while playing with this musical box.*
ES8. I could not do some of the things I wanted to do on this prototype.*
ES9. When I was playing with the prototype, I lost track of the world around me.
ES10. Playing with this musical box was worthwhile.
Questionnaire Statements for Creation Session (CS)
CS1. I was curious about the creation task.
CS2. The timeline helped me to organise my composition.
CS3. I had enough time to plan what I want to play.
CS4. I felt frustrated while creating with this prototype.*
CS5. The timeline offered support to implement different music ideas and possibilities.
CS6. I kept finding new ways of playing with the sound in this prototype.
CS7. I could not do some of the things I needed to do on this prototype.*
CS8. I was very creative with the music.
CS9. When I was creating with the music box, I lost track of the world around me.
CS10. The prototype allowed me to be expressive on music.
CS11. I think I produced a piece of music with good quality.

Table 5.3: Questionnaire for Study II

Exploration Interview
Do you find the prototype is difficult to learn?
Do you think you find different ways of playing the prototype? What are they?
Do you think the timeline helps you to learn? How?
How do you think your exploration helps for the later improvisation session?
What feature of the prototype do you think allows you to be more exploratory?
(Second) Compared to the previous version, do you think you find different way of playing the prototype?
Creation Interview
Do you think the feature that allows you to add future events on the timeline useful for creation? If yes, in what way do you think it helps you to play?
Do you find the feature of looking back to the previous record useful to your creation?
How did you utilise the timeline in the creation?
What feature of the prototype do you think helps you to be more creative?
Did you get frustrated when you were creating? When and how?
Which feature of the timeline do you think is more useful for creation?
What could be improved for better supporting the creation?
(Second) How does your creation differentiate from the previous one?
Comparison Interview
Do you think the feature that allows you to edit the previous records useful? If yes, in what way do you think it helps you to play?
Do you think the feature that allows you to edit the future records useful? If yes, in what way do you think it helps you to play?
Comparing edit previous records and edit future records, which one do you think is more helpful when you improvise? Why?
How did you utilise this feature in the improvisation?

Table 5.4: Interview Questions for Study II

	Group 1 (M_{nn} & M_{cn})	Group 2 (M_{ne} & M_{ce})
1	1. Guided Learning	
2	Exploration with M_{nn} or M_{cn}	Exploration with M_{ne} or M_{ce}
3	Creation with M_{nn} or M_{cn}	Creation with M_{ne} or M_{ce}
4	Exploration with M_{cn} or M_{nn}	Exploration with M_{ne} & M_{ce}
5	Creation with M_{cn} or M_{nn}	Creation with M_{ce} or M_{ne}

Table 5.5: Study Procedure of Study II *The procedure is the same for both Group 1 and 2. To eliminate the influence of the sequence of exposure to prototypes, the order of M_{nn} & M_{cn} and M_{ne} & M_{ce} were randomly sorted for participants in step 3 and 4.*

sequence of exposure to UI mode, the order of the UI modes was randomly assigned to participants. With each prototype there were four sessions:

- *Guided Learning (15 min)* The participants were guided in learning all the functions of the prototype. In this session, the researcher sat together with the participants and demonstrated how to interact with the prototype. The demonstration included the function of the buttons, the design of long loops and short loops and how to start and stop them, the timeline interface and the scroll function. Afterwards, the participants were encouraged to try out MTBox for a while based on the given introduction. They could ask questions while they were playing if they were confused about the functions. The researcher gave more demonstrations in response to participant's questions until the participant had no further questions at which point it was assumed that the participant understood how to interact with the prototype's different functions. The buttons of MTBox were left unlabelled because we wanted the participants to learn to use MTBox without the need to refer to labels.

- *Exploration (10 min)* The participants were encouraged to explore the prototype in their own way by themselves. The researcher told participants to explore the prototype in their own way and to play whatever they wanted. They were told that there was no a minimum number of samples that should be used nor a specific outcome to be produced. From this session onwards, the researcher sat in the corner of the room in case the participants needed any help. The participants were reminded of the time after 10 minutes of interaction and were told that they could continue if they wanted to. Afterwards, they were asked to fill in the questionnaire (ES). Interview questions were then asked to get an understanding of their exploration process.

- *Creation (10 min)* Th e participants were encouraged to create a piece of music with the prototype. The researcher asked the participants to aim at creating a piece of music, and clarified that there was no requirement on the content, nor on the genre of the music. Moreover, the researcher specified that there would not be any judgement on the quality of the final piece, and there would not be any requirement on the length of the piece nor a minimum number of samples to be used. The researcher sat in the corner of the room in case the participants needed any help. The participants were reminded of the time after 10 minutes of interaction and were told that they could continue if they wanted to. Afterwards, they were asked to fill in the questionnaire (CS). Interview questions were asked to understand their creative process.

- *Semi-Structured interview (5 min)* The participants were then interviewed to collect their feedback on the experience and the user interface.

5.4 Results

This section presents the significant results of the statistical analysis of the questionnaire data, and the results of the thematic analysis of the interview data.

5.4.1 Questionnaire feedback

Three analysis was carried out on the questionnaire data: the comparison on the paired factors of creative engagement was conducted to examine the effects of task motivations; the comparison by prototype modes and comparison by dependent variables were conducted to examine the effects of prototype modes. Figure 5.5 and 5.6 illustrate all the questionnaire feedback in box plot. For the full list of statistical test results of all conditions and comparisons, please see Appendix B.2.

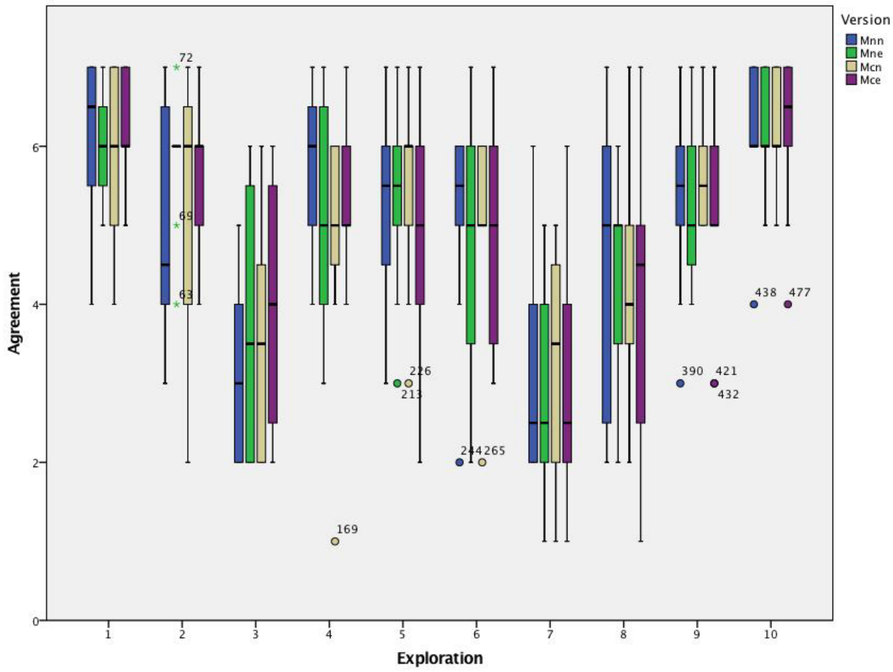

Figure 5.5: Boxplot of Questionnaire Feedback in Explore Session

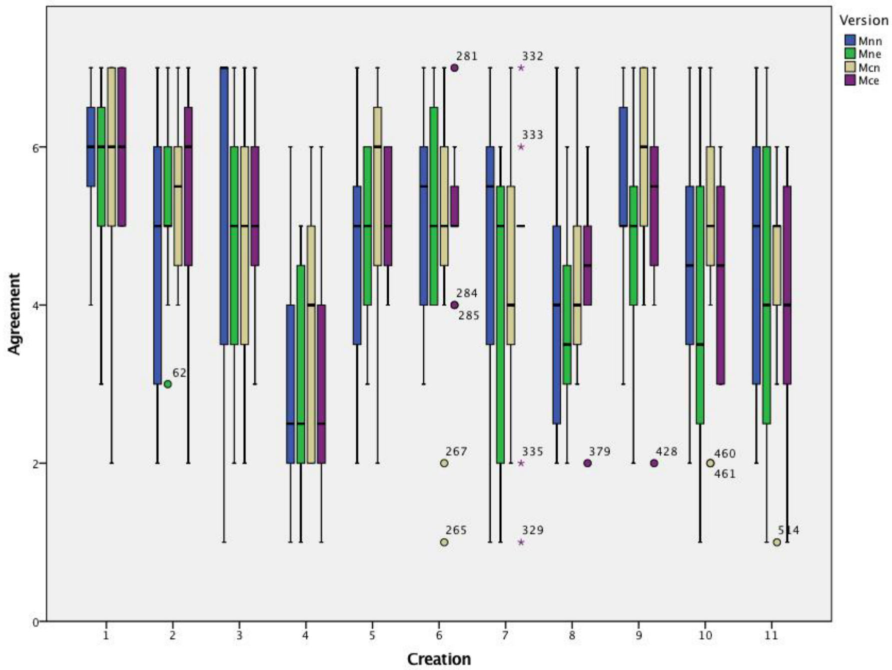

Figure 5.6: Boxplot of Questionnaire Feedback in Create Session

Comparison on Paired Factors of Creative Engagement

A three-way mixed ANOVA was conducted to investigate the impact of three independent variables (playing point, record and task) on the agreement on the paired factors of creative engagement in the questionnaire. On the factor of feedback, there was a significant three-way interaction ($F(1,22)=6.480$, $p=.018$) between the three variables. There was also a significant two-way interaction ($F(1,22)=8.000$, $p=.010$) between the playing point and task.

There was a significant main effect of task on the agreement on the paired factor of expressiveness ($F(1,22)=8.469$, $p=.008$), with a higher agreement ($M=4.979$) on the expressiveness of the prototypes when assigned with an exploratory task, compared with the creative task ($M=4.438$). There was also a significant main effect of task on the agreement on the paired factor of results worth effort ($F(1,22)=55.640$, $p<.001$), with a higher agreement ($M=6.250$) on the results worth effort of the prototype when assigned with an exploratory task, compared with the creative task ($M=4.250$). A summary is presented in part 1 of Table B.1.

Session	Factor	Agreement Mean
1. Comparison by task session		
	Expressiveness (ES6, CS10)	Explore >Create
	Results worth effort (ES10, CS11)	Explore >Create
2. Comparison by prototype modes		
Explore	Aesthetics (ES2)	$M_{ce} < M_{ne}$
Create	Creativity (CS8)	$M_{ce} > M_{ne}$
Create	Focus Attention (CS9)	$M_{cn} > M_{ne}$
3. Comparison by independent variables		
Create	Feedback (CS5)	M_{nn}&M_{ne} <M_{cn}&M_{ce}
Create	Focus Attention (CS9)	M_{nn}&M_{ne} <M_{cn}&M_{ce}

Table 5.6: Significant Results of Questionnaire Feedback in Study II

M_{nn}	M_{ne}	M_{cn}	M_{ce}
x	x	x	*t(11)*=-3.095, *p*=.010

Table 5.7: Results of Comparison between Initial Self-assessment on Music Creativity and Creativity with Prototypes

Comparison by Prototype Modes

A paired sample t-test was conducted to compare the difference between the agreement on ES0 and CS8 with all prototypes. There was no statistically significant difference between the initial self-assessment on music creativity and creativity with M_{nn}, M_{ne} and M_{cn} apart from M_{ce}. Creativity with M_{ce} (M=4.50) was rated significantly higher (*t(11)*=-3.095, p=.010) than initial self-assessment on music creativity(M=3.0), see Table 5.7.

For each statement in the questionnaire, the t-test was conducted to compare between prototype modes. A summary of significant difference is presented in part 2 of Table B.1. A paired sample t-test indicated that the agreement on ES2 ("This prototype was aesthetically appealing.") with M_{ce} (M=5.50, SD=.905) in exploration session was statistically significantly lower (*t(11)*=-2.419, p=.039) than that of M_{ne} (M=5.83, SD=.718). A paired sample t-test indicated that the agreement on CS8 ("I was very creative with the music.") with M_{ce} (M=4.50, SD=1.087) in creation session was statistically significantly higher (*t(11)*=2.345, p=.034) than that of M_{ne} (M=3.67, SD=1.231). An independent samples t-test found that the agreement on CS9 ("When I was improvising with the music box, I lost track of the world around me.") with M_{cn} (M=5.92, SD=.996) in creation session was statistically significantly higher (*t(22)*=-2.328, p=.030) than that of M_{ne} (M=4.83, SD=1.267).

Table 7.7 details the results of the prototype comparison questionnaire (second part of CEQ) with significantly different results highlighted in bold using a Chi test. Between the M_{nn}&M_{cn} comparison, there was no significant differ-

Playing point Records	No change, No edit	Changeable, No edit	No change, Editable	Changeable, Editable
	M_{nn}	M_{cn}	M_{ne}	M_{ce}
Enjoyment	5	7	4	8
Exploration	**2**	**10**	**1**	**11**
Expressiveness	**3**	**9**	4	8
Challenge	**9**	**3**	5	7
Creativity	5	7	**2**	**10**
Results worth effort	5	7	7	5

Table 5.8: Results of Comparison Questionnaire for Study II

ence between the enjoyment, creativity and results worth effort, but significant differences were found in the factor exploration (X^2=10.667, p=0.001), expressiveness (X^2=6.000, p=0.014), and challenge (X^2=6.000, p=0.014). Between the M_{ne}&M_{ce} comparison, there was no significant difference between the enjoyment, expressiveness, challenge, and results worth effort. However, significant differences were found in the factor exploration(X^2=16.667, p<0.001) and creativity (X^2=10.667, p=0.001).

Comparison by Dependent Variables

The data of M_{nn} & M_{cn} was combined to compare with the data of M_{ne} & M_{ce}, to examine the effects of editable records. An independent sample t-test was conducted on the agreement of questionnaire statements for two different task session accordingly. There was no statistical difference in any of the data between these two groups.

Similarly, the data of M_{nn} & M_{ne} was combined to compare with the data of M_{cn} & M_{ce}, to examine the effects of changeable playing point. A paired sample t-test was conducted on the agreement of questionnaire statements for two different task session accordingly. In the creation session, the agreement on CS5 ("The timeline offers support to implement different music ideas and possibilities") with prototype M_{nn} & M_{ne} (M=4.67, SD=1.373) was statistically significantly lower ($t(23)$=-2.228, p=.036) than that of M_{cn} & M_{ce} (M=5.25, SD=1.260). The agreement on CS9 ("When I was improvising with the music box, I lost track of the world around me") with prototype M_{nn} & M_{ne} (M=5.17, SD=1.239) was statistically significantly lower ($t(23)$=-2.632, p=.015) than that of M_{cn} & M_{ce} (M=5.58, SD=1.248). A summary of significant difference is presented in part 3 of Table B.1.

Summary

To summarise, significantly higher agreement on prototype **expressiveness** and **satisfaction with the result** was found when the participants were assigned with the exploratory task as compared to when they were assigned with the creative task.

With **timeline playing point**, the following significant results were found:

- When explore, M_{ne} was **more visually appealing** than M_{ce}
- Creating with M_{ce} was **more creative** than with M_{ne}.
- **More focus** when create with M_{cn} than with M_{ne}.
- M_{cn} & M_{ce} gave **better feedback** than M_{nn} & M_{ne}.
- **More focus** with M_{cn} & M_{ce} than M_{nn} & M_{ne}.
- M_{cn} & M_{ce} were **more exploratory** than M_{nn} & M_{ne}.
- M_{cn} was **more expressiveness** than M_{nn}.
- M_{cn} was **less challenging** than M_{nn}.
- M_{ce} was **more creative** than M_{ne}.

5.4.2 Interview Feedback

A bottom-up thematic analysis (Section 3.5.4) was conducted to extract participants' ideas about the prototype modes and task motivations. The researcher transcribed the interviews of each participants and went through the transcripts three times. While reading the transcripts, the researcher coded the sentences with preliminary themes. This iterative approach allowed the researcher to discover additional themes embedded in the transcript. Then the researcher went through the preliminary themes to create categorisations of themes by combining the similar ones. This process was carried out with MAXQDA[6] software. Each theme was interpreted based on the merged themes and participants' original feedback. The themes are reported below with representative quotes from participant. Participant ID is included in bracket after the quote. A full list of themes, codes and corresponding quotes is provided in Appendix B.3 for the reference of coding process.

[6] https://www.maxqda.com

Skill Set

> *"Because there are some skills involved, it's the difference between say playing tennis and doing a crossword, like there is skill in a crossword, but you get the time to sit there and think about it, you don't have to do it in a hurry." (Participant 23)*

The interview data suggested two categories of essential skills for non-musicians' creative engagement with the digital musical interface. The quote above exemplifies this point. Participant 23 reported with two examples that one skill involved more physical and muscle actions whereas the other skill involved more mental actions. These are similar to terms used in literature such as *cognitive and physical skills*, which are used to describe the required expertise for expert musicians from articulating the music in mind to expressing it onto the instrument [Ericsson, 1998, Davidson and Coulam, 2006].

Feedback that can be linked with cognitive and physical skills were mentioned by different participants. Four participants (Participant 10, 15, 19, 24) mentioned that they could not 'think' or 'concentrate' when the music was playing. According to twelve participants (Participant 3, 4, 5, 6, 9, 10, 13, 16, 19, 20, 21, 22), the most demanding skill was to memorise all the sounds, and to make decisions in the presence of the ongoing music. Therefore, it was difficult for the participants to improvise as it required both planning and remembering. In terms of the physical skill, four participants (Participant 10, 11, 14, 19) reported that they found it was hard to press the right button at the 'right time'. Participant 13 suggested offering visual feedback when they achieved a synchronised action, participant 2, 10 suggested to have auto-synchronisation embedded in the system. Some features of the timeline were reported to be conceptually or physically helpful during the process For example, eight participants (Participant 2, 4, 5, 11, 12, 13, 20, 22) reported positively on the timeline function of playing ahead as it 'free out mental space to do other things' (Participant 11). Participant 19 mentioned that with this planing ahead, she didn't need to worry about 'playing the button at the right point'. Besides, two participants (Participant 7, 8) mentioned that if the prototype was with less features, it would help to 'concentrate more'.

Based on the above feedback on concentration and memory, it can be seen that the cognitive skills related to various facts such as the conceptual understanding and creation of music. It is related to *musical aptitudes,* including knowledge of tonal and rhythmic imagery, strategies of idea exploration and generation, and the ability to shape sound structures [Webster and Ho, 1997], or the *mental representations* that help to plan and reason the actions, and to monitor the performance [Ericsson, 1998]. The definition is similar to the terms 'conceptual skill' proposed in [Davis et al., 2013a]. However, the difference is that cognitive skills emphasise on the music knowledge rather than the semantic knowledge to execute the task. Similarly, based on the feedback on timing, *physical skills* can be defined as the ability to execute the music ideas correctly, similar to the concept of *craftsmanship* proposed by Webster [Webster and Ho, 1997].

Structured Records and Plan

> *"It makes the structure more obvious, you know, of the music." (Participant 23)*

According to six participants (Participant 6, 11, 13, 16, 23, 24), the records on the timeline reminded them of the previous interactions and sound combinations they had made. being able to 're-listen' and 'review' the records, the structured records offered an easy trace back to previous success and mistakes, and free participants 'to use their imagination' (Participant 23). Therefore, the timeline interface served as a distributed cognitive tool for non-musicians as it allowed them to store knowledge and ideas temporally in the system rather than in the memory [Hollan et al., 2000], and to offload tasks and cognitive process on to environment or tools [Davis et al., 2013a].

Apart from offering an overview of the previous records, the timeline also indicated the current state of the system. As mentioned by Participant 16, 'you can see which sound is on and off at each time'. Moreover, the visual representations of the timeline enables non-musicians to approach music visually, e.g. 'the reference of the timeline, which is a lot like a graph, and then the sounds' (Participant 23). Nine participants (Participant 2, 4, 5, 11, 12, 18, 19, 20, 23) spoke highly of the timeline as it allowed them to plan future music events in a structured way. Being able to store musical ideas for the future and helped to reduce the mental workload required for music making, e.g. 'freed up to think about other things' (Participant 19).

The above evidence suggests that the timeline offered three parts of information: i) the previous records reminded participants of what was done, ii) the current status indicated what was going on, and iii) the future timeline helped participants to anticipate what was going to happen.

Improvise

> *"Then live playing is like, I'm just making some music, it's just there in the moment and then I'm gonna throw it away I don't care anymore. So it's like, yeah, just playing." (Participant 10)*

> *"In real-time I have to use my senses, and my ability to react and press it when it's supposed to be pressed." (Participant 11)*

As suggested in the above quotes, participants' concept of improvisation was associated with the activity of live playing. The term *live* refers to play directly with the sound in real-time. Ten participants (Participant 1, 4, 5, 8, 14, 15, 18, 19, 20, 22) reported that they enjoyed playing live, whereas three reported negatively. When digging further into this concept, two conceptual modes of playing live can be identified from the feedback

One is *experimenting live* on potential interactions, sound combinations and patterns in real-time. As mentioned by one participant, he was 'playing around with it' (Participant 11). When playing in this mode, participants (Participant 4, 10, 11, 16) reported that they focused more on the musical ideas and process rather than the results. For example, according to Participant 10, it was less pressure for him as he worried less about the mistakes. Moreover, six participants (Participant 4, 10, 11, 16, 20, 24) reported playing experimentally is 'intuitive', 'engaging' and 'responsive' for beginners to learn and explore, because of the direct and real-time sound feedback on interactions.

Contrary to the *experimenting* mode discussed above, the mode *performing live* was perceived as result oriented as three participants reported that they were worried about the quality of the output. Moreover, two participants (Participant 8, 23) took the idea of live playing as a process of performing music in real-time with the musical structures or ideas in mind. For example, Participant 23 reported it was 'like a musical instrument' and it required 'senses and ability to react and press when it's supposed to be pressed'. Participants 5, 8, 19 and 23 reported more 'pressure', felt 'less confident' and encountered more barriers such as skill, readiness time in this level of playing live. Therefore, it is suggested that the participant needed to put more cognitive efforts on timing, structure planning, etc. Participant 8 'assumed it's more difficult'. However, Participant 5 and 23 also reported great pleasure and fun when playing with this mode successfully as 'I enjoy at the moment right now (Participant 5)'. Despite more difficulties with performing live, five participants mentioned that the function of planning ahead plays a vital role in supporting participants' live performing by providing enough 'readiness time' to release the real-time pressure as the participants 'didn't have to worry about playing the button at the right point (Participant 19)'.

Compose

> *"If I were to make a composition, I would actually want to go, like after I'm done, sort of done, I want to go back and re-listen to it, to*

> *change it, you know."(Participant 10)*
> *"So it's actually, so the start would be good as well as the end...I was actually trying to make sounds...So you feel it's more secure, in some sense." (Participant 16)*

As suggested in the above quotes, Participant 10 and 16 viewed composing as an iterative process of building up a piece, creating, reflecting on and revising the previous records. This mode of playing was reported to be helpful for them to learn and to get inspiration from their success and mistakes. For example, Participant 7 reported when he looked back on the records, he found the mistakes he made and he thought to himself 'I'm not gonna do that again'. Participants who enjoyed playing with this mode reported the advantages of this mode of playing. For example, it offered more 'freedom' by allowing them to modify mistakes, e.g. 'I can correct it, so that will be much better.' (Participant 5). Moreover, it required less physical skills and offered enough readiness time as they did not 'have to be quicker'. In summary, these advantages produced less pressure for users as they felt 'it's more secure' (Participant 16), and it ensured good quality of results as 'the start would be good as well as the end'. In terms of the two features of prototypes, replay and revise records, participants reported that being able to replay records played a more important role in supporting the composition. This is coherent with the results from the quantitative analysis.

In terms of the process of composition, five participants (Participant 10, 11, 19, 22, 23) started with exploration on music ideas by 'randomly putting sounds together', and once they accumulated enough music ideas, they would start building up a general structure for the whole piece, e.g. 'with practice you could really layer up things' (Participant 19). This process could be thought of as a bottom-up strategy [Roads, 2015]. Contrary to the bottom-up strategy, Participant 21 began with a general structure of music in mind, followed by exploring and creating sound ideas and then filled them into a structure. This could be thought of as a top-down strategy (ibid).

Motivational Orientations

> *"It just really depends if I really want to create something, at the end I wanted to be good, probably the second one (M_{ce}). And if I really just want to playing live, like music flow, so would be the first one (M_{ne})." (Participant 18)*
> *"I could play, and just without having, to have a composition or something, just playing and listen to the sound, that was nice, and discover the sounds and stuff." (Participant 3)*

The above quotes indicate two different motivations. One aimed at the output, the other aimed at the real-time music playing. Five participants (Participant 8, 10, 16, 19, 21) mentioned that when given an explicit utilitarian task for music output, they preferred the composing mode as 'for actually creating a nice song, it would be really good to have the timeline and to be able to go back and forth' (Participant 19).

Whilst when playing with an exploratory task, Participant 1, 4, 5, 8, 14, 18, 20 and 22 mentioned that they prefered live playing as they enjoyed the responsive feedback of playing live, e.g. 'it's really easy to do at the current time, cause you can actually hear it'(Participant 16). Participant 4, 7 and 24 also reported being excited about the new ideas they encountered, e.g. 'the experiment of possibly creating something is good' (Participant 24). Besides, as mentioned in the theme *improvise*, because they were not given a goal of creating for output, they reported being more 'relaxed', 'being less worried about the mistakes' (Participant 20), and were therefore encouraged to explore more music ideas under this condition (Participant 24).

Inspiration Source

> *"I'm just put all the squares or all the circles and see if it sounds nice for some reason. But I think I like better to just mix, the shape."(Participant 3)*
> *"And the second one, more of a task that you have to, I guess helps to get different ideas. Cause you know you have this limit."(Participant 8)*

The above two quotes indicate that the participants used visual elements on the timeline as an inspiration source for creation. From the feedback, it is suggested that there were primarily three sources of inspirations in musicking. The primary source were participants' previous interactions and the music events recorded on the timeline, as mentioned also in the theme *structured records and plan*. These allowed participants to evaluate and to 'learn from' the previous success and failures, e.g. learn 'how they work together' (Participant 16), decide 'what needs to be changed' (Participant 11), and thus 'build on the previous creations' (Participant 7). Another source were the visual clues. Eight participants (Participant 3, 5, 15, 16, 17, 19, 23, 24) reported that the shape, colour, length of the graphic representations on the timeline inspired them on sound combinations and patterns, e.g. 'cause you can see which one is playing with which, with the other one' (Participant 16) so you 'know which one to cut and extend' (Participant 24). Finally, constraints were another source for inspiration. Although participants reported they felt frustrated when interacting with prototypes that had non-changeable playing points or non-editable records, it turned out that these constraints triggered the exploratory behaviours, and lead to more creative music ideas. For example, Participant 8 mentioned playing with the non-changeable playing point prototype was like 'a task that you have to, I guess it helps to get different ideas. Cause you know you have this limit.'.

5.5 Discussion

The hypothesis H1 (*Creative engagement will be greater with an explicit utilitarian task for the creative output*) is not supported by the findings. Given an exploratory task, participants' rating of expressiveness of the prototype (ES6 & CS10) and satisfaction with the results (ES10 & CS11) were significantly higher than when they were given a utilitarian task. This result suggests that an experiential task has more potential than a utilitarian task to increase the positive experience and perception of expressiveness of the prototype and satisfaction with results. One possible explanation could be when participants were given an experiential task they were more likely to be inspired to explore more musical expressions and were encouraged to employ divergent thinking[Sawyer, 2011], while the pressure of a utilitarian task may limit diverse thinking and exploration of musical ideas.

Interestingly, participants' rating of the aesthetic appeal of M_{ne} is significantly higher than M_{ce} in the exploration session. In other words, participants found the prototype without changeable playing point to be more appealing than the prototype with changeable playing point when playing with an exploratory task. The reason for this result may be that M_{ne} has fewer functions than M_{ce}, and it is simpler to learn and to play when given an exploratory task. In this condition, players were not obliged to create anything in particular so they may not have needed the functionality of a changeable playing point resulting in it becoming a cognitive burden that affects the perceived aesthetic of MTBox. This is contrary to the results that changeable playing point mode received higher agreement on creativity ($M_{ce} > M_{ne}$), focus attention ($M_{cn} > M_{ne}$) and feedback (M_{cn} & $M_{ce} > M_{nn}$ & M_{ne}) when playing with an creative task. From the above discussions, it is reasonable to infer that the task motivations largely affect the need for the changeable playing point on MTBox.

The hypothesis H2 (*Creative engagement will be greater with prototypes with changeable playing point*) was supported by the findings. Firstly, participants' rating for feedback (CS5) and focus attention (CS9) are higher with prototype M_{cn} & M_{ce} (which both had changeable playing point) than M_{nn} & M_{ne}. These higher ratings for feedback suggest that the interface with changeable playing point better supports creative engagement in keeping with findings by O'Brien and Toms who propose feedback as a key element of engagement [O'Brien and

Toms, 2008].

Secondly, participants rated their attention as significantly more focused with M_{cn} (has changeable playing point only) than with M_{ne} (has editable records and no changeable playing point). Higher ratings for focused attention suggest a deeper level of creative engagement - focused attention is proposed as a critical element of engagement [O'Brien and Toms, 2008] and a factor contributing to creativity [Carroll et al., 2009].

Thirdly, in Table 7.7 significantly more people reported that M_{nn} was more challenging than M_{cn} but no difference between M_{ne} & M_{ce}, and significantly more people reported that M_{ne} was less creative than M_{ce} but no difference between M_{nn} & M_{cn}. Also, both M_{cn} and M_{ce} were rated to be more exploratory than M_{nn} and M_{ne}. Both of these results indicate that a changeable playing point contributes to increased reporting of factors of creative engagement. Moreover, the ratings of creativity with M_{ce} were significantly higher than with M_{ne}, indicating that the changeable playing point increased perceived creativity.

Finally, the findings that when playing with a changeable playing point there was significantly more time spent on the previous timeline, and that the more time participants spent on the previous timeline the better feedback they gained from the timeline, suggest that the changeable playing point increased participants' positive experience of the prototype.

Hypothesis H3 (*Creative engagement will be greater with prototypes with editable records*) is partially supported by the findings. There is no significant difference between the participants' responses between non-editable prototypes (M_{nn} & M_{cn}) and editable prototypes (M_{ne} & M_{ce}). This suggests that the edit-ability of content does not have a direct effect on people's perception of their creativity. Alternatively, more generally the findings suggest that there was no perceived difference in support for creativity from a prototype which was designed more for improvisation (non-editable) and one which aimed to support composition (editable). This may be due to the musicking tasks given to participants which were purposefully vague (e.g. "explore" or "create"), or possibly because the participants were non-musicians who had a (relatively) short time to learn to use the system, or it could be because the comparison between editable and non-editable prototypes was between group as subjective Likert scales are compromised because of different reference groups [Heine et al., 2002].

However, participants' ratings of focus of attention with M_{cn} are significantly higher than with M_{ne}, and the ratings of the creativity with M_{ce} are significantly higher than with M_{ne}. This indicates that when both features - editable records and changeable playing point - are available, creative engagement is higher as elements of creativity are rated higher.

Interestingly, the results also seem to indicate that the feature of changeable playing point may be more crucial to non-musicians' creative engagement with musical interfaces than the feature of editable records. The ratings of expressiveness and challenge are significantly different between $\mathrm{M_{nn}}$ and $\mathrm{M_{cn}}$, but there is no significant difference between $\mathrm{M_{ne}}$ and $\mathrm{M_{ce}}$. Whilst ratings of creativity are significantly different between $\mathrm{M_{ne}}$ and $\mathrm{M_{ce}}$, but no significant difference between $\mathrm{M_{nn}}$ and $\mathrm{M_{cn}}$. This result indicates that whilst support for editing has some effect on ratings of expressiveness, challenge, and creativity, the primary effect is due to whether there is a changeable playing point or not. These results suggest that the effect of the feature of changeable playing point is enhanced by the addition of the feature of editable records.

5.5.1 A Descriptive Model for Creative Engagement

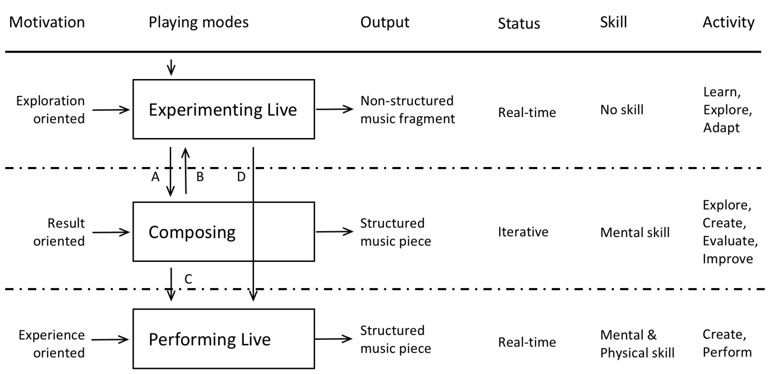

Figure 5.7: Model of Non-musician's Creative Engagement with Musical Interface

A descriptive model for non-musician's creative engagement with musical interface, see Figure 5.7, emerged from the themes extracted from participants' interview feedback in Section 5.4.2. According to the thematic analysis, the theme *improvisation* described two conceptual modes of playing live. Together with the theme *composition*, the results indicated three progressive modes of playing when participants creatively engaged in playing with the prototype, *i.e. experimenting live, compose and performing live.* The themes also indicated more information on each modes, for example essential skills for non-musicians' creative engagement and the motivational orientation of different playing stages. Each mode was encouraged by a differed motivation and demands a different set of prerequisite skills. There were different activities involved in each mode and the output were progressive levels of music. These results indicate that there was a grade of difficulty between the three modes, and a progressive level of playing. Therefore, creative engagement is described based on six factors, including the motivation of playing, the playing modes, the output, the status, the skills required, and the activities involved. Below is a description from the easiest mode to the more advanced mode.

Experimenting live was when the players were focusing on experimenting in real-time with possible musical ideas such as rhythmic patterns, typically using a trial and error approach. This playing mode required no skill, and the output was non-structured music fragments. It was usually the first mode of play adopted by non-musicians, of which the main purpose was to learn and incubate ideas for later creation [Sawyer, 2011]. As being responsive and has no conceptual and technical requirements, it encouraged the players to play in the initial stages. When playing with this mode, the players were in the very first level of creative engagement. It was oriented by exploration and involved the behaviours such as learn, explore, and adapt to system [Bilda et al., 2008] .

Compose was an iterative process of building up a structured piece and involved behaviours such as exploring, creating, listening, evaluating, improving, and recreating. It required cognitive skills and the output was a structured piece of music, which is similar to the musicking mode of composition discussed in Section 2.3.4. It was usually adopted at the second stage of the interaction process after the players reached a deeper understanding of the system [Bilda et al., 2008], and when the players had an explicit utilitarian task for producing good results. In this proposed framework, it kept player engaged after the initial encounter. When playing with this mode the players were in the second level of creative engagement.

Performing live was implementing musical ideas in a structured way in real-time, involving the behaviours such as create and perform. It required both cognitive and physical skills and the resultant output was a structured piece of music, which was similar to the mode of comprovisation and improvisation discussed in Section 2.3.4. It was usually adopted at the final stage of the interaction process when the players were pursuing the enjoyment of playing as well as a good result, and when the players were getting more confident with their cognitive and physical skills, and start to play fluent [Hansen et al., 2011] with the interface. This mode encouraged the relationship between the system and the player continues to grow. This mode was a more advanced level of creative engagement, and also the desired phase of creative engagement.

With MTBox, the most common trajectory of modes progressing started with *experimenting live* followed by *compose*, which was similar as a bottoms-up strategy of composing proposed in [Roads, 2015]. In contrast to this, one participant reported that he started with a general music structure in mind and experimenting live with musical ideas to fill in, which is similar to a top-down strategy of composing proposed in [Roads, 2015]. The trajectory towards *performing live*, illustrated in dotted line, was reported to be more difficult to handle, however, to be more enjoyable. Therefore, the trajectory of modes progressing towards performing live was the optimal trajectory of creative engagement as it offered challenges as well as joy [Csikszentmihalyi, 2014].

Barriers and Catalysts

The barriers inhibited non-musicians' creative engagement with IMS include their limit of cognitive skills, i.e. working memory, multi-task, and physical skills, i.e. synchronised or real-time act, and their lack of confidence and experience, i.e. pressure on result quality, and ease of becoming fixated without knowing what to do next. User interfaces could be designed to provide scaffolding to overcome these aspects. For example, timeline supporting plan ahead reduced the need of working memory for the task and reduced the amount of multitask in music making. The ability to change playing point supported real-time activities by allowing access to records in real-time, which is an essential feature of comprovisation discussed in Section 2.3.4. In terms of participants easily becoming fixed without knowing what to do next, the visual representations on the timeline helped participants to get more inspirations to create music expressions.

Several potential external and internal catalysts that could trigger further levels of creative engagement are proposed based on the data. External catalysts include constraints and social pressure. For example, as presented in theme *inspiration source*, when the prototype has limited control, the constraint may trigger participants to explore more possibilities. Alternatively, some participants reported that they were thinking about audiences when playing, which led them to explore and create. Internal catalysts include motivation and serendipity. When the motivation shifted from an experiential task to a utilitarian task, participants changed their playing modes. When participant encountered unexpected or surprising ideas, they were encouraged to explore more possibilities, as presented in theme *inspiration source*. These catalysts are different to those reported in studies of interactive art which suggested the participants start engaging in creative pursuits when their intentionality and expectation were not achieved [Bilda et al., 2008], or when the system initiated an unexpected change [Candy and Bilda, 2009].

5.5.2 Design Implications

To break the barriers to creative engagement for non-musicians, and to support their activities in the process, a list of design implications are discussed in detail below based on motivation, mental workload, insights and real-time activities. These design implications will have direct implications for the design of similar musical systems for non-musicians in fields such as NIME, or systems that aim to engage novices creatively in HCI.

1. Designing progressive layers of motivations. Designing motivations in different stages of interaction is a good way to catalyse novices in an optimal trajectory of creative engagement. According to the descriptive model of creative engagement, applying differentiate motivations could catalyse users towards different levels of creative engagement. It could be achieved by promoting experiential exploratory tasks by designing stepwise functions to be discovered stage by stage, or by promoting utilitarian creative tasks by encouraging participants to share the music outcome with social networks. This implication is in line with the proposal to foster and enhance motivation by setting stages and context for creative works [Selker, 2005]. It argues for an integration of different motivations into a single system, differed from the previous practices that designed only for experiential motivations [Robson, 2002, Hansen et al., 2011, Bengler and Bryan-Kinns, 2013] or utilitarian motivations [Bonnardel and Marmèche, 2004, Davis et al., 2013b, Benedetti et al., 2014].

2. Supporting cognitive skills. As discussed earlier, musical novices lack of musical skills to remember things and to cope with multi-tasks. There are two practical implications to release novices' cognitive workload in the creative process.

- Offering ***controllable structured records***. Structured records of content and interactions offer an easy trace back to previous success and mistakes [Kim et al., 2015], which supported the self-evaluation on the activities and contributed to the improvement. This implication is coherent with the call for rich history-keeping mechanism and compositional structure suggested in [Shneiderman, 2007, Carroll et al., 2009, Franco et al., 2004]. However, here the emphasis is on the mechanism to control and manipulate the records at a global level rather than merely organise or visualise the data. Being able to be reused or changed, the records could become archived resources for the learning process as well as the further creative process, which supports the activities such as learn, explore, create, improve and perform in a creative process, as discussed in Section 2.2.5. In MTBox the ability to revisit and replay previous records in real-time allows the player to use the previous records as content to create the whole piece. In music domain, this could be as simple as a timeline storing the information about melodic contour and rhythmic patterns, similar to the traditional music score.

3. Stimulating insights. As discussed in Section 2.2.4 and also from the results of this study, novices can easily get fixed in previous ideas [Kerne et al., 2014]. It is necessary to provide mechanisms to support them to get insights.

- Providing ***inspiration source*** to foster insights, by offering valuable records, visual cues, or by employing certain constraints. More specifically, this could be achieved by providing the ability to evaluate records and to encourage the user to learn from the evaluation [Shneiderman, 2007, Carroll et al., 2009]. Alternatively, applying straightforward graphic elements such as shape and colour can potentially help users to get ideas for creating music combinations and patterns. Providing inspiration source is to stimulate *analogical thinking* that connect the content of analogies across domains to support the selective comparison in a creative process [Bonnardel, 1999, Sternberg and Kaufman, 2010]. This implication is similar to the strategy to support serendipity (discussed in Section 2.2.5) by providing users with unexpected and valuable content that they might not have otherwise thoutght of or come across [Makri et al., 2014, Kerne et al., 2014]. It could also be achieved simply by employing limited control to drive the user to explore the limit of the system to trigger creativity. As discussed by Sternberg, constraints do not necessarily harm creative potential, but may be built into the construction of creativity itself [Sternberg and Kaufman, 2010].

4. Designing for real-time activities. For real-time interactions that require both cognitive and physical skills, it is difficult for novices to achieve good performance in a short time as it takes time to be fluent and be confident. Supporting real-time activities can be achieved by the following two practices.

- Supporting ***planning future events***. When pursuing outcome with good quality in real-time, it is necessary to have a clear conceptual route for upcoming events and implementation methods. A mechanism allowing preparation of events in advance can reduce multi-tasks needed for real-time interactions, similar to the proposal of distributed creativity to offload some of the conceptual and technical tasks to the tools [Davis et al., 2013b]. By doing so the interface can greatly release the cognitive workload and allow for enough readiness time, thus impose less pressure on participants and allow more confidence and chances for creativity [Gelineck and Serafin, 2010].

- Facilitating ***real-time physical skills***. Auto solutions provided by the system, e.g. auto synchronisation, auto correction, help novices to achieve a satisfied performance and thus help to release their pressure and add onto confidence [Nickerson, 1998]. In MTBox, auto-synchronisation might help non-musicians to trigger music samples at the right time. This implication is coherent with the current design practices that use solutions such as auto synchronisation to engage novices in entertainment experience [Weinberg, 2008, Shirokura et al., 2010].

5.6 Reflective Summary

This chapter presents an overview of the second study undertaken to explore the effects of task motivation and features of musicking modes on non-musicians' creative engagement with interactive musical systems. The results from an empirical study of twenty-four participants highlighted that an experiential motivation is better than a utilitarian motivation for creatively engaging non-musicians in some aspects. The feature of replay was less critical when the player was with an experiential motivation than with a utilitarian motivation. The results also showed that supporting participants to replay previous music ideas increase some aspects of their creative engagement. Moreover, when participants were able to edit their creations the increase in creative engagement was more pronounced. It was also suggested that creative engagement increases when the musical interface provides features for planning ahead. A descriptive model for non-musician's three levels of creative engagement oriented by three different purposes with musical interfaces was proposed with three playing modes. Design implications were proposed to inform future design for supporting novices creative engagement with consideration on motivation, cognitive skills, insights and real-time activities.

The theme extracted from thematic analysis and the design implication call for inspiration source informed the design of the research question of Study III. Future studies will need to look at what forms of inspiration source to trigger creativity more specifically. The limitation of MTBox used in this study informed the improvement of MTBox used in Study III. The current trigger mechanism of the samples is not intuitive enough as it involves two steps of interaction. The player needs to choose a sample first and to press ON or OFF button to be able to initiate or to stop the sample. More intuitive interaction needs to be designed.

The questionnaire which was designed based on a set of factors extracted from engagement attributes and evaluation factors for CST tools have provided informative evidence to conclude the hypothesis. This has been greatly improved as compared to the questionnaire used in Study I. However, results of some of the factors are not significant. Moreover, the study procedure was complicated, and participants were facing long questionnaires and interviews. It might make participants tired and influence the credibility of results as participant may felt tired of reading and may answer the questionnaire unmindfully. In future studies, it would be possible to streamline their implementation by eliminating some of the factors that are not obvious according to the research questions to reduce the volume of the questionnaire and lighten the workload of participants. Moreover, the data was only collected in the controlled sessions with different modes of playing and motivations. Without data collected in a non-controlled session, e.g. a baseline mode of playing and motivation, there is a lack of comparison between the controlled condition and baseline condition. It is possible to get more evidence and to develop a deeper understanding of the research question with such a comparison.

The current conclusions were drawn based on the questionnaire data. As discussed in Chapter 3 and the use of interaction log data in Study I, there is a promising potential to extract evidence from interaction log data to illuminate the level of creative engagement. More in-depth analysis methods such as data mining could be applied to detect activity patterns or to quantify activity levels on the interaction log data collected from Study II. This work will be introduced in the next Chapter.

Chapter 6

Exploring Methods of Evaluation through Interaction Log Data

This chapter presents the exploration of the methods to evaluate creative engagement through interaction log data. Data mining and recurrence quantification analysis is applied on participants' interaction log data collected from the Study II, to identify the changes or states of behaviour during the interaction process. The inter-correlation between the results of the quantitative exploration of interaction data and qualitative feedback is examined. It is aimed at exploring connections between objective data and subjective data that could give implications for understanding the user interactive process. It is worth noting that the purpose of this chapter is to explore possible methods that could be used in such an analysis. The evaluation of the methods is beyond the scope of this thesis.

6.1 Motivation

Study II (Chapter 5) has examined whether non-musicians' creative engagement is influenced by motivations and user interface features of musicking modes. The conclusions were drawn based on the analysis of questionnaire feedback from participants' subjective rating on their agreement on a list of statements. As discussed in Chapter 3, it is particularly interesting to examine the research question though interaction log data. The results could potentially serve as a complementary source for understanding user's creative engagement and improving the validity of findings.

In Study I the qualitative analysis of timeline activities offered information to understand how participants interacted with the prototypes. The visualisation of the interaction log data and the qualitative interpretation indicated participants' patterns and strategies of exploration and creation. However, the approach lacked potential for generalisation as it was subjective according to the analyst and lacked systematic guidelines. Moreover, the qualitative approach did not offer evidence that could be used to support the conclusions to the research question. Therefore, this chapter focuses on two topics: analysis of interaction log data and exploration on how such data could be used to inform the research question.

As mentioned in Section 3.5.3, studies combined the analysis of qualitative data with quantitative interaction log data to inform more complicated or more abstract topics of an interaction process. For example, to investigate the level of participation in collaborative interactions and to identify the role of shared annotation on mutual engagement in collaborative music making, the analysis of the interaction log data combined both quantitative activity analysis and qualitative content analysis [Simoff and Maher, 2000, Bryan-Kinns, 2013]. This motivated the exploration on the relationship between the interaction log data and the subjective feedback on questionnaire. The activity analysis was mostly focusing on the count of different activities with the user interface, e.g. count of mouse pointer movement, click, and drag. The idea of analysing the user' activities has direct implications for the analysis of interaction log data used in this chapter. Moreover, due to the mere focus of such analysis, this chapter sets out to explore more potential methods could be used to analysing interaction activities. The methods of analysing content were mostly qualitative oriented, e.g. coding scheme on topics of communication, thematic keywords, which can not be applied to the current study. Therefore, activity assessment (what participants did) is the primary focus of this chapter.

6.2 Activity Assessment

Objective measures of interaction activity with MTBox can be derived from numerical analysis of logs of participants' activity with the user interface, including three categories: timeline activity, pattern activity and activity recurrence. The sections below introduce the detail of data collection, choices of measures and the rationale of choice, as well as methods adopted.

Coding	Interaction
s	Switch sample
f	Scroll to future timeline
p	Scroll to previous timeline
b	Back to current playing point
c	Change playing point to previous point on timeline
d	Change playing point to future point on timeline
r	Start pause
n	Stop pause
a	Add a new ON point
e	Edit an ON point
i	Insert an ON point in the records
o	Add a new OFF point
m	Edit an OFF point

Table 6.1: Coding of Interaction Log Data in MTBox

6.2.1 Data Collection

MTBox was implemented with the ability to log every interaction on the buttons and the timeline with time stamp. The various interactions with MTBox were coded and grouped into meaningful interactions. Table 6.1 lists a full list of interaction types and coding. For each interaction process in Study II, a time series data of interaction was logged with a coded interaction type in a CSV file.

6.2.2 Timeline Activity

Timeline activities were one of the main activities that participants performed with MTBox. The analysis of timeline activity has the potential to form a descriptive understanding of how the user used the features of the timeline. Therefore the ratio time duration each participant spent on the timeline was computed, including the ratio of time they spent on the future timeline (f-duration) and on the previous timeline (p-duration).

6.2.3 Pattern Activity

Instead of counting and comparing the counts of different interaction types, this study looked for more sophisticated measures that could help to understand the process of interaction.

The idea of mining frequent patterns of interaction was inspired by the study where researchers observed participants often performed action sequences in the specific condition and generated specific results [Guo et al., 2016]. Therefore, they performed analysis by identifying frequently performed patterns and revealed the essence of the action sequences in an interaction process (ibid). The underlying assumption was that the variety of frequent patterns performed during an interaction process could be a potential indicator of how deeply the user explored the prototype because it shows how many different ways of playing the user have discovered with MTBox. Exploring the relationship between the variety of frequent patterns and the subjective feedback on the creative engagement could offer insights on how to relate the pattern activities to the subjective interaction experience [Guo et al., 2016].

Data mining (DM) techniques were developed to explore knowledge in large data sets by extracting patterns or identifying clusters. It is widely used for mining the patterns performed in an interaction process. A summary of the typical procedure for combining quantitative data mining and qualitative analysis of interaction log data is described below [Simoff and Maher, 2000, Reda et al., 2014, Guo et al., 2016].

1. Prepare data. The data preprocessing is for better applying algorithmic methods to mine data. It usually involves activities such as optimising the data format, pruning or removing unnecessary information, normalisation, anonymisation [Simoff and Maher, 2000, Wang et al., 2016].

2. Code interactions. The coding process is to put similar data into groups based on a list of coding schemes. The development of coding schema largely depends on the purpose of analysis. It could be hierarchical [Simoff and Maher, 2000] or different types of interactions, content.

3. Calculate activity. This step involves calculating the descriptive statistics on the activities, for example, activity time or duration, counts, frequency, which could offer an overall understanding of the interaction activities, and inform the further analysis.

4. Extract patterns/ clusters. Mining algorithms are used to model user behaviour at this stage. One method is to extract sequential actions that frequently happen in an interaction process. For some study, the patterns could be already used to inform later analysis. For some studies, it is necessary to cluster the patterns based on its primary features and the similarity of sequences [Berkhin, 2006].

5. Elaborate patterns/ clusters. The final step is making sense of patterns and clusters generated by mining algorithm. Subjective data provided by the user such as think-aloud or self-report data are usually collected and combined. Another typical practice is by visualising user interactions [Brown et al., 2014, Wang et al., 2016]. Some more in-depth statistical analysis is also used to calculate correlations between patterns and performance, providing further evidence to conclude.

Algorithm Development

Closed Frequent Sequential Patterns (CFSP) mining was adopted to mine the repeated interactions in this chapter. CFSP is an vital data mining method to discover subsequences as patterns that frequently occur in a consecutive time series data [Han et al., 2000, Pei et al., 2000]. The term *Close* refers that this pattern does not belong to any of the more extended patterns. The closed pattern gives a more precise representation of the repeated interactions and largely reduces the number of patterns mined from the dataset [Han et al., 2000, Pei et al., 2000]. In the case of data from Study II, an example of such a sequential pattern is 'faafoo', meaning a user first scroll the timeline to the future, start two samples successively, scroll the timeline further, and finally stop two samples successively. If this sequence happened three times or more in the overall process of the interaction, the sequence was considered to be *frequent* in the interaction process. The choice of the threshold was based on the objective that the final set of patterns should be within a reasonable number, not too big or too small.

CFSPs were extracted with an algorithm written in JAVA in two steps:

Step 1: Identify Frequent-performed Patterns Firstly, the algorithm started by splitting the time series data into small sequences. The length of the small sequences was determined with the minimum of 3 actions until the maximum of 12 actions. The process was repeated until all length of sequences had been segmented and logged as a pool of sequences. The choice of minimum length of 3 was to capture only non-trivial patterns. The choice of a maximum length of 12 was based on the test results with 5 sample interaction logs. When the sequence was more than 12 actions, there would not be any repetition of such sequences. Thus it was beyond the scope of interest in this analysis. Once the pool of sequences was generated, a comparison between the sequences was performed. The count of repetition times of each sequence, those appeared more than three times were logged for the next step.

Step 2: Identify Close Frequent Sequential Patterns. The frequent patterns mined in Step 1 were compared with each other. The ones that belong to a more extended pattern were detected and deleted from the list. After the one-to-one comparison, the patterns left in the pool were the CFSPs mined from that interaction series.

6.2.4 Recurrence Activity

Apart from the CFSP, the repetition of the interaction (*interaction repetition*) was proposed as another possible indicator for the level of creative engagement as it has the potential to show how fixed the user's interaction was when playing with MTBox. The hypothesis followed the same rationale as the choice of CFSP, that the more various actions the players have performed, the more exploratory they were when playing with MTBox, thus the deeper the level of their creative engagement.

In the current behavioural, cognitive, and physiological research, recurrence-based strategies are widely used to understand interpersonal or social activities in human interaction through human time series behavioural sequences such as physical gestural movements or movement of eyes [Shockley and Riley, 2015]. Recurrence-based methods are ideally suited for analysing the human behavioural sequences as the data is noisy, non-stationary, and complex (ibid). Recurrence Quantification Analysis (RQA) is a recurrence-based method to identify the dynamics of a time series data by discerning (a) whether the states in the time series data recur over time and, if states are recurrent over time, (b) the degree to which the patterning of recurrences are highly regular or repetitive (i.e. deterministic) [Marwan et al., 2002, 2007]. It helps to identify whether actions recur over time, and calculate the degree to which the recurrence happened in a time series dataset.

To examine whether participants repeat their interactions over time, RQA was adopted to quantify the recurrence of an interaction process for each participant. The RQA was performed with the toolbox in MATLab [1] based on methods introduced in [Yang, 2011, Chen and Yang, 2012].

6.3 Analysis & Results on Timeline Activity

The percentage of time participant spent on the previous records of the timeline (p-duration) and on the future records of the timeline (f-duration) among all the interactions was calculated, illustrated in Figure 6.1 based on prototype modes. A paired sample t-test indicated that the participant spent significantly more time (p<.001) on the future records of the timeline. There was also a significant strong positive correlation (r=.599, n=96, p<.001) between the p-duration and f-duration according to a Pearson correlation analysis. A significant regression equation about f-duration based on p-duration was found (F(1,94)=52.570, p<.001), with an R^2 of .359.

A three-way mixed ANOVA was conducted to investigate the impact of changeable playing point (within subjects), editable record (between subjects) and task (within subjects) on p-duration and f-duration. There was no significant interaction between the three variables on both p-duration and f-duration. There was no significant main effect of records and task on both p-duration and f-

[1] https://uk.mathworks.com/products/matlab.html

duration. However, there was a significant main effect ($F(1,22)=19.370$, $p<.001$) of playing point on p-duration, with higher time percentage spent on p-duration with changeable playing point prototypes ($M=.167$, $SD=.093$), compared to that with non-changeable playing point prototypes ($M=.110$, $SD=.076$).

A 2-tailed Pearson correlation was conducted to determine the relationship between f-duration/p-duration and the agreement on statements in two sessions. There was no correlation between p-duration and agreement on statements in the exploration session. However, in creation session, there were significant positive correlations between f-duration and CS2 (The timeline helps me to organise my composition)($r=.322$, $n=48$, $p=.026$), and between p-duration and CS5 (The timeline offers support to implement different musical ideas and possibilities) ($r=.297$, $n=48$, $p=.040$).

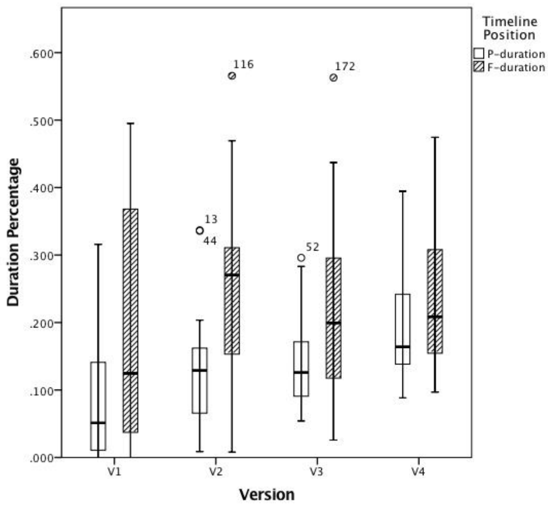

Figure 6.1: P-duration and f-duration of different prototypes

6.4 Analysis & Results on Pattern Activity

CFSPs were extracted from the interaction log data for each interaction and for each participant. The number of the types of CFSP performed in each interaction was counted for further analysis. Figure 6.2 illustrates the count of types of CFSP with four modes of the prototype in both the exploration and creation task sessions. The average types of CFSP performed by each participant were 8.77 in the creative session and 7.92 in explore session.

A two-way mixed ANOVA was conducted to investigate the impact of editable records and changeable playing point on the types of CFSP from exploration and creation session. There was no statistically significant two-way

Session	Types of CFSP
General	M_{nn} & M_{ne} >M_{cn} & M_{ce}

Table 6.2: Results of Comparisons of types of CFSP

interaction between the two variables in both sessions. However, there was a significant main effect ($F(1,22)=10.356$, $p=.004$) of the playing point on the types of CFSP in the creation session. Given the prototypes with non-changeable playing point, there were significantly more types of CFSP ($M=10.708$) performed by participants, compared to given the prototypes with changeable playing point ($M=6.833$). A further paired sample t-test indicated that the types of CFSP with mode M_{nn}&M_{ne} ($M=10.708$, $SD=5.254$) is statistically significantly higher ($t(23)=3.174$, $p=.004$) than that with mode M_{cn}&M_{ce} ($M=6.833$, $SD=4.39$).

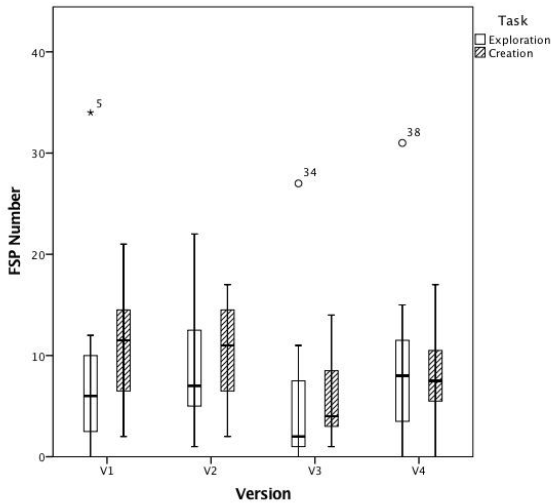

Figure 6.2: Types of CFSP in Exploration and Creation sessions

6.4.1 Correlation Analysis

According to a 2-tailed Pearson correlation comparison between the CFSP types and the agreement on the statements in questionnaires in two different task sessions, there was no correlation between the types of CFSP and agreement on any statement in the questionnaire for exploration session. However, there were significant negative correlations between the types of CFSP and the agreement on CS3 (I have enough time to plan what I want to play) ($r=-3.01$, $n=48$, $p=.038$), and CS5 (The timeline offers support to implement different music ideas and possibilities) ($r=-3.68$, $n=48$, $p=.010$) in the creation session. A further simple linear regression was calculated to predict the agreement on CS3

Mode	Relation	Attribute	Example
	Negative	CS3 (Readiness Time)	More CFSP & Less readiness time
	Negative	CS5 (Feedback)	More CFSP & Less feedback
M_{ne}	Positive	ES1 (Curiosity)	More CFSP & More curiosity
M_{ne}	Negative	ES7 (Frustration)	More CFSP & Less frustration
M_{ce}	Negative	CS3 (Readiness Time)	More CFSP & Less readiness time
M_{ce}	Positive	CS6 (Expressiveness)	More CFSP & More expressiveness

Table 6.3: Correlation Results between Types of CFSP and Questionnaire Feedback

and CS5 based on CFSP number. A significant regression equation was found for CS3 and types of CFSP ($F(1,46)=4.567$, $p=.038$), with an R^2 of .090. There was also a significant regression equation for CS5 and types of CFSP ($F(1,46)=7.187$, $p=.01$), with an R^2 of .135.

A further 2-tailed Pearson correlation comparison between the CFSP number and the agreement on the statements in questionnaires was calculated by different modes of the prototype. In the exploration session with M_{ne}, there were a positive strong correlation between types of CFSP and agreement on ES1 (I was curious about the prototype) ($r=.577$, $n=12$, $p=.050$), and a negative strong correlation between types of CFSP and agreement on ES7 (I felt frustrated while playing with this musical box) ($r=-.610$, $n=12$, $p=.035$). In creative session with M_{ce}, there was a negative, strong correlation between types of CFSP and agreement on CS3 (I have enough time to plan what I want to play) ($r=-.597$, $n=12$, $p=.040$), and a positive, strong correlation between types of CFSP and agreement on CS6 (I kept finding new ways of playing with the sound in this prototype) ($r=.580$, $n=12$, $p=.048$) A full list of strong correlation between CFSP and creative engagement factors please see Table 6.3.

6.4.2 Qualitative Interpretation on Patterns

A qualitative classification on various CFSP extracted from interaction log data was performed in order to develop an overall understanding of the interactions. After merging similar CFSPs, four kinds of behaviours can be summarised.

- **Creating.** The player performed actions to turn an individual or several samples on or off. It was the most typical repeating interactions observed in most participants' data. The example sequences were *saosaosao, sasasa, sososo, aoaoao.* It is interesting to note that these patterns tend to be very rhythmic.

- **Navigating** The player performed actions to navigate through MTBox, either by switching between different tracks or navigating through the

Session	Recurrence Value
General	Create >Explore
Explore	M_{cn} >M_{nn}

Table 6.4: Results of Comparisons of Interaction Recurrence Value

timeline. No action was performed to change any state of sound. The example sequences were *ssssss, fpfpfp, fsspss*.

- **Planning.** The player performed actions in the future of the timeline to start or stop a sample, or pause the sound and start or stop a sample. The example sequences were *fafofo, fofofo, faoaoa, rpafo*.
- **Editing.** The player performed actions to edit records, either to extend or cut off previous records. The example sequences were *pmpmpm, imimim, smsmsm*.
- **Live playing.** The player repeatedly changed the playing point to the previous or to the future timeline and started playing from there. The example sequences were *opcpci, fcf, fdfdfd*.

6.5 Analysis & Results on Activity Recurrence

The recurrence value (RV) of each interaction process was calculated for each participant. A paired sample t-test was done on participants' RV between creation and exploration sessions. A statistical significant difference (t=3.676, p=0.001) was found on the average RV between two sessions. In creation session, the RV (M=19.260, SD=4.954) was significantly higher than that in exploration session (M=16.699, SD=4.086).

In the comparison between M_{nn} and M_{cn} in exploration task with a paired sample t-test, there was a significant difference (t=-2.514, p=0.029). The RV of the interaction with M_{nn} (M=16.277, SD=2.429) was significantly lower than that with M_{cn} (M=19.535, SD=5.244). Apart from the above significant difference, there was no other significant difference on the comparison between different modes of prototype. A full list of significant differences on RV, please see Table 6.4.

6.5.1 Correlation Analysis

The correlation between the RV of each interaction and the subjective rating on the agreement of factors of creative engagement were examined.

According to a 2-tailed Pearson correlation analysis, in the exploration session the RV of participants' interaction was significantly negatively correlated

Mode	Relation	Attribute	Example
	Negative	ES9 (Focus Attention)	Higher RV & Less focus attention
M_{nn}	Positive	ES2 (Aesthetic)	Higher RV & More aesthetic
M_{nn}	Negative	ES3 (Learnability)	Higher RV & Less learnability
M_{ce}	Positive	ES4 (Feedback)	Higher RV & More feedback
M_{ce}	Negative	ES9 (Focus Attention)	Higher RV & Less focus attention

Table 6.5: Correlation Results between Recurrence Value (RV) and Questionnaire Feedback

(r=-3.26, n=48, p=.024) with the ratings on focus attention (ES9). This was the only significant finding on the correlation analysis between the RV and feedback on all questions in the questionnaire.

A further 2-tailed Pearson correlation comparison between the two dataset was calculated by different modes of prototypes. In the exploration session with M_{nn}, the RV was significantly positively correlated (r=.598, n=48, p=.040) with perceived aesthetic (ES2), and negatively correlated (r=-.637, n=48, p=.026) with the easiness of learning (ES3). In the exploration session with M_{ce}, the RV was significantly positively correlated (r=.710, n=48, p=.010) with perceived feedback (ES4), and negatively correlated (r=-.673, n=48, p=.017) with the focus attention (ES9). There was no significant finding in the creative session with all the modes of prototypes.

6.6 Discussion

6.6.1 Timeline Activity

Results reported in Chapter 4 showed that non-musicians reported more creative engagement when they had more time to prepare and to implement their musical ideas. The fact that f-duration was significantly positively correlated with the agreement on CS2 (The timeline helped me to organise my composition) support the claim that non-musicians' creative engagement increases when the musical interface provides features for planning ahead. Moreover, the finding that p-duration was significantly positively correlated with the agreement on CS5 (The timeline offered support to implement different musical ideas and possibilities) indicate that the more participants use the previous timeline, the better feedback they thought they have got from the prototype. This result suggests that the previous records have positive effects to help non-musicians to learn, explore and implement music ideas. This is coherent with the results in the thematic analysis reported in Chapter 5, which indicated that the structured records and plan the timeline offered were helpful in supporting non-musicians to create music.

When playing with the prototype with changeable playing point, there was a higher time percentage spent on the previous timeline. There was also a strong positive correlation between f-duration and p-duration, as well as a positive regression equation. With the regression equation, it is possible to predict the time people spent on the future timeline based on the time they spent on the previous timeline. These two findings support the claim that the usage of both previous and future timeline function were higher with the prototypes with changeable playing point than that with non-changeable playing point.

The results of the timeline activity are consistent with the results reported in Chapter 5. These can be used as supplementary evidence to reinforce the conclusions of Study II.

6.6.2 Pattern Activity

The assumption that the variety of CFSP indicates the how in-depth the user explored the prototype is supported by the results. The positive correlation between the number of types of CFSP and CS6 (I kept finding new ways of playing with the sound in this prototype) indicates when more types of CFSP were performed, the participants reported that they kept finding new ways of playing with the sound with M_{ce}. This result suggests that the number of the types of CFSP was positively correlated with the depth of exploration in an interaction process.

Apart from the level of exploration with the prototype, the analysis of CFSPs was informative in other aspects. The significant main effect of the prototype feature of playing point on the types of CFSP indicates that given prototypes with non-changeable playing point (M_{nn} & M_{ne}), there were significantly more types of repeated interactions (CFSP) found than given the prototype with changeable playing point (M_{cn} & M_{ce}). It is reasonable to infer that the more types of CFSP were associated with fewer functions within the prototype. This might be because more constraints encouraged or forced the players to explore more possible interactions. Therefore more types of repeated patterns were observed with the prototypes with more functions.

The negative correlations between the types of CFSP and the agreement on CS3 (I had enough time to plan what I want to play) and CS5 (The timeline offered support to implement different musical ideas and possibilities) indicate that when more types of CFSP performed, the participants rated that they had less time to plan what they want (CS3), and agreed less on the feedback (CS5) provided by the prototype. Together with the claim discussed above that with non-changeable playing point the more the types of CFSP was observed, the conclusion could be drawn that the prototype with non-changeable playing point did not support the creative experience in the aspects of readiness time and feedback from the timeline. This is coherent with the conclusion drawn on the hypothesis H2 in Study II, that creative engagement will be deeper with prototypes with changeable playing point.

With prototypes with non-changeable playing point, the correlation analysis indicated the number of types of CFSP performed in the exploration session was positively associated with subjective feedback on some factors (ES1 and ES7) of creative engagement. With more types of CFSP performed, the participants rated that they were more curious (ES1) about M_{ne} and felt less frustrated (ES7) with M_{ne} in the exploration session. Although these results seem to be opposite to the above discussions as well as the conclusion in Study II, there was not enough evidence to overturn the above conclusion considering these results were under certain conditions, for example, only with M_{ne} and only in exploration session. Moreover, this could be evidence to support the hypothesis H3 of Study II, that the prototype with editable records has positive effects on non-musicians' creative engagement.

In terms of the qualitative interpretation of patterns, the major categories of behaviour based on the extracted patterns were similar to the themes extracted from the thematic analysis reported in Chapter 5. For example, the patterns of *live playing* can be associated with the theme *improvise*, the pattern of *planning* and *navigating* can be associated with the theme *Structured Records and Plan*. The qualitative interpretation of patterns has great potential to support the thematic analysis by offering the additional information.

In summary, the correlation analysis between the variety of CFSP and subjective feedback from the questionnaire shows a high potential to contribute to the explanation of the research question in Study II. It helped to understand and to expound the interaction behaviour by providing objective evidence. Moreover, the classification of CFSP offers in-depth objective evidence on understanding player's behaviour with MTBox.

6.6.3 Activity Recurrence

In creation session, the RV of participants' interaction was significantly higher than that in exploration session. When playing without a concrete goal in the exploration session, the participants' interaction was less repeated than when they were playing with a creative goal. This result indicates that the task can significantly influence the way a participant approaching the prototype. The exploratory task encouraged participants to explore more of the prototype, and thus the interaction was less repeated. This is also coherent with the conclusion drawn for hypothesis H1 in Study II, that the creative engagement will not be greater with an explicit utilitarian goal. The evidence support the claim that given an experiential goal, the participant would demonstrate more exploratory behaviours.

In the comparison between modes, the only significant finding was that the RV with M_{nn} was significantly lower than that with M_{cn}. The lower RV with M_{nn} indicates less fixation and more variations of the interaction. The reason for this might be that the constraint of M_{nn} encouraged more exploration on the interaction than M_{cn}. This conclusion was coherent with the positive effects of constraints discussed in the previous section, that the fewer functions in the prototype, the more encouraged the player would be and thus more in-depth exploration would be carried out.

The negative correlation between the RV and agreement on ES9 (When I was playing with the prototype, I lost track of the world around me) suggested that the repeated behaviours might be a sign of disengagement. The reason might be that the participants could not find different ways of playing with the prototype, and thus they reported to be less focused. This result was coherent with the correlations that suggest the more repeated interaction is associated with less learnability with M_{nn}.

However, it is interesting to note that the repeated interaction was positively associated with the feedback on some factors of creative engagement under certain condition. For example, with M_{nn} the higher RV was associated with higher agreement on the aesthetic of MTBox, and with M_{ce} the higher RV was associated with higher agreement on the feedback of MTBox. This might be because, with more repeated interactions, the participants was less engaged in creating and therefore noticed more on the appearance of MTBox and the actual timeline interface.

The above discussions indicate that the analysis of interaction recurrence do have the potential to imply how fixed the user's interaction was under different conditions, and could contribute to the understanding of the research questions. Although the higher RV tends to suggest a less level of creative engagement, evidence also suggests under certain circumstance it might still be a positive experience. The fact that all the significant results were found only with the data in the exploration session instead of the creation session suggests the RQA might be more powerful to examine the exploratory behaviour than the creative behaviour.

6.6.4 Comparison of Pattern Activity and Activity Recurrence

The results of CFSP analysis and RV analysis were coherent with each other. The types of CFSP performed with prototypes with non-changeable playing point (M_{nn} & M_{ne}) were significantly more than that performed with changeable playing point (M_{cn} & M_{ce}). This result indicates that there were significantly more repeated interaction patterns performed with prototypes with non-changeable playing point, which was the sign of more exploration on the interactions. The RV with M_{cn} was significantly higher than the RV with M_{nn} in exploration session. This result indicates the recurrence was less obvious with the prototypes with non-changeable playing point, which also supported the claim that the prototypes with non-changeable playing point encouraged more exploratory activities.

As discussed earlier in the previous sections, the prototype with non-changeable playing point encouraged more exploratory activities. However, according to the subjective feedback presented in Chapter 5, the prototype with non-changeable playing point was rated less positive in terms of subjective experience, e.g. participants rated higher agreement on the feedback and focus attention with M_{cn} & M_{ce} in creative session. M_{nn} was more challenging than M_{cn}, M_{ne} was less creative than M_{ce}. These results indicates that although the prototypes with non-changeable playing point encouraged more exploratory activities, it was less successful to engage participants creatively. The negative correlation between RV and focus attention (ES9) indicated that the exploratory activities were positively associated with focus attention. With this it is reasonable to claim that the higher focus attention does not necessary indicated higher creativity. These are two separate factors of creative engagement. Moreover, although the behaviour data suggested that the participants performed more various interactions with M_{nn} & M_{ne}, their subjective feeling was opposite because they rated both M_{cn} & M_{ce} being more exploratory than M_{nn} & M_{ne}. With the above comparisons, it is reasonable to claim that the more exploratory behaviours were not positively associated with the subjective exploratory experience.

According to Table 6.3 and Table 6.5, when the participants were given an exploratory motivation, more exploratory activities were associated with positive feedback, e.g. more CFSP was associated with more curiosity (ES1) and less frustration (ES7) with M_{ne}, less RV was associated with more learnability (ES3) with M_{nn}. These results suggest to take motivation into account when considering the exploratory activities. Given different motivations, the exploratory activities might show different effects on participants' creative engagement.

6.7 Reflective Summary

This chapter presents an exploratory process on methods to inform and to evaluate creative engagement through interaction log data. Apart from the descriptive analysis of interaction log data, e.g. time percentage, duration, counts, the variety of CFSP mined from interaction log data was an informative indicator for the depth of exploration in an interaction. The qualitative interpretation on the CFSP showed the potential to support the qualitative analysis by offering behavioural evidence. The RQA is another informative indicator for how fixate the interaction process was. Moreover, the correlation analysis between the activity data and questionnaire feedback highlight the potential of digging additional source and objective evidence from interaction log data to explain the interactive process and contribute to the investigation on the research questions. Results of CFSP and RQA were coherent with each other. The comparison between the results with the subjective feedback offered additional information to understand the effects of motivation and the feature of changeable playing point on creative engagement.

Apart from the fact that the results are *informative*, evaluation through interaction log data is an *efficient* approach for evaluation. Within one study, it is possible to collect both interaction log data and qualitative feedback on subjective experience without putting any more burden on the participants. By offering supplementary evidence, it helps to overcome the problem of relying on self-report of participants as sometimes they are not able to self-identify their experience [Wang et al., 2016].

Another benefit of such methods is that the choices on the analysis are *affluent*. Data mining on CFSP and recurrence quantification analysis presented in this chapter are simple examples chosen based on the study design and research question. Many more methods in data mining and statistical analysis could potentially provide similar information. It is worth exploring more possible analysis methods that are suitable for the evaluation of creative engagement. Moreover, as the user-centred evaluations varied largely according to the research questions and context, choosing appropriate methods would be the first challenge for a data-driven approach. It would be a valuable work to offer a list of methods with their appropriate context of use. An example presented in this chapter is that the variety of CFSP can be an indicator of the depth of an exploration process.

Before expanding the use of the methods of CFSP and RQA to a broader context, it is necessary to test the validity and universality in a different context. Moreover, the focus of the analysis was mainly on the activities of a creative process, i.e. activity patterns and activity recurrence. Although creative engagement is not evaluated by the quality of the creative output, information in the content created by participants might be able to indicate the level of creative engagement. Future analysis on interaction log data can be carried out to explore the relationship between the *content* and the subjective experience.

Chapter 7

Study III: Effects of Abstract Visual Stimuli

This chapter presents the final study of this thesis with an aim to explore the effects of graphical scores (abstract symbol design vs straightforward symbol design) and information about the graphical score (playing with or without information about the graphical score) on non-musicians' creative engagement with MTBox. Based on an empirical study of twenty-four participants, the results support the hypothesis that abstraction has the advantage in helping non-musicians to get more inspirations and in supporting certain factors of creative engagement, i.e. aesthetics, enjoyment and challenge. A descriptive model is discussed to explain the underlying mechanisms of how abstraction supported inspirations and creative engagement. Design implications are proposed to provoke inspirations and overcome fixation for non-musicians. The measure of creative engagement, especially the measure of fixation developed in this study contribute to the evaluation of creative engagement of the interactive music systems.

7.1 Motivation

In the design implications drawn from Study I (discussed in Section 4.5.3), *catalysing insight* was proposed for the purpose to lead novices to a more in-depth creative process. In Study II, *inspirational source* emerged as a theme from the qualitative thematic analysis of the interview data (discussed in Section 5.4.2). While playing with MTBox, participants reported that they sometimes ran out of ideas and could not think of new ideas to play. Therefore, they searched for inspirations for different ideas by looking at the visual clues on the interface or what they have previously done. The results of the previous studies offered the prime motivation for this study to look at how to support non-musicians to get inspirations while playing with musical interfaces.

Section 2.2.4 introduced the barriers to creativity, of which fixation is the common cognitive problem in the creative process. When a person gets stuck in a counterproductive mental set or existing solutions, it is difficult for them to jump out of the box and come up with unusual solutions. Methods to overcome such insight problems are introduced in Section 2.2.5, including recommending digital content as strategies to support serendipity or using visual stimuli to provoke reinterpretation and restructuring on the problem. Section 2.4.1 introduced the trend of integrating visual and music in NIME, followed by Section 2.4.2 introduced the benefits of the graphical score in supporting music creativity. These related works provide theoretical basis of using the graphical score as a potential approach to provoke inspirations for musicking with NIME.

Abstract Visual Stimuli

Exposure to familiar or straightforward examples could lead designers to a situation of fixation, when they are consciously or unconsciously attached to existing solutions from the rich pictorial representations [Smith et al., 1993, Cardoso et al., 2009, Cardoso and Badke-Schaub, 2011, Goldschmidt, 2015].

Studies suggested that the presence of different kinds of visual stimuli could have different influences on the creative performance [Goldschmidt and Smolkov, 2006, Cardoso and Badke-Schaub, 2011, Cheng et al., 2014]. More distant analogies [Christensen and Schunn, 2007], more partial within-domain stimuli [Cheng et al., 2014], remote between-domain stimuli [Goldschmidt, 2011], or unexpected information [Kerne et al., 2014] were proposed as better visual stimuli due to its abstractness. For example, Cheng et al. compared the effect of different pictorial stimuli on designers' creative performance with partial or full photographs of product examples. The results indicates that when working with partial photographs designers were able to produce more original designs than designers who worked with full photographs [Cheng et al., 2014]. Similar findings have been reported in the comparison between line-drawing visual stimuli and a photo visual stimuli [Cardoso and Badke-Schaub, 2011]. With certain level of abstractness, visual stimuli can help to reduce the possible pitfall of visual stimuli by avoiding a simple replication of the stimuli source and encouraging transfer and transformation on the relations among the stimuli source, which will help to increase the likelihood of novel creative results, as compared to the more concrete and straightforward visual stimuli [Goldschmidt, 2011, 2015]. Based on this argument, Goldschmidt suggested abstraction as one of the prerequisites in enhancing creativity, as abstraction allows one to distance oneself from familiar properties, therefore being able to get more directions for associative thinking (ibid).

Built on Gabora's theory of memory structure and creative process, Goldschmidt explained the underlying mechanisms on how visual stimuli possibly support the creative process and why abstraction could have a superior effect on creativity [Goldschmidt, 2015]. As memory is stored distributed in the brain and is content addressable [Gabora, 2010], visual representations perceived by people act as stimuli to activate related ideas and solutions in memory [Goldschmidt, 2015]. Different intensity of memory activation will affect the pattern of memory retrieval, which correspond to either a divergent or a convergent thought [Gabora, 2010]. According to Goldschmidt, if the visual stimuli are directly related to the problem from the same domain, they activate limited location in memory, leading to a convergent mode of thinking, thus limiting the reach of more memory regions. Whereas if the stimuli are taken from a different domain or remote from the original problem, they help to provoke more locations in memory, thus expand the potential of more random associations or solutions retried in memory [Goldschmidt, 2015]. Therefore, the abstract visual stimuli could effectively prevent the viewer from making a direct link to the previous memory and sticking to it. Instead, it helps to activate more locations in memory and to trigger more random associations, thus to overcome fixation by evoking inspirations.

Research Question

The above literature highlighted the benefits of visual stimuli in helping designers to overcome fixation, the benefits of the graphical score in helping musicians or inexperienced non-musicians to create music, as well as the superiority of abstract visual stimuli in evoking inspiration compared to the more straightforward visual stimuli. However, the previous comparisons between abstract and straightforward visual stimuli were mostly carried out in the domain of design. Rarely any investigation was carried out to compare this difference in the context of musicking.

Hence, along with the overarching goals of this thesis (see Section 1.2.2), a particular focus of Study III was to investigate whether the abstract graphical score has advantages in helping non-musician to get inspirations when creating music compared to the straightforward graphical score? Also, more generally, whether the abstract graphical score has advantages in supporting non-musician's creative engagement with musical interface compared to straightforward graphical score?

7.2 MTBoxII

The prototype used in this study, MTBoxII, was a modified version of MTBox used in Study II. The hardware was kept the same. However, the interaction model was re-designed based on the participants' feedback. Sound samples and timeline interface were improved and designed to adapt to the new interaction model. To investigate the research questions, a real-time graphical score interface was integrated into the timeline interface. More details are given in the following sections. Supplementary videos are created in support of explaining how the prototypes work. To download the videos please see link in the footnote [1].

7.2.1 Interaction Model

Unlike with MTBox to control a sample the player needs to press the start or stop button on top of it, in the improved version a sample is triggered or stopped immediately when its corresponding button is pressed. This modification enables players to interact with the samples more easily. The concept of timeline interface and its previous and future functions are kept the same. Without the need to trigger the sample with the ON and OFF buttons, the functions of the buttons were modified. The white button was changed from ON button to control the playing point of the timeline. Once it is pressed, the timeline would jump to the indicated point on the timeline and start splaying from there. The blue button was changed from OFF button to reset the scrolled timeline to come back to the current playing point. The black button was changed to erase all the records from any indicated point on the timeline to the right.

7.2.2 Sample Design

On MTBox the sixteen buttons on the side represented sixteen pre-recorded looping samples, that all the samples will continuously be looping once triggered. In the modified version, the sixteen buttons represent sixteen pre-recorded samples, which can be divided into two groups: the eight buttons in front and at the back of MTBoxII trigger long samples, which are eight beats long and would be played in a continuous loop once triggered; the eight buttons on the left and right side of MTBoxII, trigger short samples, which are one beat long and would be played only once when triggered. In this case, MTBoxII allowed participants to produce more rhythm patterns and to be more expressive with the prototype. There are two sets of short samples embedded in MTBoxII, a set of percussions and a set of piano notes. The red button on top is used to switch between the

[1] https://doi.org/10.17636/01049923

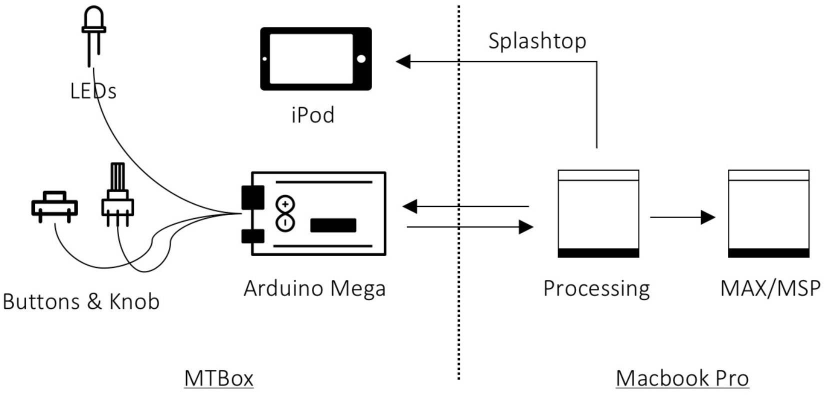

Figure 7.1: Technical Set Up of Study III

two sets of short samples. Hence in total, there are twenty-four samples could be manipulated on MTBoxII and twenty-four sample tracks drawn on the timeline interface. This design of more choices of sound samples was to add more expressiveness to MTBoxII.

An agile pilot study was carried out with two non-musician participants to test the first version of MTBoxII. They reported that it was too challenging to manipulate the samples, especially to place the percussions synchronised. The unsynchronised sound could easily mess up their creation. To solve this problem, a global transportation was implemented with a one-eighth synchronisation on the percussion samples to make sure the samples are synchronised. For the implementation of global transportation, the sound software was shifted from Pure Data used in MTBox to MAX/MSP[2].

7.2.3 Timeline Interface

The same as MTBox, the timeline records the sound events created by participants. The functions of scrolling to previous records and planning ahead were kept the same as MTBox. Minor adjustment on the sample and graphical score were implemented.For example, the timeline was re-designed by clustering long samples on the top of the timeline and short samples on the bottom of the timeline. Moreover, the representations of long and short samples was differentiated with continuous lines for long samples and dots for short samples. Twenty-four tracks on the timeline records the interactions on each sample individually. As short samples that played only once were added to MTBox, the representations

[2]https://cycling74.com/products/max/

GS	Musical Ideas
1	Start and stop different long samples one by one.
2	Start and stop different long samples altogether.
3	Start and stop a long sample. Start and stop a different one. Start and stop the previous one.
4	Trigger three short samples altogether.
5	Trigger three short samples one by one rhythmically.
6	Trigger a single short sample repeatedly rhythmically.
7	Trigger short samples to make a linear pattern on timeline.
8	Trigger short samples to make a vertical pattern on timeline.
9	Trigger short samples to make a M pattern on timeline.
10	Trigger short samples to make a V pattern on timeline.
11	Start and stop a long sample with short samples triggered in between.
12	Start and stop a long sample with short samples triggered simultaneously.
13	Start long samples one by one and stop them all at once.
14	Start long samples all at once and stop them one by one.

Table 7.1: Musical Ideas of Graphical Score

of the short samples on timeline are designed as dots. The two sets of samples were represented in different colours, percussions with green and piano notes with red.

A set of graphical symbols is displayed on top of the timeline interface while MTBox is running. The symbols are moving from left to right gradually. There were two graphical scores embedded on the timeline interface in MTBoxII: G_{straight} with the straightforward graphical score, see Figure 7.4, and G_{abstract} with the abstract graphical score, see Figure 7.5. The graphical scores on the interfaces were designed in fixed orders of symbols for both modes of timeline interfaces.

7.2.4 Graphical Scores

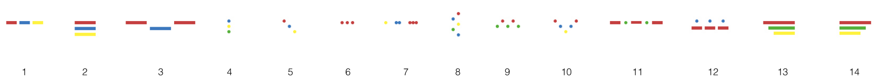

Figure 7.2: Graphical Score with Straightforward Symbols (G_{straight})

To implement the comparison between straightforward and abstract symbols, two sets of graphical scores were designed to convey the same musical ideas, with the same colour but with different visual representations. As discussed in Section 2.4.2, the symbols in the graphical score could be abstract

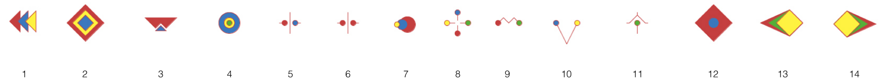

Figure 7.3: Graphical Score with Abstract Symbols (G_{abstract})

symbols, using peculiar symbols designed in a specific meaning to convey information, or it could be straightforward illustrations, using elements of graphics mapped with elements of sound. The graphical score designed in this study followed these two strategies.

In terms of the music information that the graphical score should convey, a preliminary session was carried out with three experienced musicians. They were asked to play with the prototype and try to create a piece of music. Music ideas were extracted based on their playing records on the timeline, including combinations of long samples (e.g. using three long samples one by one, starting three long samples altogether, or shifting between two samples) and patterns of short samples (e.g. triggering three percussions or piano notes together or one by one, or combining long samples and short samples). The graphical score was designed to convey these musical ideas.

The straightforward version was designed with lines and dots, see Figure 7.2. The idea of using lines and dots was inspired by the design of the records on the timeline interface, where the lines represented the long looping samples and the dots represented the short samples. It is straightforward to understand as for the direct metaphor between the graphics and the types of sound samples. The abstract version was designed as more complex symbolic icons based on rectangles, circles and lines, see Figure 7.3. Rectangles correspond to the long looping samples, and circles and lines correspond to the short samples. It is abstract as there is no direct link between the shape of the graphics and the types of sound samples. For comparison, the two sets of graphical scores were designed to convey the same musical ideas. Table 7.1 lists the musical ideas conveyed each symbol of the graphical score.

7.3 Study Design

This section introduces study design with detail on independent variables, dependent variable, hypothesis, and study procedure.

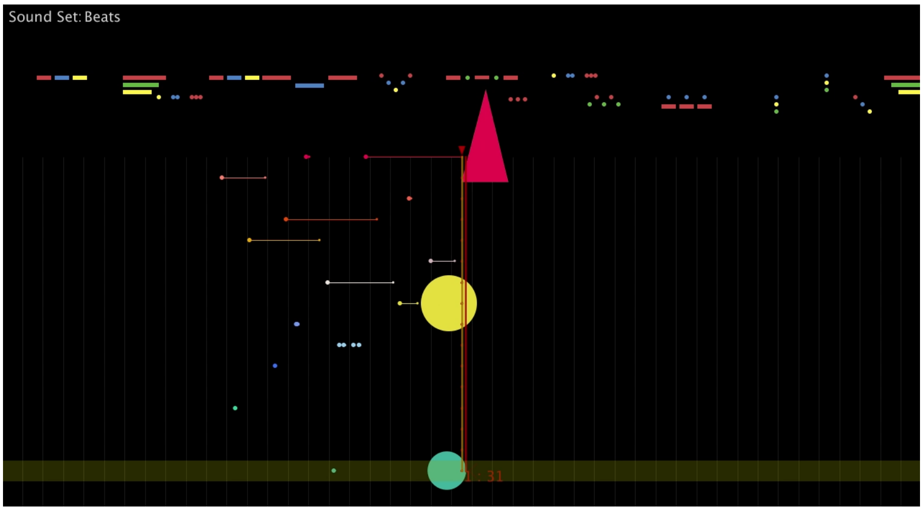

Figure 7.4: Timeline Interface with Straightforward Graphical Score

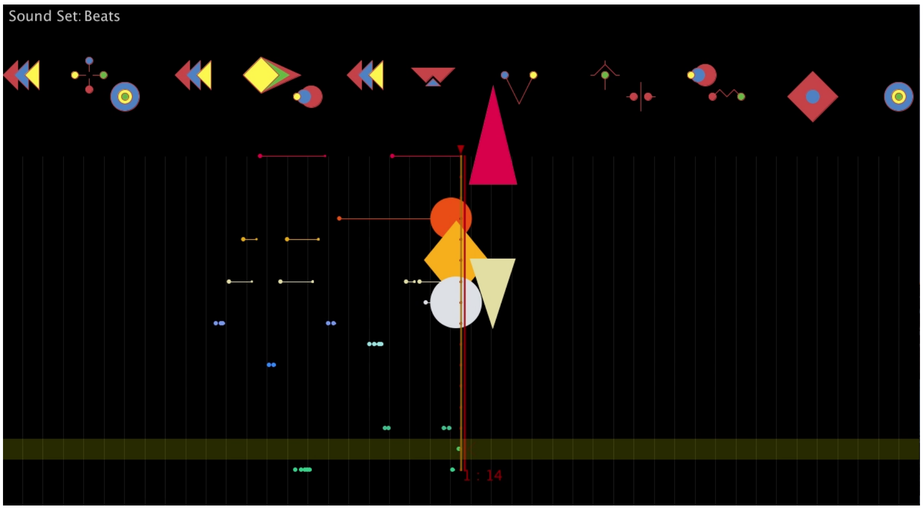

Figure 7.5: Timeline Interface with Abstract Graphical Score

7.3.1 Independent Variables

Apart from the actual design of the symbols of the graphical score, there is another perspective of interpreting *abstract* and *straightforward*: whether the participants are informed about the design concept of the graphical score or not. Information was proposed as an independent variable due to the fact in the use of most current graphical score, the coded meaning of symbols or illustrations is stipulated by the composer. If performers were informed about the design concept of the graphical score, the graphical score is no longer abstract but straightforward to the performer.

Hence, to investigate the differences between *abstract* and *straightforward* graphical score, two independent variables were developed. To compare the effect of abstract and straightforward symbols, two sets of graphical score were designed and presented to participants while they were creating music. To find whether information about the graphical score design will influence the effect of the graphical score, participants were divided into two groups. One group was informed nothing about the design of the graphical score, the other one was informed about the design concept and was explained in detail about the meaning of the symbols. In summary, two independent variables were manipulated in this study:

- A within-subjects factor (repeated) of graphical score design: whether the graphical score was designed with abstract symbols or straightforward symbols.
- A between-subjects factor (non-repeated) of information about graphical score design: whether the participant is informed about the design concept and symbol meaning before they are creating the music.

7.3.2 Hypothesis

In general, the study hypotheses the creative engagement will be greater when non-musicians are playing with abstract graphical score. The hypothesis are formalised as below:

- *H1:* A graphical score with abstract symbols can better support non-musicians to get inspirations compared to one with straightforward symbols. This hypothesis will be tested with the comparison of the prototypes with straightforward graphical score and the prototype with abstract graphical score. If this hypothesis is supported, greater inspirations will be indicated by the higher agreement on Q2, Q3, Q4 or Q6 when playing with G_{abstract}, as compared to the agreement when playing with G_{straight}.
- *H2:* Playing without information about the graphical score will better support non-musicians to get inspirations than playing with information. This hypothesis will be tested with the comparison of two groups of participants, i.e. the group playing without the information of graphical score design and the group playing with the information. If this hypothesis is supported, greater inspirations will be indicated by the higher agreement on Q2, Q3, Q4 or Q6 from the group who played without the information of graphical score design, as compared to the agreement from the group played with the information

- *H3:* A graphical score with abstract symbols can better support non-musician's creative engagement than one with straightforward symbols. This hypothesis will be tested the same as H1. If this hypothesis is supported, creative engagement will be indicated by the higher agreement on Q1, Q5, Q7, Q8, Q9, Q10 or Q11 in the questionnaire when playing with $G_{abstract}$, as compared to the agreement when playing with $G_{straight}$.

- *H4:* Playing without information about the graphical score can better support non-musician's creative engagement than playing with information. This hypothesis will be tested the same as H2. If this hypothesis is supported, greater creative engagement will be indicated by the higher agreement on Q1, Q5, Q7, Q8, Q9, Q10 or Q11 in the questionnaire from the group who played without the information of graphical score design, as compared to the agreement from the group playing with the information.

7.3.3 Data Collection

Questionnaire

The questionnaire used in this study include three parts. The first part was a list of statements for participants to rate their agreement on each statement on a seven-point Likert scale from 1 (Strongly disagree) to 7 (Strongly agree), see Table 7.3. The statement marked with the symbol (*) is coded negatively. There was a pre-statement designed to self-assess their musical creativity (Q0). Participants were asked to fill in the rest of the questions (Q1-Q11) after playing with both $G_{straight}$ and $G_{abstract}$. The majority of the statements were designed based on the factors of creative engagement discussed in Section 3.5.4, extracted from the attributes of user engagement [O'Brien and Toms, 2008, 2010] and the factors used to evaluate creativity [Carroll et al., 2009, Carroll, 2013]. Three of the statements (Q3, Q4, Q6) were built on the factors that address the heuristic, understandability, and usage of the graphical score, marked with the symbol (*). A full list of factors, please see Table 7.2.

The second part of the questionnaire included three choice questions. The first one was a single choice question to check how vital is the graphical score for the player. The choices were *very important, moderately important, neutral, slightly important, and not at all important.* The second was a multiple choice question asking the player to choose when the graphical score is essential, answers included *all the time, once I got the brief, during the learning process, during music idea generation and when I don't know what to do.* The final one was a multiple choice asking the player to choose how did the graphical score help. The answers included *activated related musical ideas in memory, gave ex-*

Creative Engagement	Definition	Question
Aesthetics	Perceived visual beauty	Q1
Heuristic	How inspired the GS is	Q2
Learnability*	The easiness of interpreting	Q3
Own Understanding*	Freedom of interpreting	Q4
Exploration	The easiness of explore new ideas	Q5
Usage Frequency*	The frequency of using	Q6
Focused Attention	The concentration on the task	Q7
Expressiveness	The ability to perform various outcomes	Q8
Results Worth Effort	Perceive value of the result	Q9
Satisfaction	Satisfaction on the interaction	Q10
Creativity	Perceived creativity	Q11

Table 7.2: Factors of Creative Engagement in Study III

Q0. I am creative in creating a piece of music.
Q1. The graphical score was visually pleasing.
Q2. The graphical score inspired me when I was creating the music.
Q3. I found it was difficult to interpret the graphical scores.*
Q4. I developed my own understanding of the graphical score.
Q5. The graphical score helped me to find many different music ideas, possibilities, or outcomes.
Q6. I looked at the graphical score frequently for inspirations.
Q7. When I was playing with the prototype, I lost track of the world around me.
Q8. The graphical score supported me to be expressive in music.
Q9. I think I produced a piece of music with good quality.
Q10. I am satisfied with what I have got out of the musical box.
Q11. I was very creative with the piece of music.

Table 7.3: Questionnaire for Study III

amples to follow, provided ideas on sample combinations, provided inspirations on music structure and others.

The third part of the questionnaire was built on the comparison questionnaire as mentioned in Chapter 3. One more question was added addressing the usefulness of the graphical score. From the two given prototypes, participants were asked to choose one from the two graphical scores that are most appropriate to the statements. With the comparisons between prototypes, it was possible to capture participants' opinions on the seven factors of creative engagement: (1)enjoyment: I enjoyed my self most; (2)exploration: I explored more music ideas; (3)expressiveness: I felt I was more expressive; (4)frustration: the interface was frustrating; (5)creativity: I felt more creative with; (6)results worth effort: I felt more satisfied with the result. (7) usefulness: the graphical score helped me get more inspirations.

Interview

A semi-structured interview was conducted with each participant after playing with G_{straight} and G_{abstract} to collect subjective feedback. After playing with each prototype participants were firstly asked to describe their creation process, how did they interpret the graphical sore, how does the graphical score affect their playing, how did they utilised the graphical score. After finished playing with all the prototypes, the participants were asked to describe the difference of the playing experience between the two versions, which one do they prefer and which one is more inspiring, and the reason of their choice. A full list of interview questions please see Table 7.4. Similar to the previous study, the questions were not posed in a systematic way, meaning not all participants were asked all the questions and in the same order. The choice was done on the spot, trying to build on the interesting insights that were emerging during the conversation.

7.3.4 Procedure

In a pilot study, two non-musician participants reported that they got lost without adequately learning the box. To enable a proper learning and exploration process with MTBoxII, a version of MTBoxII without any graphical score (G_{no}) was introduced to each participant at the beginning of the study. To eliminate the influence of the sequence of exposure to prototypes, the order of G_{straight} and G_{abstract} were randomly sorted for participants. For participants from Group 1 (playing without design information), no information about graphical score was given. For and *only* for participants from Group 2 (playing with design information), an introduction about the design concepts and symbol meaning

Creation Interviews
Can you describe your creation process?
Did you look at the graphical score when you were playing with the music box?
Did you look at the graphical score frequently? When did you start to look at it?
Do you think the graphical score helped you to play?
Please describe in what way do you think the graphical score helped you to create the music?
What kind of musical ideas did you get from the graphical scores?
Could you describe a moment when you are inspired by the graphical score?
Comparison Interviews
What's the difference between the playing experience of the two prototypes?
Did you apply different strategies for creating the music with the two prototypes?
How did you interpret the graphical score? Can you describe both prototypes?
Which one do you prefer?
Which one do you think is more inspiring? Why?
How does the two different graphical score affect your playing experience differently?
With or without the graphical score, what is different when you are playing?
Group 1: If you understand the meaning of the graphical score, do you think it's gonna be more helpful, or inspiring?
Group 2: Is your own interpretation of the graphical score different from the meaning told you before the study?
Group 2: As you were told how the graphical score were designed, how does that affect your playing?

Table 7.4: Interview Questions for Study III

Group 1 (Without GS information)	Group 2 (With GS information)
1. Guided Learning with $\mathrm{G_{no}}$	
2. Exploration with $\mathrm{G_{no}}$	
3. Creation with $\mathrm{G_{straight}}$ or $\mathrm{G_{abstract}}$	
4. Creation with $\mathrm{G_{abstract}}$ or $\mathrm{G_{straight}}$	

Table 7.5: Study Procedure of Study III *The procedure is the same for both Group 1 and 2. To eliminate the influence of the sequence of exposure to prototypes, the order of $G_{straight}$ and $G_{abstract}$ were randomly sorted for participants in step 3 and 4.*

was carried out before playing. Therefore for each participant joined the study, there were four sessions, please see Table 7.5. An example is:

- *Guided learning with G_{no}.* Participants were guided to learn all the functions of the prototype. The researcher sat together with the participants and demonstrated how to interact with the prototype. The demonstration included the function of the buttons, the design of long loops and short loops and how to start and stop them, the timeline interface and the scroll function. If the participants had questions, the researcher would give more demonstrations until the participant had no further questions at which point it was assumed that the participant understood how to interact with the prototype's different functions.

- *Exploration task with G_{no}.* Participants were encouraged to explore the prototype in their own way by themselves. They were told that they could play whatever they want, and the music can be in whichever format. They were told that there was no requirement on the outcome to be produced or a minimum number of samples should be used. From this session onwards, the researcher sat in the corner of the room in case the participants need any help. The participants were reminded of the time after 10 minutes' interaction, and they could continue if they want.

- *Creation task with one of the prototype.*In this session, the first prototype embedded with graphical score was introduced to the participants. To participants in Group 1, only the basic function of the graphical score was introduced, which is to give inspirations about the playing. To participants in group 2, more detail about the design of the graphical score was introduced. For example, the meaning of the shape of the graphical score and the meaning of each symbol were introduced. The researcher asked the participants to aim at creating a piece of music, and clarified that there was no requirement on the content, nor on the genre of the music. Moreover, the researcher specified that there would not be any judgement on the quality of the final piece, and there would not be any requirement on the length of the piece nor a minimum number of samples to be used. They were specifically reminded that they were not asked to follow the graphical score but to use it as supplementary material for creation. The participants were reminded of the time after 10 minutes' interaction, and they could continue if they want. Afterwards, they were asked to fill in the questionnaire. A few questions were asked to understand their creative process.

- *Creation task with the other prototype.* The second prototype with a different graphical score was introduced to the participants. Similarly, to participants in Group 1, only the basic function of the graphical score was introduced, which is to give inspirations about the playing. To participants in group 2, more details about the design of the graphical score was introduced. For example, the meaning of the shape of the graphical score and the meaning of each symbol were introduced. The researcher asked the participants to aim at creating a piece of music, and clarified that there was no requirement on the content, nor on the genre of the music. Moreover, the researcher specified that there would not be any judgement on the quality of the final piece, and there would not be any requirement on the length of the piece nor a minimum number of samples to be used. Again, they were specifically reminded that they were not asked to follow the graphical score but to use it as supplementary material for creation. The participants were reminded of the time after 10 minutes' interaction and they can continue if they want. Afterwards, they were asked to fill in the questionnaire. A few questions were asked to understand their creative process.

Twenty-four participants who perceive themselves as non-musicians were recruited to take part (12 male, 12 female). Thirteen of them belong to the age group 18-25, ten from 26-35, one from 36-45. These participants were a mixture of undergraduate, postgraduate students, and non-students. Participants signed a consent form and were informed that they could leave at any time. Before the playing with the prototypes, they were asked to complete a pre-questionnaire to self-assess their musical creativity.

7.4 Results

This section presents the significant results of the statistical analysis of the questionnaire data and the interaction log data, and the results of the thematic analysis of the interview data.

7.4.1 Questionnaire Feedback

Figure 5.5 and 5.6 illustrate all the questionnaire feedback in box plot. For the full list of statistical test results of all conditions and comparisons, please see Appendix C.2.

Self-assess Creativity

A comparison between the participant's rating on the pre-study question on creativity (I am creative in creating a piece of music) with the after-study ques-

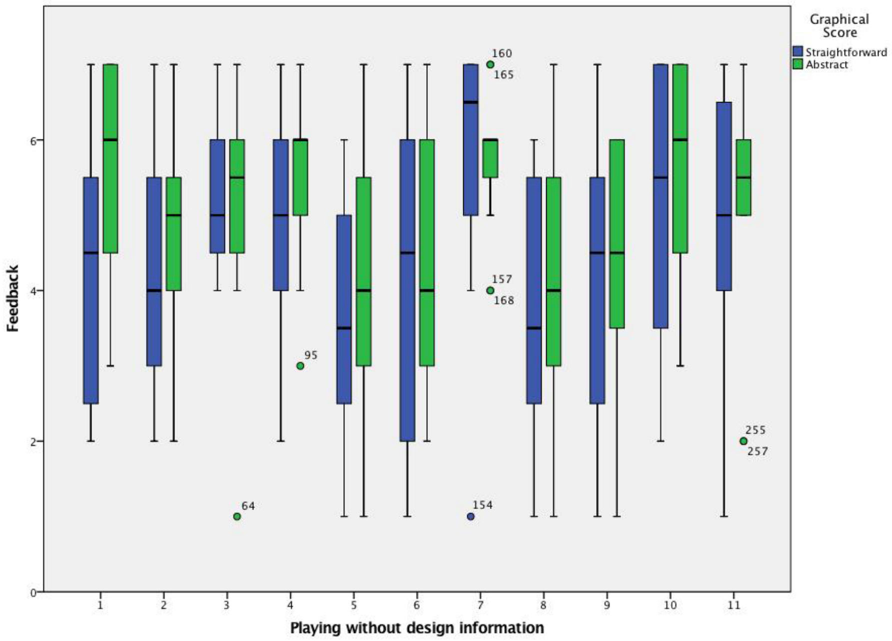

Figure 7.6: Box Plot of Questionnaire Feedback of Group Playing without Design Information

tion on Q11 (I was very creative with the piece of music) was calculated with a paired sample t-test. There were significant differences between participants' agreement on self-assessment on creativity before study and the agreement on Q10 with both G_{straight} ($t(11)$ = -2.333, p = .029) and G_{abstract} ($t(11)$ = -2.962, p = .007). The rating with G_{straight} (M = 4.54, SD = 1.956) and G_{abstract} (M = 4.58, SD = 1.767) were both higher than the original self-assessment on musical creativity (M = 3.29, SD = 1.628).

General Comparison

The study design involved both between-group factors and within-group factors. A two-way mixed ANOVA was used to conduct the impact of group and version on the questionnaire feedback. There was a significant interaction between group and version on Q1 (I found the graphical score visually pleasing) (F(1,22) = 4.824, p = .039) and Q2 (I felt that the graphical score inspired me when I was creating the music) (F(1,22) = 5.5, p = 0.028).

Additionally, there was a significant main effect of version on Q4 (I developed my own understanding of the graphical score) (F(1,22)=6.936, p=.015). The agreement on the factor that they have developed own understanding of the graphical score was significantly less with G_{straight} (M=4.04, SD=1.628) than

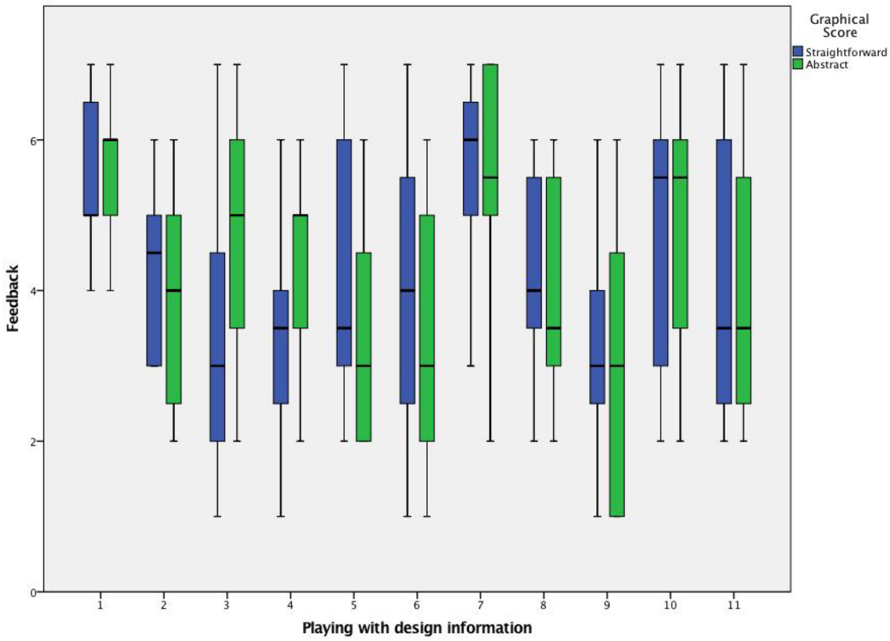

Figure 7.7: Box Plot of Questionnaire Feedback of Group Playing with Design Information

with $G_{abstract}$ (M=5.0, SD=1.319).

Comparison Between Groups

An independent sample t-test was used to investigate the impact of the information about the design of the graphical score on creative engagement factors. For $G_{straight}$, there was a statistical significant difference ($t(22)$=3.299, p=.003) on the rating of agreement on Q3 (I found it's difficult to interpret the graphical scores). Participants ranked $G_{straight}$ was significantly more difficult to interpret when without graphic design information (M=5.25, SD=.965) than with information (M=3.25, SD=1.865). However, there was no significant difference on their rating of agreement on Q3 with $G_{abstract}$ between different groups.

For both $G_{straight}$ and $G_{abstract}$, there were statistically significant differences in the agreement on Q4 (I developed my own understanding of the graphical score) between the condition of with or without information. For $G_{straight}$, participants' agreement on whether they developed their own interpretation was significantly higher ($t(22)$=2.685, p=0.014) when they were without design information (M=4.83, SD=1.467) than when with information (M=3.25, SD=1.422). Similarly, for $G_{abstract}$, participants' agreement on whether they developed their own interpretation was significantly higher ($t(22)$=2.376, p=0.027)

Session	Factor	Agreement Mean
1. Creativity Comparison		
	Creativity (Q0, Q11)	$G_{no} < G_{abstract}$
	Creativity (Q0, Q11)	$G_{no} < G_{straight}$
2. Comparison by Group Informed or not		
$G_{straight}$	Interpretation Difficulty (Q3)	Not >Informed
$G_{straight}$	Own Understanding (Q4)	Not >Informed
$G_{abstract}$	Own Understanding (Q4)	Not >Informed
3. Comparison by Graphical Score Versions		
Both groups	Own Understanding (Q4)	$G_{straight} < G_{abstract}$
Not Informed	Aesthetic (Q1)	$G_{straight} < G_{abstract}$
Informed	Interpretation Difficulty (Q3)	$G_{straight} < G_{abstract}$

Table 7.6: Significant Results of Questionnaire Feedback in Study III

when without graphic design information (M=5.58, SD=1.165) than with information (M=4.42, SD=1.240).

Comparison Between Versions

A paired sample t-test was used to investigate the impact of graphical score versions on the agreement on statements on the questionnaire. Firstly, all data from the both groups with information and without information was combined. There was a significant difference ($t(23)$=-2.673, p=.014) on agreement of Q4 (I developed my own understanding of the graphical score) between $G_{straight}$ and $G_{abstract}$. Participants rated that they developed less own understanding of the graphical score with $G_{straight}$ (M=4.04, SD=1.628) than with $G_{abstract}$ (M=5.00, SD=1.319).

Subsequently, the data were compared based on graphical versions within groups. When without graphical design information, there was a significant difference ($t(11)$=-2.679, p=.021) on the agreement of Q1 (I found the graphical score visually pleasing). Participants rated $G_{abstract}$ (M=5.67, SD=1.435) significantly more aesthetically appealing than $G_{straight}$ (M=4.25, SD=1.712). However, in the group with design information, there was no significant difference on participants' perceived aesthetics between $G_{straight}$(M=5.50, SD=1) and $G_{abstract}$(M=5.50, SD=.905).

When playing with graphical design information, there was a significant difference ($t(11)$=-2.413, p=.034) on the agreement of Q3 (I found it is difficult to interpret the graphical scores). Participants rated $G_{straight}$ (M=3.25, SD=1.865) significantly less difficult to interpret than $G_{abstract}$ (M=4.75, SD= 1.545). There was a significant difference ($t(11)$=-2.444, p=.046) on the agreement of Q4 (I developed my own understanding of the graphical score). Participants rated that they developed significantly less own understanding with

	Not Informed		Informed	
	$G_{straight}$	$G_{abstract}$	$G_{straight}$	$G_{abstract}$
Enjoyment	**2**	**10**	7	5
Exploration	6	6	6	6
Expressiveness	4	8	5	7
Frustration	8	4	**2**	**10**
Creativity	4	8	4	8
Results worth effort	4	8	6	6
Usefulness	5	7	**9**	**3**

Table 7.7: Results of Comparison Questionnaire for Study III

$G_{straight}$ (M=3.25, SD=1.422) than with $G_{abstract}$ (M=4.42, SD=1.240). Compared to the group playing without graphical design information, there was no significant difference in participants' perceived difficulty in interpreting graphical score and whether they developed their own interpretation between $G_{straight}$ and $G_{abstract}$.

Table 7.7 details the results of the third part of the questionnaire with significantly different results highlighted in bold using a Chi test. In the group without information about the graphical score, significantly (X^2= 10.667, p=0.001) more participants rated they enjoyed more with $G_{abstract}$ than with $G_{straight}$, however not in the group with information about the graphical score. In the group with information about graphical score, significantly more (X^2=10.667, p=0.001) participants rated more frustration with $G_{abstract}$ than $G_{straight}$, and significantly more (X^2=6.000, p=0.014) participants rated $G_{straight}$ helped them get more inspirations.

Choice Question Analysis

For the choices questions, frequency analysis was done for all three questions. A Chi-Square test for crosstabulation between groups and all the answers was done for all three questions. No statistical significance was found for both Q1 and Q2 between groups of participants, indicating that informed or not about the design concept does not influence participants' choice on how much and when the graphical score was important. However, for Q3 (How did the graphical score help you?), there was a statistical significance (df = 1, p = 0.041) between different groups of participants on the choice 'Give examples to follow'. 4 participants out of 12 voted Yes in the group without information and 9 out of 12 voted No in the group with information.

Summary of Results and Implications

Below is the summary of the significant results from questionnaire data and their implications.

- Participants rated that they developed significantly less own understanding of the graphical score with $\mathrm{G}_{\mathrm{straight}}$ than with $\mathrm{G}_{\mathrm{abstract}}$.
- Participants rated they developed significantly more own understanding with both $\mathrm{G}_{\mathrm{straight}}$ and $\mathrm{G}_{\mathrm{abstract}}$ when they were without design information.
- When without design information about the graphical score, participants rated $\mathrm{G}_{\mathrm{abstract}}$ significantly more visually pleasing than $\mathrm{G}_{\mathrm{straight}}$
- When without design information about the graphical score, significantly more participants rated they enjoyed more when playing with $\mathrm{G}_{\mathrm{abstract}}$ than when playing with $\mathrm{G}_{\mathrm{straight}}$.
- When with design information, $\mathrm{G}_{\mathrm{abstract}}$ was rated more difficult to interpret than $\mathrm{G}_{\mathrm{straight}}$.
- When with design information, more people rated $\mathrm{G}_{\mathrm{abstract}}$ to be more frustrating, and less useful than $\mathrm{G}_{\mathrm{straight}}$.
- Participants rated $\mathrm{G}_{\mathrm{straight}}$ was significantly more difficult to interpret when without information than when with information.
- Significantly more participants voted 'Give examples to follow' as the function offered by the graphical score in the group with information than in the group without information.

7.4.2 Interview Feedback

Following the procedure of Study II, a bottom-up thematic analysis was conducted to extract participants' ideas about the different graphical scores. The researcher transcribed the interviews of each participants and went through the transcripts three times. While reading the transcripts, the researcher coded the sentences with preliminary themes. This iterative approach allowed the researcher to discover additional themes embedded in the transcripts. Then the researcher went through the preliminary themes to create categorisations of themes by combining the similar ones. Descriptions of each theme were written based on the categorised themes and participants' original feedback. Below are some themes related to graphical score, retrieved from the interview transcripts of twenty-four participants. The themes are reported below with representative quotes from participant. Participant ID is included in bracket after the quote. A full list of codes and corresponding quotes is provided in Appendix C.3 for the reference of coding process.

Intriguer

The feedback suggested that the graphical score facilitated the player's interest in playing by intriguing the player to figure out what the graphical score was suggesting and to test the result. For example, four of them (Participant 1, 9, 18, 21) started asking themselves questions like 'Oh, what does this mean, how could I interpret that? (Participant 9)' or 'Can I actually do that? (Participant 21)'. When seeing the symbols, their motivation for exploring more of the box was triggered when they were trying to make sense of the symbol meaning. Moreover, Participant 1 and 18 reported the process of making sense of the symbols in graphical score was interesting.

Participant 21 described that she took the graphical score in G_{abstract} as a reminder of 'being creative', and a reminder of 'taking care of the structure of the piece'. Besides, Participant 24 reported that in the presence of G_{abstract} he was more willing to challenge the goal of creating more complex music. It is suggested by the above examples that the graphical score intrigued participants to set themselves a goal or a challenge for being creative.

In general, these examples suggested that the graphical score implicitly intrigued people to take actions to respond to it, either by making sense of its meaning, testing the result, or setting a creative goal.

Catalysis

The feedback suggested that the graphical score played a vital role to help to develop ones' own idea. For example, with the help of the graphical score, Participant 21 managed to play something that she likes, and reported 'from that idea I developed something else'. When asking how did the graphical score help to develop one's own idea, Participant 3 reported 'the idea just came naturally'. Participant 3 and 23 reported that it was when they started to think about modifying the ideas interpreted from the graphical score, they started to create their idea. For example, Participant 23 said she was thinking 'well, maybe I can blend something like this' when she tried to create something different.

Moreover, seeing the ideas suggested by the graphical score, which they did not think of themselves, encouraged participants to try different musical ideas. As described by Participant 18, 'I tried to do something that I probably wouldn't have done instinctively.' Participant 16 found that the graphical score in G_{abstract} allowed music to be more *'individual'*. It might be because of

$G_{abstract}$ was designed open for different interpretation and different participants can interpret it freely and create their own music.

With the above evidence, the graphical score can be argued to have the potential to catalyse individual's creative thinking while playing with musical interfaces.

Aid

Acting as an 'intuitive aid' and an 'interesting tool (Participant 17)', participants reported that they became less lost in the presence of the graphical scores.

On one hand, the graphical score was regarded as a starting base, helping the player who 'start with a blank head (Participant 19)' by giving examples for them to learn how to play chunks. Thirteen participants (Participant 1, 3, 4, 5, 6, 8, 9, 11, 14, 15, 18, 22, 24) reported that they began by following the score and started focusing on their own when they 'got into it a little bit (Participant 3)'. This result could be linked to the result of the first study, where offering non-musician a starting base to help creation was proposed as for non-musicians it is difficult to start from scratch.

On the other hand, participants tend to look at the graphical score for solutions or better sound ideas when they met some problems (Participant 5, 7), 'messed up' with sound (Participant 19), or when they were not satisfied with what they were creating (Participant 12). Six participants (Participant 5, 9, 11, 12, 16, 18) reported that it was difficult for them to remember the sound and its corresponding button and it is the graphical score helped them to recall the sound with the colour and shape.

Inspiration

The graphical score was reported to have the ability to offer various music ideas when the participants 'don't know what to do next (Participant 6)', 'get stuck (Participant 8)' or 'get repetition (Participant 7)'. From the feedback it can be seen that the ideas covered various aspects, including 'combination of different samples (Participant 21)', rhythmic pattern that can 'be translated to sound sequence (Participant 20)', music structure such as 'where to plug in the drums (Participant 4)', and music ideas such as how to 'mix', 'what to use', 'when to start or stop', 'how to finish' etc.

The randomised graphical score symbols helped to increase the variety of music. As put by Participant 23, with 14 different graphic symbols, a player was 'gonna get 14 factories of possibilities'. Besides, Participant 17 mentioned that the graphical score had the potential to inspire people to play different music styles. He also mentioned that with the graphical score he could try different music styles such as Cuba, Mexican or electronic, or even 'something for movies'.

Loose impression

With G_{abstract}, eight participants (Participant 1, 2, 6, 7, 16, 18, 19, 21) reported that they did not develop a 'one-to-one mapping' on sound and graphic elements, or a specific interpretation of each symbol. Two even reported they 'didn't really understand what it meant (Participant 7)'. Instead, they usually got a *'loose impression'* (Participant 1) or a *'feeling'* (Participant 7) out of the graphical score when giving it a glimpse occasionally. When seeing the graphical score, they were asking themselves questions such as 'What can you fill when you look at the image? (Participant 7)' and then tried to create music ideas according to the symbols they saw. Compared to the reported descriptions on G_{straight} such as 'determine', this 'loose impression' of G_{abstract} was reported positively as it allows music be to more 'individual', and 'encourages to explore more', which allowed greater space for interpretation, and thus promoted their positive attitude towards the abstract graphical score (Participant 6).

Aesthetic

Nine participants (Participant 6, 7, 8, 9, 10, 11, 18, 19, 20) expressed their appreciation of the visual design of graphical score of G_{abstract}. Even Participant 11 and 19 who thought G_{abstract} was too abstract to interpret, said that it 'looks nice'. It was also interesting to note that participants tended to pick symbols to play according to their appearance. For example one participant mentioned that 'When I like it, I would play it (Participant 10)'.

Whereas for G_{straight}, three participants reported it was 'less interesting (Participant 3)' and 'oppressive (Participant 8)' as being too similar to the timeline, and 'there was not much useful information in it'(Participant 13). Participant 16 found it was more clear.

These feedback suggested that whether the symbols were visually attracting is vital, as it triggered the participants' willingness to try something different and affected their attitude and approach towards it.

Graphic style

With reference to the Graphic style theme, the words participants used to describe G_{straight} include *'logical, specific, intuitive, simple, systematic, organised, determine, oppressive, clear, softer, less useful information, less interesting'*. For G_{abstract}, they described it as *'abstract, representative, complex, symbolic,* *bold, aggressive, relax, open, no right or wrong, more things to find, confusing, make no sense, more interesting'*. As the two sets of words are relatively opposite, it is suggested that $G_{straight}$ and $G_{abstract}$ gave quite contradictory impressions to participants.

According to the descriptive words mentioned above, it can be seen that the interpretations of $G_{straight}$ described by participants were quite consistent. Most interpretations were closely related to the original design concept of the timeline, that the lines were linked to the looping samples and the dots were related to the short samples. However, the interpretations of $G_{abstract}$ were varied. These interpretations include taking symbols 'as a reminder of taking care of general structure and of being creative (Participant 21)', mapping symbol size to sample length, e.g. 'add a loop sample when seeing a big shape (Participant 1)', or mapping symbol size, shape or position to number of samples, or viewing symbols 'as an indication of timing (Participant 14)' or as 'key points or key sound butts (Participant 8)'. The above summary implied that $G_{abstract}$ do have the potential to trigger various interpretations, and that might be the reason that it helped to 'be more creative (Participant 9)'.

Participant 22 mentioned that $G_{abstract}$ might be more attractive to young and creative people, whereas $G_{straight}$ might be good for people who are more logical. Therefore, he mentioned that the target audiences of the graphical scores might be different as well due to the different design of the style.

Approach

According to the participants, the approaches to deal with graphical score were different. For example, three participants mentioned that they decided to ignore the graphical score from the beginning as they thought it is too 'small (Participant 17)', 'determining (Participant 5)' or 'distracting (Participant 11)'. Thirteen of them (Participant 1, 9, 10, 11, 12, 14, 15, 16, 18, 19, 20, 21, 22), reported that they started by following the graphical score rigorously. They quit following graphical score after a while due to the difficulty in making sense of symbols or creating satisfactory results. The participants were quite consistent in a way that they found following the score was not satisfying. The reason for this unsatisfactory experience was either that participants felt being 'directed (Participant 17)' and 'not contributing to the music (Participant 12)', or that the result is not as satisfying as expected (Participant 6, 24). Therefore, all of these participants quit following the score sooner or later and only gave it a glimpse occasionally out of curiosity or when necessary.

According to two participants (Participant 11, 12), the preference of different versions of the prototype was based on the strategy of dealing with the score.

For example, participant 12 reported that she preferred $G_{straight}$ only because she did not follow it. Because with $G_{abstract}$ she tried to keep following and felt frustrated with the music result. Therefore, she preferred $G_{straight}$ as the approach she adopted to deal with it was more desirable.

It seemed that the approach adopted by the participants was highly related to the versions of the prototype. With $G_{straight}$ seven participants (Participant 9, 10, 11, 15, 16, 18, 19) chose to follow rigorously in the beginning, while with $G_{abstract}$ fifteen participants (Participant 1, 3, 4, 5, 9, 10, 11, 15, 16, 18, 19, 20, 21, 22, 24) chose to look at it occasionally. This was most likely due to the fact that $G_{straight}$ was easier for the participants to interpret (Participant 3, 4, 24), while $G_{abstract}$ was more abstract (Participant 7, 8, 11). Therefore it was more difficult to follow the score of $G_{abstract}$ rigorously.

Scenario

When comparing $G_{straight}$ and $G_{abstract}$, three participants (Participant 8, 17, 18) mentioned that different versions of graphical score support different scenarios of playing. For example, Participant 8 mentioned $G_{abstract}$ was good for solo playing because its abstractness could trigger more creation, whereas $G_{straight}$ was better for group collaboration as its simpleness could contribute to a systematic interpretation and satisfy the need of synchronisation for group playing.

Another aspect was related to the fact that $G_{straight}$ and $G_{abstract}$ were mentioned by two participants that they are suitable for serving different tasks. For example, Participant 17 argued $G_{straight}$ would be good for performing because it is suitable for reproduction a pre-created piece of music, or as a tool for teaching or guide, mostly because of its simpleness and easy for interpretation. Whereas $G_{abstract}$ would be good for experimenting as a creative tool as it allows open interpretation.

Challenge

According to the description on the graphical score such as 'determine', 'directed', and 'feel being obliged to follow the score' (Participant 9, 14, 17, 21), one potential challenge of having graphical score was that it might imply player to follow the score and to reproduce what the graphical score was suggesting as it was moving. On one hand, this will 'distract' (Participant 14) participants from focusing on creating their own music, thus limit their creative input on the music. On the other hand, the experience of being 'directed' (Participant 17) by graphical score and lessened personal input into music was 'frustrating' as there is no freedom. In both cases, it will be difficult for participants to engage with playing the prototype creatively.

7.5 Discussion

This section discusses the results to conclude the hypothesis. The effects of abstractness on supporting inspirations and creative engagement are discussed separately, followed by a discussion on the possible mechanisms on how abstractness encouraged to play and implications for design.

7.5.1 Abstractness to Provoke Inspiration

The hypothesis H1 (*A graphical score with abstract symbols can better support non-musicians to get inspirations compared to one with straightforward symbols.*) is supported by the findings. In general, the results support the claim that the abstract graphical score has the superiority in supporting non-musicians to get inspirations while playing with musical interfaces, however under certain conditions. When playing with $\mathrm{G}_{\mathrm{abstract}}$ participants agreed more on the statement that they developed their own understanding of the graphical score than when playing with $\mathrm{G}_{\mathrm{straight}}$. This result suggested that participants were more free to interpret the abstract graphical score in their own way than to interpret the straightforward graphical score. In the interview, participants reported that they have developed a loose impression or a feeling on the abstract graphical score, which allowed greater space for own interpretation and creation. Together with the fact that participants described the straightforward graphical score being determined and oppressive, it is reasonable to claim that abstract graphical score allows more space for own interpretation, and thus helped participants to get more inspirations.

However, the advantages of the abstract graphical score were largely depended on whether the participants were informed about the design of the graphical scores. Under the condition of playing without information, participants' perceived aesthetic and enjoyment with the abstract graphical score was higher than straightforward graphical score. Under the condition of playing with information, however, $\mathrm{G}_{\mathrm{abstract}}$ was rated more difficult to interpret, to be more frustrating, and less useful than $\mathrm{G}_{\mathrm{straight}}$. This is possible because informing participants about the design on abstract graphical score confuse them and limit their own interpretation, thus cause an unfavourable impact on participants' creative experience.

Hypothesis H2 (*Playing without information about the graphical score will better support non-musician to get inspirations than playing with information.*) is supported by the findings. Information about graphical score helped for participants to interpret the straightforward graphical score, however not for the abstract score. Although participants rated G_{straight} was significantly more difficult to interpret when without design information than when with design information, they rated that they developed more own understanding with both G_{straight} and G_{abstract} when they were playing without being informed about the design concept and symbol meaning. Moreover, when playing without information, G_{abstract} shows its superiority in terms of enjoyment and aesthetic. All the advantages of G_{abstract} no longer exist in the group playing with information. Instead, G_{abstract} is regarded as being more frustrating and less useful when given information. This result indicates that giving the information about the graphical score is likely to hinder participants' creativity with G_{abstract}. More participants in the group playing with information rated the graphical score offer examples to follow. This implies that knowing the design information may implicitly lead participants to recreate the music ideas coded in the graphical score. According to the feedback in the interview, following the score was determined, oppressive and frustrated.

To summarise, the abstract graphical score can potentially support non-musicians to get inspirations than straightforward graphical score, under the condition of being allowed to develop their own interpretation. The abstract graphical score needs to be accompanied with space to allow participants to develop their own interpretation. Otherwise, trying to make sense of the abstract graphical score in a specified way will cause frustrations and hinder participants to get more inspirations out of it. Although giving information about graphical score helped participants to interpret straightforward graphical score, it hindered participants to develop their own understanding of both graphical scores. The above results were coherent with Goldschmidt's claim that abstractness is a prerequisite to enhance creativity [Goldschmidt, 2011]. As the concept of abstractness was decomposed into two levels according to the related works, the results from both the abstract graphical score and the information about graphical score supported the hypothesis.

7.5.2 Abstractness to Support Creative Engagement

Hypothesis H3 (*A graphical score with abstract symbols can better support non-musician's creative engagement than one with straightforward symbols.*) is partially supported by the results. Under the condition of playing without information, more participants rated G_{abstract} to be more enjoyable than G_{straight}, and G_{abstract} was rated to be more visually pleasing than G_{straight}. In the theme *aesthetic* from the thematic analysis, participants reported that they found G_{abstract} looked more appealing whereas G_{straight} was less interesting. Moreover, they also picked symbols to imitate based on its appearance. However, more participants rated $G_{abstract}$ being more frustrating and less useful in helping them to get inspirations when playing with design information. Therefore, it is reasonable to claim that the abstract graphical score has positive effects on specific factors of creative engagement, i.e. increase the enjoyment and perceived aesthetics than straightforward symbols, but only under the condition that when the players have got no prior information about the design of the graphical scores.

Hypothesis H4 (*Playing without information about the graphical score will better support non-musician's creative engagement than playing with information.*) is not supported by the findings. There was no significant difference in the agreement on the creative engagement factors between the groups.

7.5.3 How Abstractness Encourage Play

The previous section draws this conclusion that the abstraction can positively help non-musicians to get inspirations and increase creative engagement in aspects such as aesthetic, enjoyment, and challenge. This section discusses possible reasons for why abstractness can encourage more inspirations and better creative engagement based on the results of the thematic analysis.

Goldschmidt proposed creative process as a mapping process to transfer or to transform the properties or relations in the source of visual analogies to get a creative output [Goldschmidt, 2011]. Visual analogies are relational commonalities among the components of the visual stimuli (source) and the problem to be solved (target). More abstract visual analogies help to distance oneself from and to avoid simple replications of source properties in the target and therefore transfer only essential relationship instead (ibid). A model of how participants develop visual analogies based on graphical score and create music ideas was proposed based on the concept of transfer and transformation mentioned above and the results of the thematic analysis, see Figure 7.8. The model proposed two creation paths on music by firstly developing direct or indirect visual analogies based on graphical scores.

One one hand, when participants started with a blank head, or without knowing what to do next, the graphical score could offer examples as a *direct visual analogy* for inspirations if an understanding of the abstract symbol was developed instantly. Participants then can *recreate* the music ideas interpreted from the graphical symbol. During this recreation process, the player might be able to take the *relations* in the music examples, e.g. the samples combinations, rhythmic patterns, structure, and to *transfer* these relations to further develop their own ideas. Through this recreate and transfer process, the graphical score catalysed player's creativity to develop their own musical ideas.

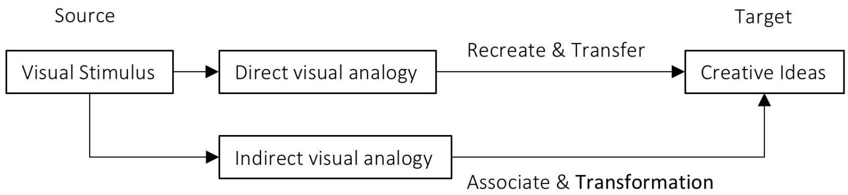

Figure 7.8: Abstractness Model: from visual stimuli to creative ideas

On the other hand, when seeing a graphical score symbol that did not trigger straightaway interpretation, participants tried to make sense of the symbol, e.g. asking themselves what to put in the music corresponding to the symbol. The abstract symbols and playing without prior information about graphical score encouraged participants to develop a loose impression on the graphical score. The loose impression may trigger associative thinking, a defocused process that might activate more memory locations in the brain [Goldschmidt, 2015], which helped to enlarge the source context and supported player to develop an indirect visual analogy based on the source. An *association* on the symbol property and meaning to other experience related to music was developed, followed by a *transformation* from the previous experience to the creation of new musical ideas. In the interview various own interpretations about abstract graphical score were reported, e.g. participants took it as a reminder for being creative or as a symbol for the sound explosion. Through this association and transformation, the graphical score provokes participants' inspirations for musical ideas.

Abstract graphical score contributed to the positive feedback on creative engagement factors. As the abstract graphical score allowed greater space for own interpretation, it gave participants more freedom and less pressure during the creative process. Meanwhile, it has the potential to intrigue a more associative and defocused thinking process and to offer more exciting findings. Therefore, participants reported it was more enjoyable to play with than the straightforward graphical score. Once the interpretation space is limited and constrained, for example when the player was informed about the design, interpreting abstract graphical score became frustrating. Therefore participants who played with information voted abstract graphical score more challenging and less useful to help to get inspirations as compared to straightforward graphical score. In terms of the aesthetic, both the variety of its visual representations and its creative space contribute to this factor.

It is also possible to explain why graphical score might be a more useful tool for non-musicians rather than experienced musicians suggested by [Walker, 1987]. The limited formal musical training and experience might be a positive factor to allow non-musicians to develop more indirect associations when they see an abstract symbol. Once they succeed in either recreating a music idea or developing a new idea, they gain confidence and are encouraged in exploring more of the music. Whereas for musicians who are experienced in music, the visual score might be less powerful stimuli as they might quickly link it to previous music ideas or playing techniques. Therefore less memory location may be activated, and thus fewer inspirations might be triggered for them.

7.6 Implications for Design

To provoke inspirations for non-musicians and to support their creative engagement in the process, a list of design implications are discussed in detail below.

- Providing direct visual analogy as a cornerstone to catalyse novices to develop their own idea. Being able to imitate existing examples when starting from zero or when getting lost or fixed, novices can quickly learn from the examples and start to develop their own idea based on them. This implication is drawn based on the themes *cornerstone, intriguer, catalysis and aid*, that the participants reported they were inspired by the graphical score in different ways when they started with a blank head or when got fixed. This implication is coherent with the theme *starting base* extracted from the thematic analysis in Study I, and also coherent with the idea of providing starting shape suggested in [Compton and Mateas, 2015].

- Providing abstract visual stimuli, e.g. abstract symbols or illustrations. The level of abstractness needs to be balanced. It is necessary to avoid too complex visual stimuli in case of distracting the users from the main task flow. It is also necessary to avoid too simple visual stimuli in case that the users feel too oppressive or being directed by the visual. This implication is in line with the studies that proposing using partial photographs or examples from across domains to provoke designer's creativity [Christensen and Schunn, 2007, Cardoso and Badke-Schaub, 2011, Cheng et al., 2014, Kerne et al., 2014]. This implication is drawn based on the theme *graphic style*, that participants reported the abstract graphical score was more inspiring.

- Allowing free interpretation on the visual stimuli. Promoting a loose impression on visual stimuli enables the visual stimuli being a supplementary source for inspirations rather than a determining instruction, which will encourage them to develop their own interpretation and avoid distracting them from the main task. This implication is drawn based on the theme *loose impression*, that the participants reported being more creative with freedom to interpret graphical score in their own way.

- Providing aesthetically appealing visual stimuli with appropriate style. Whether the visual stimuli is aesthetic appealing affect user's willingness, attitude, and strategy with it. And the graphical style should be designed accordingly based on the appetite of different groups of users. This implication is drawn based on the theme *Aesthetic*, in which participants reported they like the graphical score which looks nice.

- Choosing appropriate visual stimuli according to the tasks, i.e. for a collaborative task or individual task. The straightforward visual stimuli is more appropriate for a collaborative task as it is easier to achieve an agreed interpretation. For the choice of abstract visual stimuli, a shared coding needs to be specified so as to achieve an agreed interpretation among participants. This implication is drawn based on the theme *scenario*, in which participants reported that different graphical score suits different scenario of use.

7.7 Reflective Summary

This chapter presents an overview of the final study which aimed at exploring the effects of abstractness (abstract symbol design and playing without information about the design of the graphical score) on non-musicians' creative engagement with MTBox. An empirical study of 24 participants showed that providing abstract graphical score with free space for interpretation support non-musicians to get inspirations and to enhance certain aspects of their creative engagement. Possible mechanisms of why and how abstractness has advantages in provoking novices' inspirations and supporting their creative engagement were discussed. The results also have direct implications for the design of similar musical interfaces for non-musicians in the field such as NIME, as well as interfaces that aimed at engaging non-experts creatively.

To provoke the inspirations for non-musicians, the study approached the research question with a visual solution, which was primarily influenced by the related works in the domain of design. There were different solutions proposed from the perspective of music in the domain of NIME. For example, a compositional assistance tool was designed to allow the users to quickly produce and experiment with variations on musical objects, such as chords, melodies, and chord progressions through algorithmic methods to transform an original input into different ones [Sarwate and Fiebrink, 2013]. The idea of providing alternative musical ideas could be considered in future studies.

Participants spoke highly of MTBoxII. However, the way the graphical score appears needs to be improved or adapted according to the participants. Moving from right to left is similar to the movement of the timeline, which caused confusions to some of the participants, leading them to follow it. Questions like how should visual stimuli appear on the screen, e.g. occasionally or constantly, its appropriate speed of movement without being too distractive, its appropriate position on the interfaces are all interesting future topics to be investigated.

There were limitations in terms of the study design and the choice of analysis methods. The choices questions might be a less useful format of questions compared to the questions based on the Likert scale as they did not offer enough information to illuminate the research question. According to the discussion in Section 3.5.3, by exploring how the content (the music created by participants) varies in different conditions, it is possible to find how the different versions of graphical score affect participants' creativity and creative experience. Therefore, different analysis methods could also be applied to explore the interaction log data to find how different the music content were created with different versions of graphical score. For example, intraclass correlation coefficient (ICC) is widely used to quantify the degree of consistency or reproducibility of data, which could be a potential method to use for content analysis in the future works.

The current work mainly focused on musical creativity. Whether the conclusions could be applied to other domain needs to be evaluated. Future works can also be carried out to explore the effects of abstract visual stimuli in different contexts such as collaborative scenario. As mentioned earlier for creative collaboration, it is necessary to consider how does different participant perceive the visual stimuli and how to achieve agreement on interpretation. How to support consistent group interpretation on visual stimuli is interesting future works as well.

Chapter 8

Discussion

This chapter brings together all the findings presented in Chapters 3-6, to reflect more broadly on how the results relate to each other and how they can inform and contribute to the design and research on supporting novices' creative engagement with interactive systems more generally.

First, the findings of each study are discussed reflectively, with respect to how they relate to the literature reviews and how the outcomes of each study informed the design and improvement of subsequent studies. The results of the thematic analysis in each study are connected and discussed. Next, a general model of creative engagement is proposed based on the model discussed in Chapter 5. The results of Study III are integrated into this model and discussed. Several general design implications for supporting non-musicians' creative engagement are proposed and discussed. In addition, the methodological approach is discussed reflectively, with critical analysis of the potential pitfalls and estimated solutions.

8.1 Discussion of Findings

This section gives a consolidated structure of the three studies, for example, how they are connected with each other and how the findings together respond to the general research question, with a highlight on the main differences and similarities between the findings.

The studies conducted in this thesis follow a step-by-step process, with a focus on how two aspects of the interaction process, namely visual interfaces and interaction mode, affect creative engagement. The research questions constructed in each study were partially informed by the results or implications extracted from the previous ones. For a general structure of the studies, please see Figure 8.1.

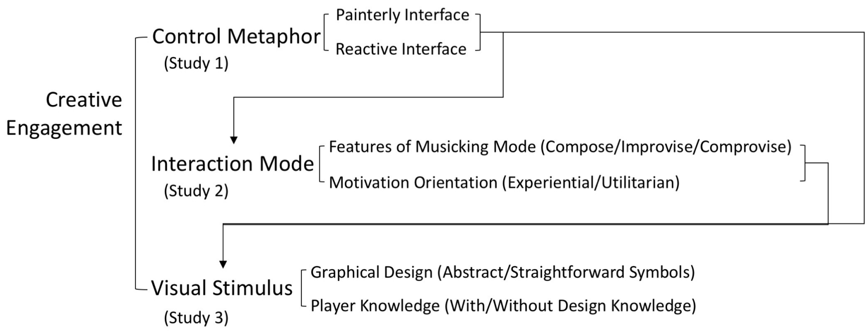

Figure 8.1: Structure of Studies

8.1.1 Study I

Study I set out to look at how control metaphors of interactive musical systems could affect non-musicians' creative engagement. Instead of supporting the hypothesis that the interface based on the painterly control metaphor has more advantages than the one using the reactive control metaphor in supporting non-musicians' creative engagement, the questionnaire results suggested that the participants showed a preference for the interface designed with the reactive control metaphor.

The results of Study I did not support the benefits of the painterly interface metaphor as discussed by Levin [Levin, 2000]. This might be because of the limited control parameters in the interface, which highly restricted the freedom and expressiveness of the interaction and thus decreased the potential for creativity with the painterly control metaphor. The preference might be due to the pitfall of design rather than the control metaphor itself. Therefore it is not reasonable to conclude that the reactive interface is superior to the painterly interface in supporting creative engagement. More reflections on the study design will be discussed in the last section of this chapter.

Despite the weakness of the study design, it is possible to find the reasons for the preferences of the interface using the qualitative data. They suggest that some of the key features of the reactive interface, *scaffolding starting from blank, structuring composition, managing sound, and playing live*, helped participants to engage creatively. These findings are coherent with some of the related works discussed in Chapter 2. Helping to structure the composition and to manage sounds and parameters can support distributed creativity as it offloads some of the conceptual and technical tasks to the tools [Davidson and Coulam, 2006]. As an example, being able to plan ahead of time enabled participants to record their ideas on the interface. Also, the interface feature of scaffolding starting from blank addressed the argument presented by Weinberg that it is difficult for novices to create and develop their own musical ideas from scratch [Weinberg and Gan, 2001, Weinberg, 2003]. Overall, the design implications developed from these findings from Study I are consistent with the implications suggested for designing creativity support tools, to allow a quick capture on the related knowledge, possible ideas or insights and to facilitate the management of creative work, as discussed in Section 2.2.5.

The findings of Study I informed the research question of Study II. Participants' distinct approaches in exploring the music ideas - random exploration and precise exploration - indicated that whether the participants have a goal in mind influences their creative engagement as well as their strategy. This finding motivated the idea of looking at the effects of goals on non-musicians' creative engagement in Study II. Moreover, the value of scaffolding the composition and the enjoyment of playing live reported by the participants motivated a closer investigation on how the two related musicking modes (composition and improvisation) relate to creative engagement.

Besides, the findings of Study I highlighted the needs for improving the questionnaire and analysis methods in Study II. The initial questionnaire in Study I did not allow to collect enough information, thus more factors of creative engagement were extracted from the related works and included in the version for Study II. The fact that the visualisation of interaction log data helped to understand the style of playing encouraged further exploration of the potential usage of interaction log data. However, in order to reduce the subjectiveness of the qualitative interpretation of the visualisation graphs, quantitative analysis methods were explored to analyse the interaction log data of Study II.

8.1.2 Study II

Study II focused on the effects of motivations (whether the participant had an experiential experiential goal or a utilitarian goal) and the effects of user interface features (whether the interface featured a changeable playing point and editable records) on non-musicians creative engagement with interactive musical systems. The results indicates that being able to revisit and reuse previous records was helpful in supporting creative engagement, and that the effects were more pronounced if the records were also editable. The experiential motivation had positive effects on supporting creative engagement on certain factors, i.e. expressiveness and results worth effort, compared to the utilitarian motivation. However, according to qualitative results, the utilitarian motivation had its benefits in supporting a sustained creative engagement over an extended period of time. Moreover, a more in-depth descriptive model of creative engagement with interactive musical interfaces was proposed in Study II. The model identifies three modes of musicking, an optimal trajectory between such modes and a description of inferred motivations during each mode.

The results supported a neutral view on the relationship between different motivations and the level of creative engagement, that both motivations, i.e. utilitarian motivation and exploratory motivation, have benefits on supporting creative engagement in different aspects or under certain conditions [O'Brien, 2010], rather than the binary view that one is more superior than the other [Novak et al., 2003, Rozendaal et al., 2007, Hassenzahl and Ullrich, 2007], as discussed in Section 2.2.6. Regarding the effects of motivation on creativity, related works have suggested the advantages of a utilitarian motivation in increasing creativity and productivity [Ironson and Davis, 1979, Shalley, 1991]. Study II rejected this point since the agreement on expressiveness and results worth effort were both higher in the exploratory session than in the creative session. The reason might be that the related works were carried out in contexts that are extremely results oriented, e.g. working environment. Therefore, the participants were focusing on the creative output rather than on the experience and the measurements were results oriented. On the contrary, in Study II participants were told that they were not judged by the quality of the results. Thus they were more relaxed to explore and were more satisfied with the results. This finding indicated that an emphasis on an experiential motivation is helpful in designing an interactive system that is mainly experience oriented. This study also contributed to the research of motivation in HCI by adding a case study on music interface to the general focus on interactive products, e.g. websites, discussed in Section 2.2.6.

The findings suggested that the prototypes with changeable playing point supported non-musicians' creative engagement and that the feature of editable records did not necessarily support creative engagement unless accompanied with the feature of changeable playing point. These findings are in keeping with the current design practices of new interfaces for musical expressions, most of which follow a real-time paradigm of design. However, instead of promoting the real-time *improvisation* paradigm for non-musicians, the above results highlighted the importance of having the changeable playing point on the timeline interface to be able to revisit and replay the records, which is more similar to the *comprovisation* paradigm [Dudas, 2010] discussed in Section 2.3.4. This is a relatively new implication in the design for non-musicians.

According to the qualitative feedback, the structured records on content and interactions offered an easy trace back to previous success and mistakes, similar to the design suggestion of designing for failure [Kim et al., 2015]. By this means, the interface supported the self-evaluation of the creation and contributed to its improvement. This result is also coherent with the calling for rich history-keeping mechanisms in related works of CST as discussed in Chapter 2. However, contrary to the narrow focus on the organisation or visualisation of history records, the results emphasised to control and manipulate the records at a global level. Being able to be reused or changed, the records could become archived resources for activities such as learn, explore, create, improve as well as perform. The structured records also helped to solve the problem of non-musicians' lack of cognitive skills, e.g. the skill to take care of the overall music structure [Colley et al., 1992] and to develop mental representations of music, as discussed in Section 2.3.5.

In Chapter 6, the results of data mining on CFSP and the recurrence quantification analysis of the interaction log data were coherent with each other. The correlation analysis between the results and the questionnaire data provided informative evidence to further support the findings. The combined results also provided additional information on the interaction behaviour that was not observed otherwise. For example, the prototypes with non-changeable playing point encouraged participants to perform more exploratory activities and was rated to sustain more focus attention but failed to engage participants creatively. Moreover, when participants were playing with an exploratory goal, the exploratory activities with the prototype with non-changeable playing point were associated with positive subjective feedback, e.g. less frustration and better learnability. The additional evidence confirmed the potential of using objective interaction data to understand subjective experience as discussed in Chapter 3. The analysis on data collected in Study II focused on the activities, while Study III explored the interaction log from the perspective of content assessment.

8.1.3 Study III

The call for *catalysing insight* in Study I and the call for *providing inspiration source* in Study II informed the research question in Study III. Study III set out to look at how abstraction (abstract vs straightforward visual stimuli, playing with or without information about design) could affect non-musicians' inspirations and creative engagement with interactive musical systems. The results from questionnaire analysis indicated that the abstract graphical score had more advantage on supporting inspiration acquisition and creative engagement as compared to straightforward visual representation, however this was valid only when participants did not have information about the design concept of the graphical score. According to the thematic analysis, the *loose impression* developed with the abstract graphical score indicated how participants sift out relevant information from significant amount of information, which is an essential process to generate creative insights [Sternberg and Kaufman, 2010], as discussed in Section 2.2.2.

Instead of positively contributing to the creative process, informing participants about the design concept of abstract visual representation allowed less freedom for participants to develop their own understanding and resulted in confusion. Thus it failed to support non-musicians to get inspirations. This finding indicated the importance of allowing creative freedom for interpretation on the graphical scores. It is closely related to the concept of *autonomy* discussed in the domain of creativity, for which balanced autonomy is an essential stimulant [De Alencar and De Bruno-Faria]. As an example, a more efficient creative production process is achieved by means of mood boards, which contribute to balancing the coordination of visual objects and creative autonomy [Endrissat et al., 2016]. As a visual communication tool, mood boards contribute to creative freedom in the forms of *leaving room for interpretation, providing a source of inspiration and allowing self-expression and signature style* (ibid). This practice is coherent with the implications suggested by the results of Study III.

Moreover, the results not only reinforced the claims from previous related works that the visual is an effective external provocative stimuli to overcome the fixation problem in the creative process and to support creativity [Cardoso et al., 2009,?, Eckert and Stacey, 2000, Goldschmidt, 2011, 2015], but also contribute to this topic with evidence on the positive effects of visual stimuli for novices' music creation in the domain of music, when the previous works were mostly carried out in the domain of design and with a focus on the experienced musicians rather than novices. The findings also contribute to the existing practices on how to increase serendipity, as discussed in Section 2.2.5, suggesting that the use of visual as secondary and less dominating stimuli rather than the current doings of offering obvious recommendations for supporting or fostering serendipity.

The positive feedback on the graphical score and the timeline interface offered more support to the trend of integrating visual and music in NIME design, as discussed in Section 2.4.1. The results suggested differed benefits of the mapping relationship between the visual and music in a graphical score, as discussed in Section 2.4.2, in particular the strategy of direct mapping elements of graphics to the musical language was less beneficial in provoking inspirations and supporting creative engagement than the strategy of coded symbols. According to the subjective feedback, although the abstract graphical score had advantages over the straightforward graphical score, there were specific scenarios where it is more appropriate to use straightforward graphical score, for example, collaborative music making.

8.1.4 Relationship between Thematic Results

Although the studies were designed to look at different research questions and the analyses were done independently, some connections between the themes emerged from the interviews. This section presents the interrelations between the results of thematic analysis from all three studies.

The theme *starting base* from Study I and the theme *cornerstone* from Study III are closely related. Both emerged from participants expressing their appreciation for the fact that the prototype provided mechanisms to support them starting from scratch. Providing examples to follow or to mimic helped novices to learn how to use the interfaces and also to develop their own ideas further. This is a practical implication which adds to the guideline suggested by Shneiderman [Shneiderman, 2007], calling for low thresholds of interfaces for novices to easily begin with.

The theme *serendipity* from Study I, the theme *inspiration source* from Study II and the theme *Inspiring* from Study III highlight the importance of supporting inspirations acquisition so as to support novices' creative engagement. Lacking of confidence, experience, skills and knowledge, as well as the predicament that fixation hinders professionals' creativity set the barriers for novices to be engaged in a long-term creative process. Providing proper inspirational sources, e.g. visual stimuli, could potentially trigger divergent thinking and association [Goldschmidt, 2011, 2015] and help them to get over such barriers.

The theme *play live* from Study I and the theme *improvise* from Study II indicate that being able to play and perform in real-time offered great pleasure to novices and is one of the key modes of playing with musical interfaces to achieve creative engagement. Providing mechanisms to support real-time activities is essential to catalyse a long-term creative engagement. The highlight of real-time activity for the creative process is an exclusive finding of this thesis as previous related works and discussions about supporting creativity mostly focused on iterative or collaborative creative process, e.g. design [Nickerson, 1998, Shah et al., 2001].

The themes *solo listen (enable to solo listen each sound object), affordance (indicate the state of the system), readiness time (provide enough time for preparations)* from Study I, the theme *skill set* from Study II and the theme *aid* from Study III suggest different features for supporting novices' physical and cognitive skills. The physical skills were mostly related to the ability to perform fluently with the right timing, which are particular important to the real-time creative activities. Cognitive skills were mostly related to the working memory, e.g. to remember music objects, to fluently perform and plan simultaneously. The theme *readiness time and structure composition* from Study I and the theme *structured records and plan* from Study II provide similar practical directions for supporting novices' cognitive skill by giving enough readiness time to plan and to interaction to reduce the need for working memory while musicking.

The theme *repeatability* from Study I is closely related to the theme *compose* from Study II in that the participants do need to revisit their own previous ideas during the creative process. These two themes together indicate the importance of the feature of reusing or replaying records during music creation or performing process as it encourages more exploration and offers inspirations.

8.2 A General Model of Creative Engagement

Chapter 5 proposed a descriptive model of novices' creative engagement with musical interfaces which consists of three progressive modes of playing, *experimenting live, composing, and performing live.* Each playing mode differed from each other on aspects such as output, motivation, skill, and activity. These three modes of playing can be linked to the three steps of the framework ('learn', 'exploration', 'creation') of creative engagement proposed in Study I. However they are more advanced and specific steps for modelling novices' creative engagement with musical interfaces. This model offers a structured way for designers and researchers to understand novices' creative engagement with interfaces that involves real-time activities.

Although the model described above was developed with the studies on the musical interface, it has direct implications for the design of interaction with interfaces in other domains. A more general model for creative engagement can hereby be described, see Figure 8.2. Similar to the model described in Chapter 5, there are three modes of interaction *experimenting, creating and performing.* *Experimenting* is when the user is motivated by an exploratory goal and is trying to learn, to explore possible ideas and to adapt to the system so as to create. It could be iterative or in real-time. This is the first level of creative engagement. *Creating* is when the user is motivated by a utilitarian creative goal and is adopting an iterative creative strategy to explore, create, evaluate and improve so as to achieve a creative output. It is the second level of creative engagement. At this stage, they might get stuck at any point and not be able to proceed. *Performing* is when the user is confident and fluent in creating, with ideas built in mind and trying to perform the ideas smoothly. This process involves real-time activities, and is the stage when the user is performing the creative activities in real-time fluently [Hansen et al., 2011]. It is usually motivated by

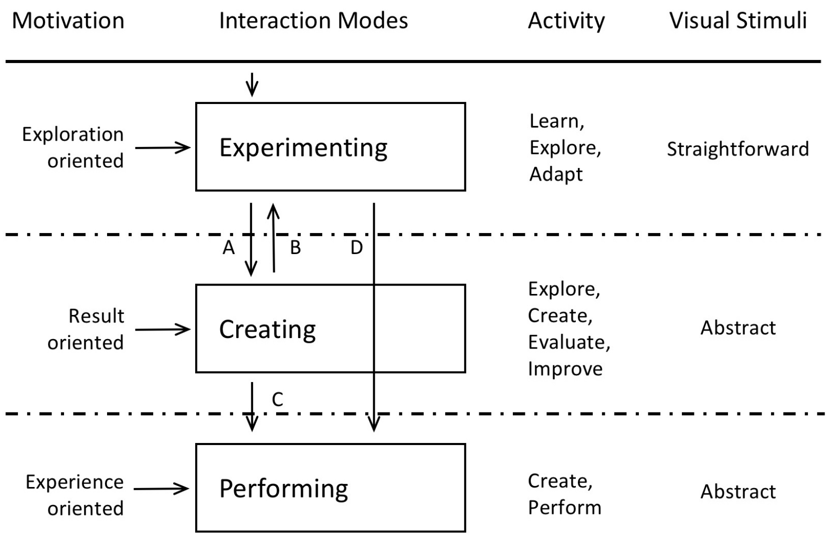

Figure 8.2: General Model of Creative Engagement

the experience goal. This is the most desirable stage of creative engagement.

Based on this descriptive model of creative engagement, it is possible to project the discussion of how abstraction encourages play in Study III into the levels of creative engagement. At the stage of *experimenting*, the player is trying to learn, to explore and to adapt to the system. As discussed earlier on the call for support to start from scratch, providing straightforward visual stimuli might be helpful at this stage as a direct visual analogy is easier for novices to understand and to transfer examples into new ideas. At the stage of composing and performing live, more abstract visual stimuli might be better choices as an indirect visual analogy is helpful to trigger different associations and is easier for novices to transform ideas.

The modes of interactions are closely related to models of experience and engagement discussed in Section 2.1.1 and 2.1.3. The *experimenting* mode is similar to the concept of *participation* when the users are developing technical abilities through participating [Sheridan and Bryan-Kinns, 2008]. The *performing* mode is also close to the state when the users are performing to express themselves [Sheridan and Bryan-Kinns, 2008] and are able to obtain major decision-making and have full creative power [Tanaka, 2011]. The *performing* mode involves the features of both *fluent* and *expressive* user-product interactions [Forlizzi and Battarbee, 2004]. The *fluent* user-product interactions are automatic and skilled interactions with the product, similar to the *performing* mode that highlights the fluency of interaction. The *expressive* user-product interactions help the user form a relationship to the product. Similar to *performing* with the system, the user is satisfied and is creating meaning and emotion together through product use.

This model advances the understanding of the process of creative engagement proposed by Bilda [Bilda et al., 2008] addressed in Section 2.1.4. The four phases *adaptation, learning, anticipation and deeper understanding* in Bilda's model can be correlated to the *experimenting* and the *creating* mode of interaction. The *performing* mode, however, is an interaction mode that has not been discussed before.

More broadly, this model contributes to the related works on the creative process discussed in Section 2.2.2 with an emphasis on real-time creative process. As discussed in previous studies, a creative process involves mental phases such as preparation, incubation, insight, evaluation and elaboration [Csikszentmihalyi, 2014]. The preparation and incubation stages correspond to the first interaction mode in the model - experimenting, in which the participants are seeking to define the problem, to acquire knowledge and gather potential information, and to take time for incubation [Sawyer, 2011, p. 222]. The evaluation is an iterative process that can modify and improve the previous actions, which corresponds to the second interaction mode - creating. In this phase, participants are seeking to generate a large variety of ideas, combine ideas in unexpected ways, selecting ideas and externalise the ideas (ibid). Apart from that, the model takes real-time creative activities into account in a creative process by proposing a *performing* interaction mode in the final stage. In this mode, the participants are generating creative output that satisfies themselves in real-time based on the accumulations in previous interaction modes. It is in this phase when they are experiencing the ultimate joy of interaction and creative engagement. Unlike the previous theories that suggested insight as one of the creative stages [Csikszentmihalyi, 2014], this model proposes the creative process as a rational and incremental process influenced by the insight at different stages. The findings of Study III suggested insight provided by visual stimuli could help the participants to experiment in the initial stage and to overcome fixation when they run out of ideas.

8.3 General Guidelines for Supporting Novices' Creative Engagement

This section merges together the design implications from all three studies and presents three general design guidelines for supporting novices' creative engagement with interactive systems.

8.3.1 Fostering Performing Live

Performing live is the desired state of creative engagement when the player is confidently and fluently creating and performing creative ideas in real-time. This is also an important feature that a lot of commercial applications adopted in the design. Unlike the iterative creative process, performing live requires both physical and cognitive skills. To achieve this goal more specific guidelines are proposed in the following sessions.

Offering Intuitive Control Metaphor

Implications from CST research have emphasised the needs for a low entry fee for the user to intuitively interact with the system [Shneiderman, 2007]. This thesis proposes solutions for intuitiveness at a more specific level, i.e. employing an appropriate and intuitive control metaphor. An appropriate control metaphor need to be easy to learn, be designed with a good mental model, good scalability and consistent mapping strategies [Waite, 2016]. The themes such as *affordance and consistency* presented in the results of Study I indicate that providing appropriate affordance and consistent mapping strategies between parameters can help the user to learn the interface. The application *Musyc* discussed in Section 2.3.3 applied similar idea in its interaction design. By simulating real world physics to make music, the metaphor is no longer controlling the rhythm directly but to control the movement of objects.

Supporting Planning Future Events

A clear conceptual route for recording and planning future events and implementation will significantly reduce the cognitive workload as it acts as a distributed cognitive tool [Davis et al., 2013b]. This mechanism could allow enough readiness time by queuing events in the future and release cognitive workload to the tool. Thus it gives more freedom to the user to manage their cognition resource, either concentrating on the current interaction or planning new ideas. By this means it reduces pressure of novices, especially for creative process that involves real-time activities. This design guideline is a relatively new proposal as most of the current commercial applications discussed in Section 2.3.3 does not applied this mechanism.

Scaffolding Physical Skills

Apart from offering support on the aspect of cognitive skills, another factor needs to be considered is the physical skills, e.g. what level of physical skills the potential user group employ. For activities that need real-time interactions, it is always challenging for novices to achieve good performance in a short time, e.g. pressing the right button at the right timing. It takes time for them to adapt to the interaction, to train themselves and to establish the muscle memory. Auto solutions provided by systems can help novices to achieve a satisfied performance, and thus help to release pressure and increase their confidence. This implication addresses the issue that novices' lack of skills discussed in [Weinberg and Driscoll, 2005, Davis et al., 2013a].

8.3.2 Scaffolding Structured Composition

A structured composition is to scaffold novices' cognitive skills in terms of better managing working memory. There are three practical suggestions.

Providing Starting Base

Both the results of Study I and III suggest providing a starting base gives the novices a clear guidance for creating in the first place, and also contribute to spark new ideas. This helps to address the issue that it is difficult for novices to create and develop their own musical ideas from scratch [Weinberg and Driscoll, 2005]. Likewise, similar design pattern was suggested in [Compton and Mateas, 2015], that providing starting shape or a suggested challenge to overcome the terror that comes from facing a blank canvas as the novices have more flexible requirements for the final product (ibid).

Helping on Managing Resources

Offering conceptual or physical space is helpful to novices to manage different resources in a systematic way. The conceptual space could be virtually divided spaces on the graphical interface, e.g. the past, current, and future timeline in MTBox, or the four virtual space on the interface of $\mathrm{P}_{\mathrm{react}}$. The physical space could be the physical shape on the prototype, e.g. the four sides of the MTBox to manage different sound genre. This implication is similar to the suggestion to support the management of creative work in [Lubart, 2005]. However, the difference is that the previous suggestion emphasised the management of output (ibid), whereas the implication here is focusing on the management of resources.

Providing Structured Records

A structured records of content and interactions offers an easy trace back to previous successes and mistakes. This is similar to the design pattern - 'entertaining evaluations', which allows relaxing evaluations to provide optional direction to the user [Compton and Mateas, 2015]. Compared to the call for a rich history-keeping mechanism in CST [Shneiderman, 2007, Carroll et al., 2009] and the call for compositional structure in music making [Dudas, 2010], this implication highlights the need to provide the mechanism to control and manipulate the records at a global level rather than merely to organise or visualise them. Being able to be reused or modified, the records become archived resources for the further creative process, which can contribute to the performing of real-time activities. Some of the current commercial applications that utilise the idea of sequencer, e.g. *Beatwave, Poly*, allows users to modify previous records, however, in a small scale. There is no overview of the piece of music in general. The guideline here propose the idea of a holistic records with all the music events recorded.

8.3.3 Designing Progressive Layers of Motivations

Designing progressive layers of motivations in different stages of interaction could catalyse an optimal trajectory of creative engagement. Different motivations have different positive effects on different phases of creative engagement. It could be achieved by applying differentiate motivations in different stages of interaction. Employ experiential motivations in the early stage of interaction could help to quickly engage users in a more relaxed way. Utilitarian motivations could be introduced in a later stage of interaction for engaging users in a long-term interaction. As discussed in Chapter 4, in the creation stage there were two approaches to explore the music ideas. Each approach required different features of the interface. The findings of Study I offered two practical suggestions described below.

Designing for Free Exploration

When the novices are with an exploration goal, it is necessary to design features to facilitate more in-depth exploration, which is the same idea as proposed by Compton and Mateas [2015] , which suggests to encourage exploration by providing limiting actions. To trigger the participants' interest in the system and to increase their confidence to dig more of the system, one possible solution is designing *serendipities* in the interface, e.g. functions that they did not expect. This implication is similar to the unexpected change in interactive arts that contribute to creative engagement by leading a positive cognitive transformation and renewing the user's long-term interest in the system [Candy and Bilda, 2009]. Another solution is by designing *expressive* interfaces with a relatively big range of control or parameters. By this means the participants can explore more possibilities and can implement their ideas with more alternative choices. However, the designer need to be cautious in adding the expressiveness to the interfaces designed for novices as the potential pitfall is that the interface become more complex. One example is the application *Figure*. As being able to control more sound parameters, *Figure* is more complex than the others to learn and to interact.

Designing for Clear Goal

When novices have clear goals, being able to quickly implement their idea is vital for them to quickly evaluate and select their output and to improve the creation [Csikszentmihalyi, 1996, Sawyer, 2011]. Designing for a clear goal requires easy implementation techniques such as *precise control* on parameters to help quickly implement ideas and the *repeatability* of previous ideas to be able to reuse preferred ideas.

8.3.4 Providing Abstract Visual Stimuli for Inspirations

Providing abstract visual stimuli is useful for supporting inspirations acquisition, as discussed in the related workss in the domain of design [Cheng et al., 2014, Cardoso and Badke-Schaub, 2011]. The empirical findings of Study III proposed visual stimuli could serve different functions in a creative process. At the initial stage, while encountering the interfaces starting with a blank head, visual stimuli could possibly offer examples to the user to learn and to explore. By giving a loose impression, visual stimuli could also catalyse users to develop their own ideas based on the examples. At the fixation stage when running out of ideas, visual stimuli could offer ideas such as new combinations, modifications, to inspire further exploration and creation. This is a new proposal that has not been adopted in any of the current commercial applications. Below are three more specific suggestions for designing abstract visual stimuli.

Allowing Autonomy

Allowing free interpretation on the visual stimuli is essential. Without autonomy on the interpretation, the user will fell being directed and thus be less motivated to explore more possibilities and to be creative. Apart from the issue that the abstract visual stimuli is difficult to explain, the directed interpretation can easily bring confusion to the users if there is a mismatch between their first impression and the explanation. Therefore, allowing a certain degree of free interpretation will motivate users to interpret, explore and think of new ideas.

Balancing Simplicity and Abstractness

The balance of the simplicity and abstractness of visual stimuli need to be carefully determined. Being too obvious to interpret, the visual stimuli will be determine and the users might feel obliged to follow. Moreover, too simple visual stimuli might be oppressive that the users may find it's boring and less aesthetically apealling. Whereas too abstract visual stimuli might be too hard to interpret and distract the users from the primary task flow.

Considering Task Scenario

The visual stimuli should be designed according to the task scenarios, whether it will be used in a collaborative task with multiple users or in a task involves only one user. For the collaborative tasks, a shared coding needs to be specified to achieve an agreed interpretation among team members. Therefore, a straightforward visual stimuli is more appropriate in this case as it is easier to remember and communicate its meaning, and to achieve agreement among a group of users.

8.4 Discussion of Methodological Approach

The following section discusses the methodological approach with emphasis on how the selected methods contributed to the primary goals and findings of this thesis. It also reflects on the shortcomings of the methods that arise from the practices of the studies and future works that could be done to improve the evaluation of the creative engagement.

8.4.1 Mixed-group Study Design

Both Study II and Study III followed a paradigm of mixed-group study design. In the mixed group study, there are two independent variables. Each of them has two or more comparable factors, see Table 8.1. In the mixed-group study, the participants are divided into two groups. Each group goes through the condition Y1 and Y2 in random orders under condition X1 or X2. Therefore there is a between-subject comparison on variable X1 & X2 and a within-subject comparison on variable Y1 & Y2. The benefits of conducting a mixed group

Condition	X1	X2
Y1		
Y2		
Group	Group 1	Group 2

Table 8.1: Mixed Group Study Design

study, are that it controls the time needed to conduct a study and the learning effects of participants as compared to pure within-group study design and that it effectively reduces the sample size needed for the number of conditions [Lazar et al., 2017].

There is a potential weakness of between-group study design for exploratory studies that try to understand people's subjective experience. As the data is collected in a qualitative format, it is difficult to make comparisons between groups on the subjective experience as there is rarely standardised qualitative analysis approach to compare the qualitative data between groups of participants. Previous studies have compared the results of field studies and interview [Becker and Geer, 1957] with the aim to improve the accuracy of the interview results based on the results of field studies. Comparative keyword analysis was used to compare two sources of qualitative data in social and health research by comparing the frequencies of keywords appeared in the text written by two groups [Harvey et al., 2007, Seale et al., 2010]. This approach is not applicable to the data collected in this thesis as the feedback was quite similar between the two groups of participants. This is mostly because the questions asked in the interview were focused on the descriptive feedback on the experience and the frequencies of keywords cannot give valid evidence to understand the process of experience. Moreover, while the participants were confident in comparing the within-group independent variables as they have played with both of them, the comments on between-group independent variables were mostly subjective assumptions rather than feedback of a first-hand experience. It is difficult to get validate comparison on the between-group variable from the participants.

One possible approach is to conduct independent thematic analysis individually for the two sets of data collected from the between-groups participants. However this can be prohibitively time consuming. At least another six to eight weeks of work are necessary for conducting independent thematic analysis for each group to compare between groups for each study, of which whether the results are comparable is not guaranteed. Therefore, it was not feasible to conduct such comparisons on qualitative data between groups for Study II and Study III. In future studies, independent thematic analysis could be carried out for comparing the qualitative data.

In terms of within-group study design, the potential problem is that the participants' preference or experience might be influenced by the order of the conditions they go through. This phenomenon was observed in all the studies in this thesis. One suitable solution for this problem is to randomise the order of the conditions for participants, which was applied in all three studies in this thesis. Another potential problem is that as the participants need to go through different conditions, they might be tired and confused towards the end of the session, which will largely affect their choices and feedback. It is necessary to control the length of the study and make sure it is within their ability. The study can also be separated into multiple sessions over weeks to eliminate the influence of the previous condition and to lessen the burden of participants in each session. However, the challenge of this practice is to recruit participants who are willing to make this commitment over a longer period.

8.4.2 Controlled Lab Study Design

The studies were all carried out in a controlled scenario within a limited time. As discussed in Chapter 3, a controlled lab study enables participants to concentrate and to provide in-depth feedback in different format. e.g. qualitative and quantitative. Moreover, controlled studies were necessary to conduct comparisons between conditions.

Whilst the systematic studies were essential for examining the research questions, some limitations need to be considered. The studies did not evaluate non-musicians' long-term creative engagement with the prototype, nor did they examined the natural scenarios of use, e.g. at home or school, in galleries or museums, or with multiple players. Even though a session was designed to provide guided learning and to allow time for practising it might still be difficult for some participants to become confident with the prototype in the time given. The lack of real contexts and scenarios may distort the participants' feedback on their real experience. Approaches to address these issues in future research could be conducting long-term studies with participants in a real scenario or designing multiple MTBoxes to allow collaborative music making with multiple participants.

8.4.3 Prototype Design

In Study I the results provided evidence that the prototype built on the reactive control metaphor had more advantages than the one built on the painterly control metaphor. However, due to the limitations of the prototype design, it was not reasonable to draw a valid and expandable conclusion that the reactive control metaphor is better in supporting creative engagement than the painterly control metaphor. Designed to address the control metaphors of IMSs, the control model and sound mapping mechanism were constrained to two parameters, i.e. pitch and volume. The limited parameters and the mapping design restricted the design of gestural interactions in the P_{paint} prototype, thus constrained the expressiveness and militated against the interpretation of it [Stowell and McLean, 2013]. Whereas for P_{react} prototype, the expressiveness of the interaction was less influenced by the limited control parameters. Therefore the failure of P_{paint} might be due to the limitations of its design rather than the control metaphor itself. A more expressive painterly interface is necessary to continue the investigation of the effects of control metaphor on non-musicians' creative engagement. Considering the complexity of gestural interaction in the painterly interface, machine learning algorithms could be used in the fast prototyping on the drawing gestures recognition and to map the gestural parameters to the sound parameters [Fiebrink and Caramiaux, 2016].

The questionnaire data and the interview data provided valuable information in understanding the process of creative engagement and factors that might affect non-musicians creative engagement. With more understanding of non-musicians' creative engagement with musical interfaces, MTBox designed for Study II was significantly improved regarding the expressiveness and usability. The tangible user interface was adopted to provide an intuitive interaction and to help manage sound objects and parameters. A timeline interface was built to implement the benefits of *scaffolding composition* and *plan ahead* that emerged as design implications in Study I. In Study III, MTBoxII was improved based on the feedback on MTBox in Study II. The interaction required to trigger or to stop the sound was reduced to only one step rather than two steps in the previous version. Instead of looping, the short samples were changed to be played only once when triggered so as to add more expressiveness to the prototype. For the same reason the MTBoxes were designed with a finite number of buttons thus with limited sound choices, two sets of short samples were embedded in MTBoxII. However, despite the improvement, the pre-recorded samples in MTBoxes still restricted the expressiveness of the prototypes. Besides, the samples embedded in MTBoxes were restricted to the electronic sound genre on all the prototypes. The limited choices of sound might have restricted some participants' creative engagement because that might not be their preferred music. Solutions to this could be allowing participants to choose the sample set from their preferred genre to satisfy their appetite. Moreover, whether the sound genre is a factor that influences creative engagement is an interesting topic to look at in future studies.

An ultimate solution to the issue of expressiveness is to allow higher autonomy for the players to customise their music content. For example, the players could create the looping samples from scratch. This proposal leads back to the dilemma that it is difficult for novices to create things from scratch [Weinberg and Gan, 2001, Weinberg, 2003]. The idea of mix-initiate creative interface generating alternative ideas with artificial intelligence techniques [Deterding et al., 2017] could potentially solve this conflict. Moreover, algorithmic techniques could be implemented to allow the users to produce and experiment with variations on musical objects quickly[Sarwate and Fiebrink, 2013]. Another interesting research question emerged as to how to integrate these algorithm-based solutions seamlessly into the current IMSs while preserving the intuitiveness of interaction.

Due to the implementation of the prototypes, and the design of the study setup, the sound of prototypes was generated from the computer instead of from the prototype itself or the headphone. The disconnected sound did not provide an immersive environment, which might restrict participants from being engaged in the interaction, and thus affect the feedback collected from the studies. Embedding the sound within the MTBox is necessary for future studies. A solution is replacing the micro-controller board in MTBox from the current Arduino Mega with Bela[1] as Bela is capable of processing real-time sound. This would make it possible to embed the sound interface in MTBox itself and to generate sound from the box.

The shift of design from graphical user interface used in Study I to the tangible user interface (TUI) used in Study II and Study III resulted in an inconsistent comparison between Study I and Study II and III. More direct comparisons between studies could be achieved if all the prototypes were built with graphical user interfaces. However, the intuitiveness suggested by TUI would be lost. In future studies, the consistency need to be considered before finalising the study design.

8.4.4 Data Collection and Analysis

Questionnaire based on Creative Engagement factors

In general, the questionnaire based on the Likert scale used in both Study II and III proved to be a useful tool to elicit feedback on the subjective experience on creative engagement. The analysis of the results provided substantial and informative evidence in answering the research questions. However, some participants may not have been able to identify their preference or that they may not be willing to rate their feeling distinctly thus they might have placed their choices in the middle of the Likert scale. This could have hidden some additional differences between the comparisons.

[1] https://bela.io

There are limitations on the creative engagement factors derived from engagement attributes and factors for evaluating CST, based on which the questionnaire was built. As noted in the reflective summary of Study II in Section 5.6, the results of some of the factors were not significant. In both Study II and Study III, there were significant differences found on factors that were added based on the research question rather than from the pool of engagement attributes and CST evaluation factors. The results suggest more factors outside the current pool that may be used to measure non-musicians' creative engagement with musical interfaces. It should be considered that the creative engagement factors may vary according to the different context of use, e.g. collaborative use. They may also vary across different domains due to the distinct creative activities, e.g. improvisation involves real-time activities whereas composition involves iterative activities. Therefore to evaluate creative engagement, the validity of the present factors need to be evaluated, and more potential factors need to be explored.

The validation of the current factors of creative engagement can start by looking at the inter-correlation between the factors. As an example, a 2-tailed Pearson correlation analysis was conducted on the questionnaire feedback of Study III. Strong correlations were observed between different questions. The agreement on Q11 (Creativity) was strongly correlated with the agreement on Q9 (Results Worth Effort) ((r)=.766, n=48, p<.0001) and Q10 (Satisfaction) ((r)=.746, n=48, p<.0001). The agreement on Q2 (Heuristic) was strongly correlated with the agreement on Q5 (Exploration) ((r)=.736, n=48, p<.0001) and Q8 (Expressiveness) ((r)=.821, n=48, p<.0001). This means the factors assessed in the correlated questions are very similar to each other. In future works, the factor analysis[2] of dimension reduction can be used to combine and reduce similar factors in the questionnaire. Factor analysis is a statistical method used to uncover the relations between the measured variables by combining the correlated measured variables into groups [Fodor, 2002]. Table 8.2 shows the results of the factor analysis on the questionnaire feedback of Study III. It indicates that the questions can be categorised into three components according to participants feedback. The first component covers the factors of aesthetics, heuristic, exploration, usage frequency, focused attention and expressiveness, the second component covers the factors of results worth effort, satisfaction and creativity, and the third component covers the factors of learnability and own understanding. These results indicate three general underlying factors of the original eleven factors. In the future, the analysis can be carried out to analyse the results of Study II as well. A more validated set of factors for evaluating creative engagement can be extracted based on the interpretation of the results.

[2]https://en.m.wikipedia.org/wiki/Factor_analysis

Factors	Component 1	Component 2	Component 3
Q1 (Aesthetics)	.476		
Q2 (Heuristic)	.808		
Q3 (Learnability*)			.608
Q4 (Own Understanding*)			.722
Q5 (Exploration)	.833		
Q6 (Usage Frequency*)	.737		
Q7 (Focused Attention)	.559		
Q8 (Expressiveness)	.836		
Q9 (Results Worth Effort)		.729	
Q10 (Satisfaction)		.663	
Q11 (Creativity)		.734	

Table 8.2: Factor Analysis on Questionnaire Feedback in Study III

The comparison questionnaire significantly contributed to illuminating the research questions by providing informative evidence. By forcing the participants to choose one from the two compared condition, it is easier to collect significant results as compared to the questions based on the Likert scale. However, the usage of the comparison questionnaire is limited to the study of within-subject variables. It is not possible to apply the same method to between-subject variables as the participants are exposed to only one condition.

Interview and Thematic Analysis

As discussed in Chapter 3, although the questionnaire could indicate the subjective preference of the experience, it lacks the potential to explain the underlying reasons behind that preference. The interview, however, could collect more detailed feedback from participants on their subjective experience. With the in-depth qualitative data from the interview, it is possible to dig potential value of a condition or a feature of the prototype that did not show its advantages in the questionnaires. As an example, evidence extracted from the questionnaire suggested the exploratory motivation has more advantages than the utilitarian motivation in the comparison by task session. The thematic analysis of the interview feedback identified the potential advantages of a utilitarian motivation in supporting a sustained creative process.

The choice of inductive thematic analysis aimed at exploring the essence of creative engagement without bringing pre-assumption or existing theoretical ideas to the data. Although the results were informative, the process of inductive thematic analysis was extremely time-consuming without an overview of the data. Multiple iterations of analysis were necessary for building a comprehensive understanding of the data. Some of the more efficient methods of dealing with qualitative data could be worth looking at, e.g. designing the interview with the capacity to be abstracted as quantified data, adopting text-analytical methods such as word cloud to work out the frequency of words. This might help researchers to quickly preview the data and to increase the efficiency of the inductive thematic analysis. Moreover, as noted earlier, the themes can not be compared between groups unless the analysis are carried out independently. This makes the comparisons of qualitative data between groups more difficult since independent analysis needs extra work and is time-consuming.

The thematic analysis in this thesis was carried out individually by the author. The reason for not inviting multiple researchers to code the transcripts was related to the exploratory purpose of the data. As the previous practices were carried out by multiple researchers to ensure the reliability and validity of the analysis [Ryan and Bernard, 2003], it would be valuable to have other researchers to go through the data and conduct thematic analysis in future studies.

Interaction Log Data and Analysis

Apart from the analysis of the activities, e.g. numbers of interactions, time of interaction, the analysis in this thesis proposes to take the interaction log data as a time series data and to analyse them from a global perspective. The analysis presented in this thesis highlighted the potential to inform of interaction log data, support and complement self-report measures and subjective feedback. The thesis proposes to look at the time series data from the following two perspectives:

Activity Assessment The activity assessment is to look at how the interactions repeat, vary, or shift over time. As demonstrated, in this thesis, Closed Frequent Sequential Pattern (CFSP) mining could be one potential method to mine the interaction patterns that repeatedly occur over time. According to the correlation analysis between the subjective feedback and the number of types of CFSP presented in Chapter 6, the variety of CFSPs could indicate how expressive the prototype was and how frustrating the participant felt. For digging more in the sequential activities, methods such as sequence analysis [Abbott, 1995], which is developed and widely used in the domain of sociology and linguistics, could be explored in future studies.

The recurrence quantification analysis could also offer a quantified value on how repetitive the whole interaction process is within itself. The disadvantage of recurrence quantification analysis is that it can only be applied to single time series data instead of multiple time series data that happen simultaneously. This will largely limit its application in the broader contexts of evaluation. One version of this analysis, cross recurrence quantification analysis, can compare different interaction processes. It is worth to investigate the use of this method in future studies.

The fact that the results of CFSP and RQA were coherent with each other confirmed the assumption that these two analysis could be used to indicate the variety of activities in an interaction. This exploration on the methods suggest a promising approach to understand and evaluate the activities in future studies.

Qualitative Assessment The analysis of interaction log data also supported a qualitative understanding of the interaction process. For example, the visualisation on the interaction log data from Study I (Chapter 4) allowed the development of a descriptive understandings of the different exploration and creative strategies. The categorisation of the frequently performed patterns reported in Chapter 6 gave indications about the typical interactions and has the potential to offer additional objective evidence to the qualitative analysis of subjective data (discussed in Section 6.6.2). However, the interpretation of the data, e.g. visualisation or categories of CFSP, is largely dependent on the research question and research context, and quite subjective according to the analyst as it lacks systematic guidelines. It is also difficult to use this method when the data set is large. Clustering data mining techniques that can divide data into groups based on similarity [Berkhin, 2006] could be explored and applied to automatically categorise the frequent interactive patterns participants performed. This could offer a more objective tool for interpreting the interactive patterns.

Participants

People who perceived themselves as musicians were excluded from the research during the recruitment phase. Even though the prototypes were designed for non-musicians initially, in future works it would be interesting to research which factors influence the musicians' creative engagement when interacting with them. Such insights from experienced musicians could be compared with those from non-musicians and inform the understanding of creative engagement.

The thesis carried out studies with a focus on individual players as the understanding of the definition and process of creative engagement was vague in the beginning. Now that the thesis has contributed to a better understanding of individual's creative engagement, it is interesting to consider the various social dynamics in a collective music making activity. What are the features of collective creative engagement and how do they relate to and influence individual's creative engagement? These are critical questions that future works can focus on, in order to build an integrated framework of creative engagement.

8.5 Summary

This chapter has put together the findings of the three studies, compared and discussed them reflectively. A series of general design implications was proposed based on these findings, including 1) fostering performing live by offering intuitive control metaphor, by supporting planning future events and by scaffolding physical skills, 2) scaffolding structured composition by helping on managing resources and by providing structured records, 3) designing progressive layers of motivations and designing for different goals, and 4) providing abstract visual stimuli for inspirations by allowing autonomy, by balancing simplicity and abstractness and considering task scenario. Finally, the methodology was reviewed reflectively, with possible pitfalls in the aspects of study design, prototype design, data collection and analysis and participants being discussed and potential solutions to address them. The following chapter concludes the thesis.

Chapter 9

Conclusion

This chapter recapitulates the major findings in relation to the research goals presented in Chapter 1, as well as the contributions of this thesis. Limitations are discussed and potential future works are indicated.

The subject of this thesis was the study of *creative engagement*, when the user is engaged in an active, reflective and constructive cognitive process in pursuing a creative outcome with an interactive system, however for the purpose of creating something that is valuable as personal creative experience rather than for a broader audience. The thesis set out with the general research question - *how to design and evaluate support for non-musicians' creative engagement with musical interfaces*. Based on the literature review on engagement, creativity support and new trends on designing interactive music systems for novices, more specific research questions are developed to examine the effects of different factors on novices' creative engagement. These factors include control metaphors, motivations, features of musicking modes and abstract visual stimuli.

The three empirical studies together addressed the primary research goals of this thesis. Each study investigated the effects of one or two of the above factors on non-musicians' creative engagement. Different prototypes were designed and developed for the purpose of investigating the specific research question in each study. Parallel to the investigation on the research questions, the thesis also developed a descriptive understanding of novices' creative engagement with interactive music systems and explored the evaluation methods for assessing levels of creative engagement through the questionnaire, interview and interaction log data.

9.1 Major Findings

There are four sections of major findings in this thesis. Each of the findings can be linked to one of the research goals described in Section 1.2.2.

1. Developing a descriptive model of novices' creative engagement with interactive music systems.

A descriptive model for novices' creative engagement with the musical interface was developed based on the qualitative thematic analysis. There were three modes of interaction, *experimenting, composing and performing.* Each playing mode differed from each other on aspects such as motivation and activity. Each demanded a set of prerequisite skills and output progressive levels of results, corresponding to different phases of the creative engagement, *exploration oriented, result oriented, and experience oriented* creative engagement. This model offers a structured way for designers and researchers to understand novices' creative engagement with interfaces that involves real-time activities.

2. Examining the effects of various factors on novices' creative engagement with interactive music systems.

The three empirical studies provided a systematic understanding of the effects of factors that may influence non-musicians' creative engagement with interactive systems. This results of Study I suggested that *scaffolding starting from the blank, structuring composition, managing sound and playing live* were the essential user interface features to support non-musicians' creative engagement. Results in Study II suggested that the experiential motivation had more positive effects on supporting non-musicians' creative engagement compared to utilitarian motivation. The feature of revisiting and reusing previous records was helpful in supporting non-musicians' creative engagement while playing with musical interfaces. The effects were more pronounced if it was accompanied with the feature of editable records. In Study III, the abstract graphical score showed its superiority in provoking inspiration and creative engagement, however only under the condition that the participants were given no information about the design concepts of the graphical score.

3. Exploring the evaluation criteria for assessing the level of creative engagement.

The thesis presented the mixed-methods approach to evaluate creative engagement through the combination of questionnaire, interview and the quantitative analysis of the interaction log data. The factors extracted from the existing literature were helpful in designing the Likert scale based questionnaire, which contributed to the evaluation on different aspects of creative engagement. The semi-structured interviews offered informative subjective feedback from participants to develop deeper understandings of the rationale of the questionnaire choices and the process of creative engagement. The studies also showed the potential of using objective interaction log data to understand, explain and evaluate subjective experience with three key benefits: the results are *informative*, the data collection is *efficient*, and the choices of analysis are *scalable*. The thesis contributes to the application of this approach with a proposal to analyse the interaction log data from three angles: activity assessment, content assessment and qualitative assessment.

4. Providing a set of design implications that could inform other designs intended to facilitate novices' creative engagement.

A series of general design implications was proposed based on the results of three studies. The implications cover various aspects of design, including 1) fostering performing live by offering intuitive control metaphor, by supporting planning future events and by scaffolding physical skills, 2) scaffolding structured composition by helping on managing resources and by providing structured records, 3) designing progressive layers of motivations and designing for different goals, and 4) providing abstract visual stimuli for inspirations by allowing autonomy, by balancing simplicity and abstractness and considering task scenario. These design implications will have direct implications for the design of similar musical systems for non-musicians in NIME, or systems that aim to engage novices creatively in HCI.

9.2 Limitations and Future Works

As discussed earlier in Chapter 8, there were some limitations due to the methodology and study design.

Research Scope

The thesis managed to investigate a scope of factors that might influence non-musicians creative engagement, i.e. control metaphors, task motivation, features of musicking mode and abstract visual stimuli. However, the focus was limited. More factors are potentially influential on novices' creative engagement, which needs to be investigated in future studies. For example, a user's emotional state might be influential to the level of creative engagement, as it is influential to user experience [Desmet and Hekkert, 2007, Wright et al., 2008, Bargas-Avila and Hornbæk, 2011] and to creativity [Hewett, 2005, Sawyer, 2011, Sternberg and Kaufman, 2010].

Besides, various potential factors that might influence creative engagement have emerged in the studies, which are worth looking at in future research. For example, in Study III the results implied that a balanced autonomy was essential for non-musicians to develop a loose impression and interpretation on the abstract graphical score. Without autonomy, they reported the feeling of being determined, whilst with too much autonomy they felt it is difficult to interpret. Both inhibited their creative engagement. However, the balance is a vague concept. To which extent the autonomy is necessary and can contribute to the creative engagement need to be investigated. Moreover, auto-synchronisation was embedded in MTBoxII so as to support non-musicians to play. Auto solutions were proposed to be essential for supporting novices' physical skills in interactions that involve real-time activities. However, auto solutions might also limit the expressiveness of the interface by reducing the controllability. More auto solutions that can support playing with musical interfaces and balance the need for expressiveness are interesting topics to look at in future studies.

More generally, future studies could investigate the research question in broader domains, e.g. art, literature. Questions such as how such technology-mediated interfaces can contribute to creative engagement and does the factors examined in this thesis have the same effects on novices' creative engagement in those domains are exciting works for future studies.

Study Design

The limitations of the prototypes designed in Study I prohibited to draw the conclusions on the effects of different control metaphor. Future studies need to improve the prototypes with richer and more expressive interactions. MTBox designed for Study II and Study III can be improved as well, especially on account of sound design. The limited sound choices might have restricted some participants' creative engagement. The disconnected sound did not provide an immersive sound environment for engaging participants. In future studies, these problems need to be addressed.

The current studies were carried out with only non-musicians and with a focus on individual creative process. To develop a comprehensive understanding of creative engagement, future studies need to take into account the experienced players' creative process. What factors might affect creative engagement in collaborative scenarios and how does an individual's creative engagement differed from collaborative creative engagement are also exciting research questions that are worth looking at.

The study may have failed to evaluate non-musicians' long-term creative engagement with the prototype in a real scenario. Therefore to explore the long-term creative engagement in the real-world scenario would be an interesting direction for future work. For example, this could be pursued in a longitudinal study with participants engaged with the prototype for multiple sessions, or allow participants to take the prototype to home and play with it for a few days.

Data Collection and Analysis

The questionnaire used in Study II and III were designed based on a set of factors extracted from engagement attributes and evaluation factors for creativity support tool. Although the results provided substantial evidence to explain the hypothesis and to draw conclusions, whether the factors could be a set of criteria for evaluating the creative engagement with other interactive systems needs to be verified with future studies. Factor analysis could be potential method to categorise the current factors based on the existing data. An in-depth interpretation on the results of factor analysis can offer more understanding of the creative engagement in future studies.

Although the mix-approach method combining analysis of interaction log data as well as the subjective feedback showed great potential to contribute to future evaluation on an interactive system, it is necessary to evaluate its validity and universality with more practices. The analysis was carried out with limited methods, i.e. Closed Frequent Sequential Pattern (CFSP) mining, Recurrence Quantification Analysis, Dynamic Time Warping. It is an exciting direction for future studies to explore possible analysis methods, e.g. sequence analysis, data mining, to offer more options for such mixed-approach analysis. Moreover, there were some conflicts with the results. For example between the variety of CFSPs and the subjective feedback, there were positive correlations and negative correlations observed. Although in the discussions it was explained. It is necessary to notice this phenomenon and look into it in future studies. Moreover, the analysis in Study II was carried out with a narrow focus on the users' activities. In future works, the analysis of the content, what the users has performed and created, should also be taken into consideration so as to dig more information about the users' creative engagement based on their creative output.

The data visualisation in Study I was informative for understanding the participants' exploratory and creative strategies. Future research could explore more strategies to visualise interaction log data and how to effectively employ them to promote a deeper understanding of creative engagement. One disadvantage of this approach was that the interpretation of the visualisation was carried out by the researcher and was too subjective. There is a similar drawback for the categorisation on CFSP in Chapter 6. Clustering data mining techniques that can divide data into groups based on similarity [Berkhin, 2006] could be explored and applied to auto categorise the frequent interactive patterns participants performed to offer a more objective tool for interpreting the interactive patterns.

9.3 Closing Remarks

> *The Dao produced the one, the one produced the two, the two produced the three, the three produced all things. - Laozi (ca.600BC)*

Ancient Chinese philosophy narrates that once a seed has sprouted, there will be numerous possibilities. Creative engagement is the seed in this thesis. The ultimate goal of studying how to design and evaluate support for creative engagement in HCI is to empower people with the intrinsically rewarding creative experience and the confidence to engage with interactive systems, particularly for the sake of novices. By this means they are empowered with the seed to produce numerous possibilities. This thesis suggests facilitating non-musicians' creative engagement with musical interfaces with consideration of the control metaphors of interfaces, motivations of participants, user interface features of musicking modes and provoking inspirations in the creative process when designing an HCI system. It is hoped that this thesis provided useful implications for germinating the seed of creative engagement.

Bibliography

Andrew Abbott. Sequence analysis: new methods for old ideas. *Annual review of sociology*, 21(1):93–113, 1995.

Anne Adams and Anna L Cox. Questionnaires, in-depth interviews and focus groups. 2008.

Teresa M Amabile. Within you, without you: The social psychology of creativity, and beyond. 1990.

Daniel Gábana Arellano and Andrew McPherson. Radear: A tangible spinning music sequencer. In *Proceedings of the 14th International Conference on New Interfaces for Musical Expression*, pages 84–85, 2014.

Myung-Sook Auh. Effects of using graphic notations on creativity in composing music by australian secondary school students. 2000.

Myung-Sook Auh and Robert Walker. Compositional strategies and musical creativity when composing with staff notations versus graphic notations among korean students. *Bulletin of the Council for Research in Music Education*, pages 2–9, 1999.

Myung-Sook Auh and Robert Walker. Creative visual thinking reflected in graphic notations of compositions. In *Verified OK*. University of Liege, 2002.

Jerônimo Barbosa, Filipe Calegario, Veronica Teichrieb, Geber Ramalho, and Giordano Cabral. Illusio: A drawing-based digital music instrument. In *Proceedings of the 13th International Conference on New Interfaces for Musical Expression*, 2013.

Jeronimo Barbosa, Joseph Malloch, Marcelo M Wanderley, and Stéphane Huot. What does "evaluation" mean for the nime community? In *NIME 2015-15th International Conference on New Interfaces for Musical Expression*, pages 156–161. Louisiana State University, 2015.

Javier A Bargas-Avila and Kasper Hornbæk. Old wine in new bottles or novel challenges: a critical analysis of empirical studies of user experience. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pages 2689–2698. ACM, 2011.

Howard S Becker and Blanche Geer. Participant observation and interviewing: A comparison. *Human organization*, 16(3):28–32, 1957.

Luca Benedetti, Holger Winnemöller, Massimiliano Corsini, and Roberto Scopigno. Painting with bob: Assisted creativity for novices. In *Proceedings of the 27th annual ACM symposium on User interface software and technology*, pages 419–428. ACM, 2014.

Ben Bengler and Nick Bryan-Kinns. Designing collaborative musical experiences for broad audiences. In *Proceedings of the 9th ACM Conference on Creativity & Cognition*, pages 234–242. ACM, 2013.

Pavel Berkhin. A survey of clustering data mining techniques. In *Grouping multidimensional data*, pages 25–71. Springer, 2006.

Gilbert Beyer and Max Meier. Music interfaces for novice users: Composing music on a public display with hand gestures. In *Proceedings of the 11th International Conference on New Interfaces for Musical Expression*, pages 507–510, 2011.

Zafer Bilda, Ernest Edmonds, and Linda Candy. Designing for creative engagement. *Design Studies*, 29(6):525–540, 2008.

Alan F Blackwell. The reification of metaphor as a design tool. *ACM Transactions on Computer-Human Interaction (TOCHI)*, 13(4):490–530, 2006.

Tina Blaine and Sidney Fels. Contexts of collaborative musical experiences. In *Proceedings of the 2003 conference on New interfaces for musical expression*, pages 129–134. National University of Singapore, 2003.

AE Blandford. Semi-structured qualitative studies. Interaction Design Foundation, 2013.

Florian Block, James Hammerman, Michael Horn, Amy Spiegel, Jonathan Christiansen, Brenda Phillips, Judy Diamond, E Margaret Evans, and Chia Shen. Fluid grouping: Quantifying group engagement around interactive tabletop exhibits in the wild. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, pages 867–876. ACM, 2015.

Margaret A Boden. Creativity and artificial intelligence. *Artificial Intelligence*, 103(1-2):347–356, 1998.

Margaret A Boden. *The creative mind: Myths and mechanisms*. Psychology Press, 2004.

Nathalie Bonnardel. Creativity in design activities: The role of analogies in a constrained cognitive environment. In *Proceedings of the 3rd conference on Creativity & cognition*, pages 158–165. ACM, 1999.

Nathalie Bonnardel and Evelyne Marmèche. Evocation processes by novice and expert designers: Towards stimulating analogical thinking. *Creativity and Innovation Management*, 13(3):176–186, 2004.

Minda Borun, Margaret B Chambers, Jennifer Dritsas, and Julie I Johnson. Enhancing family learning through exhibits. *Curator: The Museum Journal*, 40(4):279–295, 1997.

Oliver Bown. Experiments in modular design for the creative composition of live algorithms. *Computer Music Journal*, 35(3):73–85, 2011.

Virginia Braun and Victoria Clarke. Using thematic analysis in psychology. *Qualitative research in psychology*, 3(2):77–101, 2006.

Jeanne H Brockmyer, Christine M Fox, Kathleen A Curtiss, Evan McBroom, Kimberly M Burkhart, and Jacquelyn N Pidruzny. The development of the game engagement questionnaire: A measure of engagement in video game-playing. *Journal of Experimental Social Psychology*, 45(4):624–634, 2009.

Eli T Brown, Alvitta Ottley, Helen Zhao, Quan Lin, Richard Souvenir, Alex Endert, and Remco Chang. Finding waldo: Learning about users from their interactions. *IEEE Transactions on visualization and computer graphics*, 20 (12):1663–1672, 2014.

Nick Bryan-Kinns. Daisyphone: the design and impact of a novel environment for remote group music improvisation. In *Proceedings of the 5th conference on Designing interactive systems: processes, practices, methods, and techniques*, pages 135–144. ACM, 2004.

Nick Bryan-Kinns. Mutual engagement and collocation with shared representations. *International Journal of Human-Computer Studies*, 71(1):76–90, 2013.

Nick Bryan-Kinns and Fraser Hamilton. Identifying mutual engagement. *Behaviour & Information Technology*, 31(2):101–125, 2012.

Nick Bryan-Kinns, Patrick GT Healey, and Joe Leach. Exploring mutual engagement in creative collaborations. In *Proceedings of the 6th ACM SIGCHI conference on Creativity & cognition*, pages 223–232. ACM, 2007.

Charles Byrne, John Halliday, Mark Sheridan, Rebecca Soden, and Simon Hunter. Thinking music matters: key skills and composition. *Music Education Research*, 3(1):63–75, 2001.

John Cage. Experimental music. *Silence: Lectures and writings*, pages 7–12, 1961.

Linda Candy. Evaluation and experience in art. In *Interactive Experience in the Digital Age*, pages 25–48. Springer, 2014.

Linda Candy and Zafer Bilda. Understanding and evaluating creativity. In *Proceedings of the Seventh ACM Conference on Creativity and Cognition*, C&C'09, pages 497–498, New York, NY, USA, 2009. ACM. ISBN 978-1-60558-865-0. doi: 10.1145/1640233.1640376. URL http://doi.acm.org/10.1145/1640233.1640376.

Linda Candy and Ernest A Edmonds. Supporting the creative user: a criteria-based approach to interaction design. *Design Studies*, 18(2):185–194, 1997.

Carlos Cardoso and Petra Badke-Schaub. The influence of different pictorial representations during idea generation. *The Journal of Creative Behavior*, 45 (2):130–146, 2011.

Carlos Cardoso, Petra Badke-Schaub, and Ana Luz. Design fixation on non-verbal stimuli: the influence of simple vs. rich pictorial information on design problem-solving. In *ASME 2009 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference*, pages 995–1002. American Society of Mechanical Engineers, 2009.

Erin A Carroll, Celine Latulipe, Richard Fung, and Michael Terry. Creativity factor evaluation: towards a standardized survey metric for creativity support. In *Proceedings of the seventh ACM conference on Creativity and cognition*, pages 127–136. ACM, 2009.

Erin Ashley Carroll. *Quantifying the personal creative experience: evaluation of digital creativity support tools using self-report and physiological responses*. PhD thesis, The University of North Carolina at Charlotte, 2013.

Joel Chadabe. Electric sound:{The} past and promise of electronic music. 1997.

Peter Chapman and Sanjeebhan Selvarajah. Engagement in multimedia training systems. In *Proceedings of the Thirty-Second Annual Hawaii International Conference on System Sciences-Volume 1 - Volume 1*, HICSS '99, pages 1084–, Washington, DC, USA, 1999. IEEE Computer Society. ISBN 0-7695-0001-3. URL http://dl.acm.org/citation.cfm?id=874068.875906.

Peter Chapman, Sanjeebhan Selvarajah, and Jane Webster. Engagement in multimedia training systems. In *Systems Sciences, 1999. HICSS-32. Proceedings of the 32nd Annual Hawaii International Conference on*, pages 9–pp. IEEE, 1999.

Peter McFaul Chapman. *Models of engagement: Intrinsically motivated interaction with multimedia learning software*. PhD thesis, University of Waterloo, 1997.

Yun Chen and Hui Yang. Multiscale recurrence analysis of long-term nonlinear and nonstationary time series. *Chaos, Solitons & Fractals*, 45(7):978–987, 2012.

Peiyao Cheng, Ruth Mugge, and Jan PL Schoormans. A new strategy to reduce design fixation: Presenting partial photographs to designers. *Design Studies*, 35(4):374–391, 2014.

Erin Cherry and Celine Latulipe. Quantifying the creativity support of digital tools through the creativity support index. *ACM Transactions on Computer-Human Interaction (TOCHI)*, 21(4):21, 2014.

Ed H Chi, Peter Pirolli, and James Pitkow. The scent of a site: A system for analyzing and predicting information scent, usage, and usability of a web site. In *Proceedings of the SIGCHI conference on Human Factors in Computing Systems*, pages 161–168. ACM, 2000.

Bo T Christensen and Christian D Schunn. The relationship of analogical distance to analogical function and preinventive structure: The case of engineering design. *Memory & cognition*, 35(1):29–38, 2007.

Andy Clark. *Being there: Putting brain, body, and world together again.* MIT press, 1998.

Ann Colley, Louise Banton, Julia Down, and Anthony Pither. An expert-novice comparison in musical composition. *Psychology of Music*, 20(2):124–137, 1992.

Kate Compton and Michael Mateas. Casual creators. In *Proceedings of the 6th International Conference on Computational Creativity*, pages 228–235, 2015.

Sunny Consolvo and Miriam Walker. Using the experience sampling method to evaluate ubicomp applications. *IEEE Pervasive Computing*, 2(2):24–31, 2003.

Andrew Crabtree, Mark Rouncefield, and Peter Tolmie. *Doing design ethnography.* Springer, 2012.

Anna Craft, Kerry Chappell, and Peter Twining. Learners reconceptualising education: widening participation through creative engagement? *Innovations in Education and Teaching International*, 45(3):235–245, 2008.

Mihaly Csikszentmihalyi. The psychology of optimal experience. *Harper&Row, New York*, 1990.

Mihaly Csikszentmihalyi. *Flow and the psychology of discovery and invention.* New York: Harper Collins, 1996.

Mihaly Csikszentmihalyi. *Flow and the foundations of positive psychology.* Springer, 2014.

Mihaly Csikszentmihalyi and Keith Sawyer. Creative insight: The social dimension of a solitary moment. In *The systems model of creativity*, pages 73–98. Springer, 2014.

Gideon D'Arcangelo. Creating contexts of creativity: musical composition with modular components. In *Proceedings of the 1st conference on New interfaces for musical expression*, pages 1–4, 2001.

Jane Davidson and Alice Coulam. Exploring jazz and classical solo singing performance behaviours. In Irène Deliège and Geraint A. Wiggins, editors, *Musical Creativity*, page 181. Psychology Press, 2006.

Gary A Davis. Barriers to creativity and creative attitudes. *Encyclopedia of creativity*, 1:165–174, 1999.

Nicholas Davis, Holger Winnemöller, Mira Dontcheva, and Ellen Yi-Luen Do. Toward a cognitive theory of creativity support. In *Proceedings of the 9th ACM Conference on Creativity & Cognition*, pages 13–22. ACM, 2013a.

Nicholas Davis, Alexander Zook, Brian O'Neill, Brandon Headrick, Mark Riedl, Ashton Grosz, and Michael Nitsche. Creativity support for novice digital filmmaking. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pages 651–660. ACM, 2013b.

Filipa Martins de Abreu and Álvaro Barbosa. Creative engagement: Multimodal digital games in children's learning environment in macau sar. In *Proceedings of the 8th International Conference on Digital Arts*, pages 47–54. ACM, 2017.

Eunice ML Soriano De Alencar and Maria F(á De Bruno-Faria. Characteristics of on organizational environment which stimulate and inhibit creativity.

Irène Deliège, Geraint A Wiggins, et al. *Musical creativity: Multidisciplinary research in theory and practice.* Psychology Press, 2006.

Pieter Desmet and Paul Hekkert. Framework of product experience. *International journal of design*, 1(1), 2007.

Sebastian Deterding, Jonathan Hook, Rebecca Fiebrink, Marco Gillies, Jeremy Gow, Memo Akten, Gillian Smith, Antonios Liapis, and Kate Compton. Mixed-initiative creative interfaces. In *Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems*, pages 628–635. ACM, 2017.

John Dewey. *Experience and education*. Simon and Schuster, 1997.

Judy Diamond. The behavior of family groups in science museums. *Curator: The Museum Journal*, 29(2):139–154, 1986.

Haojing Diao, Yanchao Zhou, Christopher Andrew Harte, and Nick Bryan-Kinns. Sketch-based musical composition and performance. In *NIME*, pages 569–572, 2014.

Christian Dindler. Designing infrastructures for creative engagement. *Digital creativity*, 25(3):212–223, 2014.

Alan Dorin and Kevin B Korb. Creativity refined: Bypassing the gatekeepers of appropriateness and value. In *Computers and creativity*, pages 339–360. Springer, 2012.

Wenwen Dou, Dong Hyun Jeong, Felesia Stukes, William Ribarsky, Heather Richter Lipford, and Remco Chang. Recovering reasoning processes from user interactions. *IEEE Computer Graphics and Applications*, 29(3), 2009.

Steven P Dow, Alana Glassco, Jonathan Kass, Melissa Schwarz, Daniel L Schwartz, and Scott R Klemmer. Parallel prototyping leads to better design results, more divergence, and increased self-efficacy. In *Design Thinking Research*, pages 127–153. Springer, 2012.

Richard Dudas. "comprovisation": The various facets of composed improvisation within interactive performance systems. *Leonardo Music Journal*, 20:29–31, 2010.

Miguel Pina e Cunha, Stewart R Clegg, and Sandro Mendonça. On serendipity and organizing. *European Management Journal*, 28(5):319–330, 2010.

Claudia Eckert and Martin Stacey. Sources of inspiration: a language of design. *Design studies*, 21(5):523–538, 2000.

Ernest Edmonds. Art, interaction and engagement. In *Information Visualisation (IV), 2011 15th International Conference on*, pages 451–456. IEEE, 2011.

Ernest Edmonds, Lizzie Muller, and Matthew Connell. On creative engagement. *Visual communication*, 5(3):307–322, 2006.

Ludvig Elblaus, Carl Unander-Scharin, and Åsa Unander-Scharin. Singing interaction: Embodied instruments for musical expression in opera. *Leonardo music journal*, 24:7–12, 2014.

Nada Endrissat, Gazi Islam, and Claus Noppeney. Visual organizing: Balancing coordination and creative freedom via mood boards. *Journal of Business Research*, 69(7):2353–2362, 2016.

K Anders Ericsson. The scientific study of expert levels of performance: general implications for optimal learning and creativity 1. *High Ability Studies*, 9(1): 75–100, 1998.

William Farr, Nicola Yuill, and Hayes Raffle. Social benefits of a tangible user interface for children with autistic spectrum conditions. *Autism*, 14(3):237–252, 2010.

Mark Christopher Feldmeier. *Large group musical interaction using disposable wireless motion sensors*. PhD thesis, Citeseer, 2002.

Sidney Fels. Designing for intimacy: Creating new interfaces for musical expression. volume 92, pages 672–685. IEEE, 2004.

Jennifer Fereday and Eimear Muir-Cochrane. Demonstrating rigor using thematic analysis: A hybrid approach of inductive and deductive coding and theme development. *International journal of qualitative methods*, 5(1):80–92, 2006.

Rebecca Fiebrink and Baptiste Caramiaux. The machine learning algorithm as creative musical tool. In *Handbook of Algorithmic Music*. Oxford University Press, 2016.

Ronald A Finke. *Creative imagery: Discoveries and inventions in visualization*. Psychology press, 1990.

Ronald A Finke, Thomas B Ward, and Steven M Smith. Creative cognition: Theory, research, and applications. 1992.

Gerhard Fischer. Beyond "couch potatoes": From consumers to designers and active. In *Contributors, in FirstMonday (Peer-Reviewed Journal on the Internet), Available at http://firstmonday. org/issues/issue7_12/fischer*, 2002.

Maurice D Fisher, Laird R Blackwell, Angela B Garcia, and Jennifer C Greene. Effects of student control and choice on engagement in a cai arithmetic task in a low-income school. *Journal of Educational Psychology*, 67(6):776, 1975.

Morten Fjeld, Jonas Fredriksson, Martin Ejdestig, Florin Duca, Kristina B́otschi, Benedikt Voegtli, and Patrick Juchli. Tangible user interface for chemistry education: comparative evaluation and re-design. In *Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 805–808. ACM, 2007.

Imola K Fodor. A survey of dimension reduction techniques. *Center for Applied Scientific Computing, Lawrence Livermore National Laboratory*, 9:1–18, 2002.

Jodi Forlizzi and Katja Battarbee. Understanding experience in interactive systems. In *Proceedings of the 5th conference on Designing interactive systems: processes, practices, methods, and techniques*, pages 261–268. ACM, 2004.

Jodi Forlizzi and Shannon Ford. The building blocks of experience: an early framework for interaction designers. In *Proceedings of the 3rd conference on Designing interactive systems: processes, practices, methods, and techniques*, pages 419–423. ACM, 2000.

Enrique Franco, Niall JL Griffith, and Mikael Fernström. Issues for designing a flexible expressive audiovisual system for real-time performance & composition. In *Proceedings of the 2004 conference on New interfaces for musical expression*, pages 165–168. National University of Singapore, 2004.

Ronald S Friedman and Jens Förster. The effects of promotion and prevention cues on creativity. *Journal of personality and social psychology*, 81(6):1001, 2001.

Minoru Fujimoto, Naotaka Fujita, Yoshinari Takegawa, Tsutomu Terada, and Masahiko Tsukamoto. A motion recognition method for a wearable dancing musical instrument. In *Wearable Computers, 2009. ISWC'09. International Symposium on*, pages 11–18. IEEE, 2009.

Liane Gabora. Revenge of the "neurds": Characterizing creative thought in terms of the structure and dynamics of memory. *Creativity Research Journal*, 22(1):1–13, 2010.

Jérémie Garcia, Theophanis Tsandilas, Carlos Agon, and Wendy Mackay. InkSplorer: Exploring Musical Ideas on Paper and Computer. In *New Interfaces for Musical Expression (NIME 2011)*, Oslo, Norway, May 2011. URL `https://hal.inria.fr/inria-00600083`.

Steven Gelineck and Stefania Serafin. A practical approach towards an exploratory framework for physical modeling. *Computer Music Journal*, 34(2): 51–65, 2010.

Gabriela Goldschmidt. The dialectics of sketching. *Creativity research journal*, 4(2):123–143, 1991.

Gabriela Goldschmidt. Avoiding design fixation: transformation and abstraction in mapping from source to target. *The Journal of creative behavior*, 45(2): 92–100, 2011.

Gabriela Goldschmidt. Ubiquitous serendipity: Potential visual design stimuli are everywhere. In *Studying visual and spatial reasoning for design creativity*, pages 205–214. Springer, 2015.

Gabriela Goldschmidt and Maria Smolkov. Variances in the impact of visual stimuli on design problem solving performance. *Design Studies*, 27(5):549–569, 2006.

Daniel Gómez, Tjebbe Donner, and Andrés Posada. A look at the design and creation of a graphically controlled digital musical instrument. In *Proceedings of the 7th international conference on New interfaces for musical expression*, pages 327–329. ACM, 2007.

Florian Güldenpfennig, Wolfgang Reitberger, Eva Ganglbauer, and Geraldine Fitzpatrick. Duography in the classroom: Creative engagement with two-sided mobile phone photography. *International Journal of Mobile Human Computer Interaction (IJMHCI)*, 6(3):51–67, 2014.

Hua Guo, Steven R Gomez, Caroline Ziemkiewicz, and David H Laidlaw. A case study using visualization interaction logs and insight metrics to understand how analysts arrive at insights. *IEEE transactions on visualization and computer graphics*, 22(1):51–60, 2016.

Kilem Li Gwet. Computing inter-rater reliability and its variance in the presence of high agreement. *British Journal of Mathematical and Statistical Psychology*, 61(1):29–48, 2008.

JoAnn T Hackos and Janice Redish. User and task analysis for interface design. 1998.

Jiawei Han, Jian Pei, Behzad Mortazavi-Asl, Qiming Chen, Umeshwar Dayal, and Mei-Chun Hsu. Freespan: frequent pattern-projected sequential pattern mining. In *Proceedings of the sixth ACM SIGKDD international conference on Knowledge discovery and data mining*, pages 355–359. ACM, 2000.

Anne-Marie Skriver Hansen, Hans J Anderson, and Pirkko Raudaskoski. Play fluency in music improvisation games for novices. In *Proceedings of the 11th International Conference on New Interfaces for Musical Expression*, pages 220–223, 2011.

Jiffer Harriman. Sinkapater-an untethered beat sequencer. In *Proceedings of the International Conference on New Interfaces for Musical Expression*, 2012.

Steve Harrison, Deborah Tatar, and Phoebe Sengers. The three paradigms of hci. In *Alt. Chi. Session at the SIGCHI Conference on Human Factors in Computing Systems San Jose, California, USA*, pages 1–18, 2007.

Kevin James Harvey, Brian Brown, Paul Crawford, Aidan Macfarlane, and Ann McPherson. 'am i normal?' teenagers, sexual health and the internet. *Social science & medicine*, 65(4):771–781, 2007.

Marc Hassenzahl and Noam Tractinsky. User experience - a research agenda. *Behaviour & information technology*, 25(2):91–97, 2006.

Marc Hassenzahl and Daniel Ullrich. To do or not to do: Differences in user experience and retrospective judgments depending on the presence or absence of instrumental goals. *Interacting with Computers*, 19(4):429, 2007. doi: 10.1016/j.intcom.2007.05.001. URL +http://dx.doi.org/10.1016/j.intcom.2007.05.001.

Marc Hassenzahl, Markus Schöbel, and Tibor Trautmann. How motivational orientation influences the evaluation and choice of hedonic and pragmatic interactive products: The role of regulatory focus. *Interacting with Computers*, 20(4-5):473–479, September 2008. ISSN 0953-5438. doi: 10.1016/j.intcom.2008.05.001. URL http://dx.doi.org/10.1016/j.intcom.2008.05.001.

Ted Hayes. Neurohedron: A nonlinear sequencer interface. In *Proceedings of the 10th International Conference on New Interfaces for Musical Expression*, pages 23–25, 2010.

Naomi Haywood and Paul Cairns. Engagement with an interactive museum exhibit. In *People and computers XIXâĂŤThe bigger picture*, pages 113–129. Springer, 2006.

Christian Heath and Dirk Vom Lehn. Configuring'interactivity' enhancing engagement in science centres and museums. *Social Studies of Science*, 38(1): 63–91, 2008.

Steven J Heine, Darrin R Lehman, Kaiping Peng, and Joe Greenholtz. What's wrong with cross-cultural comparisons of subjective likert scales?: The reference-group effect. *Journal of personality and social psychology*, 82(6): 903, 2002.

Beth A. Hennessey. The creativity-motivation connection. In James C Kaufman and Robert J Sternberg, editors, *The Cambridge Handbook of Creativity*, chapter 18, pages 342–365. Cambridge University Press, Cambridge, 2010.

Thomas Hewett. Informing the design of computer-based environments to support creativity. *International Journal of Human-Computer Studies*, 63(4): 383–409, 2005.

Thomas Hewett, Mary Czerwinski, Michael Terry, Jay Nunamaker, Linda Candy, Bill Kules, and Elisabeth Sylvan. Creativity support tool evaluation methods and metrics. *Creativity Support Tools*, pages 10–24, 2005.

James Hollan, Edwin Hutchins, and David Kirsh. Distributed cognition: toward a new foundation for human-computer interaction research. *ACM Transactions on Computer-Human Interaction (TOCHI)*, 7(2):174–196, 2000.

Thomas B Holmes and Thom Holmes. *Electronic and experimental music: pioneers in technology and composition.* Psychology Press, 2002.

Michael Horn, Zeina Atrash Leong, Florian Block, Judy Diamond, E Margaret Evans, Brenda Phillips, and Chia Shen. Of bats and apes: an interactive tabletop game for natural history museums. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pages 2059–2068. ACM, 2012.

Eva Hornecker. "i don't understand it either, but it is cool"-visitor interactions with a multi-touch table in a museum. In *Horizontal interactive human computer systems, 2008. TABLETOP 2008. 3rd IEEE International Workshop on*, pages 113–120. IEEE, 2008.

Eva Hornecker and Matthias Stifter. Learning from interactive museum installations about interaction design for public settings. In *Proceedings of the 18th Australia conference on Computer-Human Interaction: Design: Activities, Artefacts and Environments*, pages 135–142. ACM, 2006.

Olivier Houix, Stefano Delle Monache, Hélène Lachambre, Frédéric Bevilacqua, Davide Rocchesso, and Guillaume Lemaitre. Innovative tools for sound sketching combining vocalizations and gestures. In *Proceedings of the Audio Mostly 2016*, pages 12–19. ACM, 2016.

Ya-Hsin Hung and Paul Parsons. Assessing user engagement in information visualization. In *Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems*, pages 1708–1717. ACM, 2017.

Elisa A Hurley. Working passions: Emotions and creative engagement with value. *The Southern Journal of Philosophy*, 45(1):79–104, 2007.

Edwin Hutchins. Metaphors for interface design. Technical report, CALIFORNIA UNIV SAN DIEGO LA JOLLA INST FOR COGNITIVE SCIENCE, 1987.

Gail H Ironson and Gary A Davis. Faking high or low creativity scores on the adjective check list. *The Journal of Creative Behavior*, 13(2):139–145, 1979.

Hiroshi Ishii. The tangible user interface and its evolution. *Communications of the ACM*, 51(6):32–36, 2008.

R Jacques. Using engagement to evaluate hypermedia. In *Research symposium presented at CHI*, volume 95, pages 7–11, 1995.

Charlene Jennett, Anna L Cox, Paul Cairns, Samira Dhoparee, Andrew Epps, Tim Tijs, and Alison Walton. Measuring and defining the experience of immersion in games. *International journal of human-computer studies*, 66(9): 641–661, 2008.

Pamela Jennings, Elisa Giaccardi, and Magda Wesolkowska. About face interface: creative engagement in the new media arts and hci. In *CHI'06 Extended Abstracts on Human Factors in Computing Systems*, pages 1663–1666. ACM, 2006.

Alexander Refsum Jensenius and Michael J Lyons. *A NIME Reader: Fifteen Years of New Interfaces for Musical Expression.* Springer, 2017.

Bonnie E John and David E Kieras. Using goms for user interface design and evaluation: Which technique? *ACM Transactions on Computer-Human Interaction (TOCHI)*, 3(4):287–319, 1996.

AJ Johnston. Fluid simulation as full body audio-visual instrument. In *International Conference on New Interfaces for Musical Expression.* Korea Advance Institute of Science and Technology, 2013.

Andrew Johnston. Keeping research in tune with practice. In *Interactive Experience in the Digital Age*, pages 49–62. Springer, 2014.

Sergi Jordà. Sonigraphical instruments: from fmol to the reactable. In *Proceedings of the 2003 conference on New interfaces for musical expression*, pages 70–76. National University of Singapore, 2003.

Sergi Jordà. Instruments and players: Some thoughts on digital lutherie. *Journal of New Music Research*, 33(3):321–341, 2004.

Sergi Jordà. *Digital Lutherie Crafting musical computers for new musics' performance and improvisation.* PhD thesis, Universitat Pompeu Fabra, 2005.

Sergi Jordà, Ǵunter Geiger, Marcos Alonso, and Martin Kaltenbrunner. The reactable: exploring the synergy between live music performance and tabletop tangible interfaces. In *Proceedings of the 1st international conference on Tangible and embedded interaction*, pages 139–146. ACM, 2007.

Patrick W Jordan. *Designing pleasurable products: An introduction to the new human factors.* CRC press, 2002.

Martin Kaltenbranner, Sergi Jorda, Gunter Geiger, and Marcos Alonso. The reactable*: A collaborative musical instrument. In *Enabling Technologies: Infrastructure for Collaborative Enterprises, 2006. WETICE'06. 15th IEEE International Workshops on*, pages 406–411. IEEE, 2006.

Martin Kaltenbrunner, Sergi Jorda, Gunter Geiger, and Marcos Alonso. The reactable*: A collaborative musical instrument. In *Enabling Technologies: Infrastructure for Collaborative Enterprises, 2006. WETICE'06. 15th IEEE International Workshops on*, pages 406–411. IEEE, 2006.

James C Kaufman, John Baer, et al. *Creativity across domains: Faces of the muse.* Psychology Press, 2005.

Dave S Kerby. The simple difference formula: An approach to teaching nonparametric correlation. *Comprehensive Psychology*, 3:11–IT, 2014.

Andruid Kerne, Andrew M Webb, Steven M Smith, Rhema Linder, Nic Lupfer, Yin Qu, Jon Moeller, and Sashikanth Damaraju. Using metrics of curation to evaluate information-based ideation. *ACM Transactions on Computer-Human Interaction (ToCHI)*, 21(3):14, 2014.

Joy Kim, Avi Bagla, and Michael S Bernstein. Designing creativity support tools for failure. In *Proceedings of the 2015 ACM SIGCHI Conference on Creativity and Cognition*, pages 157–160. ACM, 2015.

M Kim and Mary Lou Maher. Comparison of designers using a tangible user interface and a graphical user interface and the impact on spatial cognition. *Proc. Human Behaviour in Design*, 5, 2005.

Charles Kivunja. Creative engagement of digital learners with gardnerâĂŹs bodily-kinesthetic intelligence to enhance their critical thinking. *Creative Education*, 6(06):612, 2015.

André Knörig, Boris Müller, and Reto Wettach. Articulated paint: musical expression for non-musicians. In *Proceedings of the 7th international conference on New interfaces for musical expression*, pages 384–385, 2007.

Tina Kobus, Lee Maxwell, and Jeanette Provo. Increasing motivation of elementary and middle school students through positive reinforcement, student self-assessment, and creative engagement. *Online Submission*, 2007.

Christina Koeffel, Wolfgang Hochleitner, Jakob Leitner, Michael Haller, Arjan Geven, and Manfred Tscheligi. Using heuristics to evaluate the overall user experience of video games and advanced interaction games. In *Evaluating user experience in games*, pages 233–256. Springer, 2010.

Nicholas Kohn and Steven M Smith. Partly versus completely out of your mind: Effects of incubation and distraction on resolving fixation. *The Journal of Creative Behavior*, 43(2):102–118, 2009.

Kristiina Kumpulainen, Marianna Karttunen, Leenu Juurola, and Anna Mikkola. Towards children's creative museum engagement and collaborative sense-making. *Digital Creativity*, 25(3):233–246, 2014.

Steve Larson. Composition versus improvisation? *Journal of Music Theory*, 49 (2):241–275, 2005.

Brenda Laurel. *Computers as theatre.* Addison-Wesley, 1993.

Jonathan Lazar, Jinjuan Heidi Feng, and Harry Hochheiser. *Research methods in human-computer interaction.* Morgan Kaufmann, 2017.

Sang Won Lee and Jason Freeman. Real-time music notation in mixed laptop -acoustic ensembles. *Computer Music Journal*, 37(4):24–36, 2013.

Janette Lehmann, Mounia Lalmas, Elad Yom-Tov, and Georges Dupret. Models of user engagement. In *International Conference on User Modeling, Adaptation, and Personalization*, pages 164–175. Springer, 2012.

Gaea Leinhardt and Kevin Crowley. Museum learning as conversational elaboration: A proposal to capture, code, and analyze talk in museums. *Museum Learning Collaborative, http://museumlearning. org/paperresearch. html (accessed March 1, 2007)*, 1998.

Golan Levin. *Painterly interfaces for audiovisual performance.* PhD thesis, Massachusetts Institute of Technology, 2000.

Todd Lubart. How can computers be partners in the creative process: classification and commentary on the special issue. *International Journal of Human-Computer Studies*, 63(4):365–369, 2005.

Tod Machover. Instruments, interactivity, and inevitability. In *Proceedings of the 2nd conference on New interfaces for musical expression*, pages 1–1, 2002.

Thor Magnusson. Algorithms as scores: Coding live music. *Leonardo Music Journal*, pages 19–23, 2011.

Thor Magnusson. Improvising with the threnoscope: integrating code, hardware, gui, network, and graphic scores. In *Proceedings of the Internation Conference on New Interfaces for Musical Expression*. Goldsmiths University of London, 2014.

Stephann Makri and Ann Blandford. Coming across information serendipitously–part 2: A classification framework. *Journal of Documentation*, 68(5):706–724, 2012.

Stephann Makri, Ann Blandford, Mel Woods, Sarah Sharples, and Deborah Maxwell. "making my own luck": Serendipity strategies and how to support them in digital information environments. *Journal of the Association for Information Science and Technology*, 65(11):2179–2194, 2014.

Regan L Mandryk and Kori M Inkpen. Physiological indicators for the evaluation of co-located collaborative play. In *Proceedings of the 2004 ACM conference on Computer supported cooperative work*, pages 102–111. ACM, 2004.

Paul Marshall, Richard Morris, Yvonne Rogers, Stefan Kreitmayer, and Matt Davies. Rethinking'multi-user': an in-the-wild study of how groups approach a walk-up-and-use tabletop interface. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pages 3033–3042. ACM, 2011.

Norbert Marwan, Niels Wessel, Udo Meyerfeldt, Alexander Schirdewan, and Jürgen Kurths. Recurrence-plot-based measures of complexity and their application to heart-rate-variability data. *Physical review E*, 66(2):026702, 2002.

Norbert Marwan, M Carmen Romano, Marco Thiel, and Jürgen Kurths. Recurrence plots for the analysis of complex systems. *Physics reports*, 438(5-6): 237–329, 2007.

Abraham Harold Maslow. *Religions, values, and peak-experiences*, volume 35. Ohio State University Press Columbus, 1964.

Richard E Mayer. Fifty years of creativity research. *Handbook of creativity*, 449, 1999.

Marco (M.C.) Rozendaal, David V. Keyson, and Huib Ridder. Product features and task effects on experienced richness, control and engagement in voicemail browsing. *Personal Ubiquitous Comput.*, 13(5):343–354, June 2009. ISSN 1617-4909. doi: 10.1007/s00779-008-0201-8. URL `http://dx.doi.org/10.1007/s00779-008-0201-8`.

Kenneth B McAlpine. Shake and create: Reappropriating video game technologies for the enactive learning of music. In *Serious Games and Edutainment Applications*, pages 77–97. Springer, 2017.

Abigail McBirnie. Seeking serendipity: the paradox of control. In *Aslib Proceedings*, volume 60, pages 600–618. Emerald Group Publishing Limited, 2008.

John McCarthy and Peter Wright. *Technology as experience*. MIT press, 2004.

Lori McCay-Peet and Elaine G Toms. Researching serendipity in digital information environments. *Synthesis Lectures on Information Concepts, Retrieval, and Services*, 9(6):i–91, 2017.

Susan H McFadden and Anne D Basting. Healthy aging persons and their brains: promoting resilience through creative engagement. *Clinics in geriatric medicine*, 26(1):149–161, 2010.

Oussama Metatla, Nuno N Correia, Fiore Martin, Nick Bryan-Kinns, and Tony Stockman. Tap the shapetones: Exploring the effects of crossmodal congruence in an audio-visual interface. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*, pages 1055–1066. ACM, 2016.

Michael Minge and Manfred Thüring. Hedonic and pragmatic halo effects at early stages of user experience. *International Journal of Human-Computer Studies*, 109:13–25, 2018.

Eduardo Reck Miranda and Marcelo M Wanderley. *New digital musical instruments: control and interaction beyond the keyboard*, volume 21. AR Editions, Inc., 2006.

Homei Miyashita and Kazushi Nishimoto. Thermoscore: a new-type musical score with temperature sensation. In *Proceedings of the 2004 conference on New interfaces for musical expression*, pages 104–107. National University of Singapore, 2004.

Ali Momeni and Cyrille Henry. Dynamic independent mapping layers for concurrent control of audio and video synthesis. *Computer Music Journal*, 30(1): 49–66, 2006.

Andrew Monk, Marc Hassenzahl, Mark Blythe, and Darren Reed. Funology: designing enjoyment. In *CHI'02 extended abstracts on human factors in computing systems*, pages 924–925. ACM, 2002.

Jacqui H Morris, Chris Kelly, Madalina Toma, Thilo Kroll, Sara Joice, Gillian Mead, Peter Donnan, and Brian Williams. Feasibility study of the effects of art as a creative engagement intervention during stroke rehabilitation on improvement of psychosocial outcomes: study protocol for a single blind randomized controlled trial: the aces study. *Trials*, 15(1):380, 2014.

Tim Murray-Browne. *Interactive music: Balancing creative freedom with musical development*. PhD thesis, Queen Mary University of London, 2012.

Dennis C Neale and John M Carroll. The role of metaphors in user interface design. In *Handbook of Human-Computer Interaction (Second Edition)*, pages 441–462. Elsevier, 1997.

Kia Ng. Interactive feedbacks with visualisation and sonification for technology-enhanced learning for music performance. In *Proceedings of the 26th annual ACM international conference on Design of communication*, pages 281–282. ACM, 2008.

Raymond S. Nickerson. *Enhancing Creativity*, page 392âĂŞ430. Cambridge University Press, 1998. doi: 10.1017/CBO9780511807916.022.

Donald A Norman. Introduction to this special section on beauty, goodness, and usability. *Human-Computer Interaction*, 19(4):311–318, 2004.

Thomas P Novak, Donna L Hoffman, and Adam Duhachek. The influence of goal-directed and experiential activities on online flow experiences. *Journal of consumer psychology*, 13(1-2):3–16, 2003.

Heather L O'Brien. The influence of hedonic and utilitarian motivations on user engagement: The case of online shopping experiences. *Interacting with computers*, 22(5):344–352, 2010.

Heather L O'brien and Karon E MacLean. Measuring the user engagement process. In *Digital Life New World Conference, Boston, MA*, 2009.

Heather L O'Brien and Elaine G Toms. What is user engagement? a conceptual framework for defining user engagement with technology. *Journal of the American Society for Information Science and Technology*, 59(6):938–955, 2008.

Heather L O'Brien and Elaine G Toms. The development and evaluation of a survey to measure user engagement. *Journal of the Association for Information Science and Technology*, 61(1):50–69, 2010.

Dan Overholt. The musical interface technology design space. *Organised Sound*, 14(2):217–226, 2009.

Dale E Parson. Chess-based composition and improvisation for non-musicians. In *NIME*, pages 157–158, 2009.

Jian Pei, Jiawei Han, Runying Mao, et al. Closet: An efficient algorithm for mining frequent closed itemsets. In *ACM SIGMOD workshop on research issues in data mining and knowledge discovery*, volume 4, pages 21–30, 2000.

Jennifer Radbourne, Hilary Glow, and Katya Johanson. Knowing and measuring the audience experience. *The Audience Experience: A critical analysis of audiences in the performing arts*, pages 1–13, 2013.

Pedro Rebelo. Notating the unpredictable. *Contemporary Music Review*, 29(1): 17–27, 2010.

Pedro Rebelo. Composing with graphics: Revealing the compositional process through performance. In *In Proceedings of On New Tools for Music Notation and Representation*, 2015.

Khairi Reda, Andrew E Johnson, Jason Leigh, and Michael E Papka. Evaluating user behavior and strategy during visual exploration. In *Proceedings of the Fifth Workshop on Beyond Time and Errors: Novel Evaluation Methods for Visualization*, pages 41–45. ACM, 2014.

Anna Reid and Ian Solomonides. Design students' experience of engagement and creativity. *Art, Design & Communication in Higher Education*, 6(1): 27–39, 2007.

Rosemary C Reilly. Is expertise a necessary precondition for creativity?: A case of four novice learning group facilitators. *Thinking Skills and Creativity*, 3(1): 59–76, 2008.

Mitchel Resnick, Amy Bruckman, and Fred Martin. Pianos not stereos: Creating computational construction kits. *interactions*, 3(5):40–50, 1996.

Mel Rhodes. An analysis of creativity. *The Phi Delta Kappan*, 42(7):305–310, 1961.

Ruth Richards. Everyday creativity: Process and way of life âĂŞ four key issues. In James C Kaufman and Robert J Sternberg, editors, *The Cambridge Handbook of Creativity*, chapter 10, pages 189–215. Cambridge University Press, Cambridge, 2010.

Curtis Roads. *Composing electronic music: a new aesthetic*. Oxford University Press, USA, 2015.

Philip A Robinson, Phil Macnaghten, Sarah Banks, Janie Bickersteth, Angela Kennedy, Yvonne Richardson, Sue Shaw, and Ingrid Sylvestre. Responsible scientists and a citizens' panel: new storylines for creative engagement between science and the public. *The Geographical Journal*, 180(1):83–88, 2014.

Dominic Robson. Play!: Sound toys for non-musicians. *Computer Music Journal*, 26(3):50–61, 2002.

Carl R Rogers. Toward a theory of creativity. *ETC: A review of general semantics*, pages 249–260, 1954.

Yvonne Rogers. Hci theory: classical, modern, and contemporary. *Synthesis Lectures on Human-Centered Informatics*, 5(2):1–129, 2012.

Yvonne Rogers, Nicola Yuill, and Paul Marshall. Contrasting lab-based and in-the-wild studies for evaluating multi-user technologies. *The Sage handbook of digital technology research*, 2013.

Robert Rowe. *Interactive music systems: machine listening and composing*. MIT press, 1992.

Marco M. C. Rozendaal, David V. Keyson, and Huib de Ridder. Product behavior and appearance effects on experienced engagement during experiential and goal-directed tasks. In *Proceedings of the 2007 Conference on Designing Pleasurable Products and Interfaces*, DPPI '07, pages 181–193, New York, NY, USA, 2007. ACM. ISBN 978-1-59593-942-5. doi: 10.1145/1314161.1314178. URL `http://doi.acm.org/10.1145/1314161.1314178`.

Sandra W Russ and Julie A Fiorelli. Development approaches to creativity. In James C Kaufman and Robert J Sternberg, editors, *The Cambridge Handbook of Creativity*, chapter 12, pages 233–249. Cambridge University Press, Cambridge, 2010.

Gery W Ryan and H Russell Bernard. Techniques to identify themes. *Field methods*, 15(1):85–109, 2003.

Kimiko Ryokai, Stefan Marti, and Hiroshi Ishii. I/o brush: drawing with everyday objects as ink. In *Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 303–310. ACM, 2004.

Elizabeth B-N Sanders and Pieter Jan Stappers. Co-creation and the new landscapes of design. *Co-design*, 4(1):5–18, 2008.

Avneesh Sarwate and Rebecca Fiebrink. Variator: A creativity support tool for music composition. In *NIME*, pages 279–282, 2013.

R Keith Sawyer. *Explaining creativity: The science of human innovation.* Oxford University Press, 2011.

Jan C Schacher, Chikashi Miyama, and Daniel Bisig. Gestural electronic music using machine learning as generative device. In *Proceedings of the 15th International Conference on New Interfaces for Musical Expression*, 2015.

Clive Seale, Jonathan Charteris-Black, Aidan MacFarlane, and Ann McPherson. Interviews and internet forums: a comparison of two sources of qualitative data. *Qualitative Health Research*, 20(5):595–606, 2010.

Colleen M Seifert, David E Meyer, Natalie Davidson, Andrea L Patalano, and Ilan Yaniv. Demystification of cognitive insight: Opportunistic assimilation and the prepared-mind hypothesis. 1994.

Ted Selker. Fostering motivation and creativity for computer users. *International Journal of Human-Computer Studies*, 63(4-5):410–421, 2005.

Orit Shaer, Eva Hornecker, et al. Tangible user interfaces: past, present, and future directions. *Foundations and Trends® in Human-Computer Interaction*, 3(1–2):4–137, 2010.

Jami J Shah, NOE Vargas-Hernandez, Joshua D Summers, and Santosh Kulkarni. Collaborative sketching (c-sketch)âĂŤan idea generation technique for engineering design. *The Journal of Creative Behavior*, 35(3):168–198, 2001.

Christina E Shalley. Effects of productivity goals, creativity goals, and personal discretion on individual creativity. *Journal of Applied psychology*, 76(2):179, 1991.

Nathan Shedroff. *Experience design 1.* New Riders Publishing, 2001.

Jennifer G Sheridan and Nick Bryan-Kinns. Designing for performative tangible interaction. *International Journal of Arts and Technology*, 1(3-4):288–308, 2008.

Takumi Shirokura, Daisuke Sakamoto, Yuta Sugiura, Tetsuo Ono, Masahiko Inami, and Takeo Igarashi. Robojockey: real-time, simultaneous, and continuous creation of robot actions for everyone. In *Proceedings of the 7th International Conference on Advances in Computer Entertainment Technology*, pages 53–56. ACM, 2010.

Ben Shneiderman. Creating creativity: user interfaces for supporting innovation. *ACM Transactions on Computer-Human Interaction (TOCHI)*, 7(1):114–138, 2000.

Ben Shneiderman. Creativity support tools: Accelerating discovery and innovation. *Communications of the ACM*, 50(12):20–32, 2007.

Ben Shneiderman. Creativity support tools: A grand challenge for hci researchers. In *Engineering the User Interface*, pages 1–9. Springer, 2009.

Kevin Shockley and Michael A Riley. Interpersonal couplings in human interactions. In *Recurrence Quantification Analysis*, pages 399–421. Springer, 2015.

Simeon J Simoff and Mary Lou Maher. Analysing participation in collaborative design environments. *Design studies*, 21(2):119–144, 2000.

Nina Simon. *The participatory museum*. Museum 2.0, 2010.

Christopher Small. *Musicking: The meanings of performing and listening*. Wesleyan University Press, 2011.

J David Smith. The place of musical novices in music science. *Music Perception: An Interdisciplinary Journal*, 14(3):227–262, 1997.

Steven M Smith and Steven E Blankenship. Incubation and the persistence of fixation in problem solving. *The American journal of psychology*, pages 61–87, 1991.

Steven M Smith, Thomas B Ward, and Jay S Schumacher. Constraining effects of examples in a creative generation task. *Memory & cognition*, 21(6):837–845, 1993.

Samaneh Soleimani and Effie Lai-Chong Law. *The Influence of Motivation on Emotional Experience in E-commerce*, pages 281–288. Springer International Publishing, Cham, 2015. ISBN 978-3-319-22701-6. doi: 10.1007/978-3-319-22701-6_20. URL http://dx.doi.org/10.1007/978-3-319-22701-6_20.

Robert J Sternberg and James C Kaufman. Constraints on creativity. *The Cambridge handbook of creativity*, pages 467–482, 2010.

Dan Stowell and Alex McLean. Live music-making: A rich open task requires a rich open interface. In *Music and human-computer interaction*, pages 139–152. Springer, 2013.

Dan Stowell, Mark D Plumbley, and Nick Bryan-Kinns. Discourse analysis evaluation method for expressive musical interfaces. In *NIME*, pages 81–86, 2008.

Dan Stowell, Andrew Robertson, Nick Bryan-Kinns, and Mark D Plumbley. Evaluation of live human–computer music-making: Quantitative and qualitative approaches. *International Journal of Human-Computer Studies*, 67(11): 960–975, 2009.

Fay Sudweeks and Simeon J Simoff. Complementary explorative data analysis: The reconciliation of quantitative and qualitative principles. *Doing Internet research: Critical issues and methods for examining the Net*, pages 29–55, 1999.

Helena Sustar. Facilitating and measuring older people's creative engagement in a user centered design process. In *Proceedings of the 22nd British HCI Group Annual Conference on People and Computers: Culture, Creativity, Interaction-Volume 2*, pages 253–254. BCS Learning & Development Ltd., 2008.

Atau Tanaka. Sensor-based musical instruments and interactive. In Roger T. Dean, editor, *The Oxford Handbook of Computer Music*, chapter 12, pages 233–257. Oxford University Press, Oxford, 2009.

Atau Tanaka. Music one participates in. In *Proceedings of the 8th ACM conference on Creativity and cognition*, pages 105–106. ACM, 2011.

Atau Tanaka, Nao Tokui, and Ali Momeni. Facilitating collective musical creativity. In *Proceedings of the 13th annual ACM international conference on Multimedia*, pages 191–198. ACM, 2005.

Atau Tanaka, Adam Parkinson, Zack Settel, and Koray Tahiroglu. A survey and thematic analysis approach as input to the design of mobile music guis. In *NIME*. Citeseer, 2012.

Jean-Baptiste Thiebaut, Patrick GT Healey, and Nick Bryan-Kinns. Drawing electroacoustic music. In *ICMC*, 2008.

Priyamvada Tripathi and Winslow Burleson. Predicting creativity in the wild: Experience sample and sociometric modeling of teams. In *Proceedings of the ACM 2012 conference on computer supported cooperative work*, pages 1203–1212. ACM, 2012.

Adinda Rosa van't Klooster and Nick Collins. In a state: Live emotion detection and visualisation for music performance. In *NIME*, pages 545–548, 2014.

Edward Vul and Harold Pashler. Incubation benefits only after people have been misdirected. *Memory & Cognition*, 35(4):701–710, 2007.

Si Waite. Church belles: An interactive system and composition using real-world metaphors. In *NIME 2016-16th International Conference on New Interfaces for Musical Expression*. Griffith University, Brisbane, Australia, 2016.

Diane Walker and Florence Myrick. Grounded theory: An exploration of process and procedure. *Qualitative health research*, 16(4):547–559, 2006.

Robert Walker. The effects of culture, environment, age, and musical training on choices of visual metaphors for sound. *Perception & Psychophysics*, 42(5): 491–502, 1987.

Graham Wallas. The art of thought. 1926.

John L Walters. Sound, code, image. *Eye*, 26:24–35, 1997.

Marcelo M Wanderley. Gestural control of music. In *International Workshop Human Supervision and Control in Engineering and Music*, pages 632–644, 2001.

Marcelo Mortensen Wanderley and Nicola Orio. Evaluation of input devices for musical expression: Borrowing tools from hci. *Computer Music Journal*, 26 (3):62–76, 2002.

Gang Wang, Xinyi Zhang, Shiliang Tang, Haitao Zheng, and Ben Y Zhao. Unsupervised clickstream clustering for user behavior analysis. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*, pages 225–236. ACM, 2016.

Ge Wang. Principles of visual design for computer music. In *ICMC*, 2014.

Jane Webster and Hayes Ho. Audience engagement in multimedia presentations. *SIGMIS Database*, 28(2):63–77, April 1997. ISSN 0095-0033. doi: 10.1145/264701.264706. URL `http://doi.acm.org/10.1145/264701.264706`.

Peter R Webster. Creativity as creative thinking. *Music Educators Journal*, 76 (9):22–28, 1990.

Gil Weinberg. *Interconnected musical networks: bringing expression and thoughtfulness to collaborative group playing*. PhD thesis, Massachusetts Institute of Technology, 2003.

Gil Weinberg. The beatbug–evolution of a musical controller. *Digital Creativity*, 19(1):3–18, 2008.

Gil Weinberg and Scott Driscoll. iltur: Connecting novices and experts through collaborative improvisation. In *Proceedings of the 5th conference on New interfaces for musical expression*, pages 17–22, 2005.

Gil Weinberg and Seum-Lim Gan. The squeezables: Toward an expressive and interdependent multi-player musical instrument. *Computer Music Journal*, 25(2):37–45, 2001.

Gil Weinberg, Roberto Aimi, and Kevin Jennings. The beatbug network: a rhythmic system for interdependent group collaboration. In *Proceedings of the 2002 conference on New interfaces for musical expression*, pages 1–6, 2002.

David Wessel and Matthew Wright. Problems and prospects for intimate musical control of computers. *Computer Music Journal*, 26(3):11–22, 2002.

Ceri Williams. Creative engagement in interactive immersive environments. *Digital Creativity*, 19(3):203–211, 2008.

Rudolph R Willmann. An experimental investigation of the creative process in music: The transposability of visual design stimuli to musical themes. *Psychological Monographs*, 57(1):i, 1944.

Peter Wright and John McCarthy. Experience-centered design: designers, users, and communities in dialogue. *Synthesis Lectures on Human-Centered Informatics*, 3(1):1–123, 2010.

Peter Wright, Jayne Wallace, and John McCarthy. Aesthetics and experience-centered design. *ACM Transactions on Computer-Human Interaction (TOCHI)*, 15(4):18, 2008.

Yongmeng Wu and Nick Bryan-Kinns. Supporting non-musicians' creative engagement with musical interfaces. In *Proceedings of the 2017 ACM SIGCHI Conference on Creativity and Cognition*, C&C '17, pages 275–286, New York, NY, USA, 2017. ACM. ISBN 978-1-4503-4403-6. doi: 10.1145/3059454.3059457. URL `http://doi.acm.org/10.1145/3059454.3059457`.

Yongmeng Wu, Leshao Zhang, Nick Bryan-Kinns, and Mathieu Barthet. Open symphony: Creative participation for audiences of live music performances. *IEEE MultiMedia*, 24(1):48–62, 2017.

Anna Xambó. Embodied music interaction: Creative design synergies between music performance and hci. In *Digital Bodies*, pages 207–220. Springer, 2017.

Anna Xambó, Eva Hornecker, Paul Marshall, Sergi Jordà, Chris Dobbyn, and Robin Laney. Let's jam the reactable: Peer learning during musical improvisation with a tabletop tangible interface. *ACM Transactions on Computer-Human Interaction (TOCHI)*, 20(6):36, 2013a.

Anna Xambó, Robin Laney, Chris Dobbyn, and Sergi Jordà. Video analysis for evaluating music interaction: musical tabletops. In *Music and Human-Computer Interaction*, pages 241–258. Springer, 2013b.

Hui Yang. Multiscale recurrence quantification analysis of spatial cardiac vectorcardiogram signals. *IEEE Transactions on Biomedical Engineering*, 58(2): 339–347, 2011.

Lin Yao, Yanfang Liu, Wen Li, Lei Zhou, Yan Ge, Jing Chai, and Xianghong Sun. Using physiological measures to evaluate user experience of mobile applications. In *International Conference on Engineering Psychology and Cognitive Ergonomics*, pages 301–310. Springer, 2014.

Mark Zadel and Gary Scavone. Different strokes: A prototype software system for laptop performance and improvisation. In *Proceedings of the 2006 Conference on New Interfaces for Musical Expression*, NIME '06, pages 168–171, Paris, France, France, 2006. IRCAM — Centre Pompidou. ISBN 2-84426-314-3. URL http://dl.acm.org/citation.cfm?id=1142215.1142255.

Francisco Zamorano. Simpletones: A system of collaborative physical controllers for novices. In *Proceedings of the 12th International Conference on New Interfaces for Musical Expression*, 2012.

Victor Zappi and Andrew McPherson. Design and use of a hackable digital instrument. 2014.

Appendix A

Study I Material

A.1 Study Scripts

Study I Procedure

1. Introduction (5 minutes) *(An introduction about the study process will be given in the beginning provided with an information sheet.)*

- The purpose of the study.

  - The purpose of this study is to understand how different user interface will affect the interaction process in terms of learning process and creative process.

- The study process. The study includes three main sessions. It will take approximately 80 minutes, during which time your are free to opt out at any point.
  - Firstly, you will be introducing and play with one prototype.
  - Secondly, free exploration with one prototype. Then you can create a piece of music with this prototype, then followed by a simple interview.
  - free exploration with the other prototype, then improvise a piece of sound, then followed by a simple interview.
  - Finally questions regarding comparison of two prototypes will be asked.
- Consent form.(video recording, data logging, anonymous)

2. Play with Prototype A/B (35 minutes) *(The order of the prototype will be randomised for different participants so as to minimise the influence of the order.) (Screen/sound recording will be made and participant's interaction will be video recorded on each section.)*

- **Prototype introduction (5 minutes)**

Prototype description. (*As a training process, the prototypes will presented and the following information will be provided to participant.*)

1. The basic concept of the interface. There are three main categories of objects in both of the prototypes.
   - The effectors, which will make sound when triggered. There are four effectors with four different sound effects.
   - The generator, which generate graphical elements rhythmical to trigger the sound controlled by effectors.
   - The sequencer, which will offer a background sound. There are three sound effects to choose. Only one of them is available at each time.
   - There are some variables of the sound can be changed by adjusting the objects added on the canvas. (Participant need to explore by themselves what kind of sound variable they are able to adjust and how to adjust them)
2. The basic design of the interface.
   - There are different functions can be chose from the left sidebar. In the Effector mode, different effectors can be added on the canvas; In the Editor mode the effector can be adjusted; In the Deleter mode effector can be deleted. In the Sequencer mode the Sequencer can be changed or adjusted.
   - The sound design of two prototypes is the same while the interface design is different, and the ways to manipulate the sound variable are different.

- **Free exploration (10 minutes).** Please try out the interface for a while and explore it in your own way. Please try to understand the concept I described just now and try as many functions as possible when you are interacting with the prototype.

- **Semi-structured interview (3 minutes).** The interview will be addressing the exploration experience.

  -. Why did you find it is easy/difficult to learn? Do you have any suggestions in terms of making it easier to learn?

  -. How did you go about learning to use this application?

  -. What do you think helps you to learn this prototype when you first started?

- **Guided learning (3 minutes).** According to participants' understanding and questions, guide participants to learn all the functions and elements.
- **Creative Improvisation (10 minutes).** Please try to create a piece of music with this prototype that you are satisfied. Try to create around a mood, or a style, or a topic, anything that you would like to.
- **Semi-structured interview (4 minutes).** The participant will be asked questions in terms of their creation process with prototype A.

  Create Experience

  -. Did you had any target before you started the improvisation? What is it?

  -. Do you think you achieved the target you had in mind in your composition?

  -. Do you find it is easy/difficult to create a composition with this prototype?

  -. What was your strategy to create a composition with this application?

  -. Are you satisfied with your final work with this prototype?

  -. What do you think would help you to be more creative with the system?

  Design 01 - Generator

  -. What do you think is the functionality of the generator in this prototype?

  -. What kind of sound variable do you think it controls?

  -. Did you find out it is adjustable?

  -. How did you go about adjusting this sound variable?

  -. How did you find out they are adjustable in this way?

  -. Do you think it is a good way to control this variable in this way? Why?

  Design 02 - Effector

  -. What do you think is the functionality of the effector in this prototype?

  -. Did you find out it is adjustable?

  -. What kind of sound variable do you think can be adjustable for effector?

  -. How did you go about adjusting this sound variable?

  -. How did you find out they are adjustable in this way?

  -. Do you think it is a good way to control this variable in this way? Why?

  Design 03 - Sequencer

  -. What do you think is the functionality of the sequencer in this prototype?

  -. Do you think it is useful in creating a composition in this application?

  -. Did you find out it is adjustable?

  -. What kind of sound variable do you think can be adjustable for sequencer?

  -. How did you go about adjusting this sound variable?

  -. How did you find out they are adjustable in this way?

  -. Do you think it is a good way to control this variable in this way? Why?

3. Play with Prototype B (35 minutes)

All the procedure and instructions are exactly the same as the previous one.

4. Interview (5 minutes)

Participants will be asked questions in order to compare two prototypes (Questions attached below.) (Need to inform participants that the interview will be video recorded and transcript will be made afterwards.)

- Interview questions

    Overall experience

    -. Explain in your own words how you think the system works in terms of the sound and graphical elements?

    -. Do you feel confident in making a composition in the beginning before playing with this prototype?

    Compare two Prototypes

    -. Which prototype do you prefer to play with? Why?

    -. Which control model do you prefer, drawing(size & density) or adjusting(position & size)?

    -. Which prototype do you think helps you better create a piece of sound? Why do you think so?

A.2 Questionnaire

Study I Questionnaire

Thank you for participating in our study.

Explore Session

1. **Do you understand how generator works?**

   Mark only one oval.

   - Yes
   - No

2. **Do you understand how to adjust generator?**

   Mark only one oval.

   - Yes
   - No

3. **Do you understand how effectors works?**

   Mark only one oval.

   - Yes
   - No

4. **Do you understand how to control the note of effectors?**

   Mark only one oval.

   - Yes
   - No

5. **Do you understand how to control the volume of effectors?**

   Mark only one oval.

   - Yes
   - No

6. **Do you understand how to the sequencer works?**

   Mark only one oval.

   - Yes
   - No

7. **Are you satisfied with the work you've created?**
Mark only one oval.

- Yes
- No

8. **Is this prototype easy to learn?**
Mark only one oval.

- Yes
- No

9. **How would you rate your learning experience in this session?**
Mark only one oval.

- Not at all easy
- Not really easy
- Neutral
- Easy
- Very easy to learn

Creative Session

Here are some more questions.

10. **Do you like the interaction model of this prototype?**
Mark only one oval.

- Yes
- No

11. **Do you think you were creative during the process?**
Mark only one oval.

- Yes
- No

12. **Do you enjoy the graphic design of this interface?**
Mark only one oval.

- Yes
- No

13. **Do you think the outcome is with good?**
Mark only one oval.

- Yes
- No

14. **How would you rate your creative experience in this session?**

Mark only one oval.

- ⬭ Not at all creative
- ⬭ Not really creative
- ⬭ Neutral
- ⬭ Creative
- ⬭ Very creative

A.3 Thematic Analysis

Code System

Code System	
Solo Learn	
	Tried one by one
	Listening (Laughs), yeah, touching buttons and listening.
	Try each effect, one by one
	Close all the objects and just listening to the sequencer
	Chaos
	I had too much happening
	I had a lot stuff going on.
	because there are lots of notes, I kind of get lost which one is which.
Mapping problems	
	Don’t know how exactly it works
	I don’t know if this is something that relate to the sound
	you don’t know the mapping of the interface
	I couldn’t map really well what would drawing.
Low entry fee/ instant effect	
	it's easy to start with and have some interesting effects.
	Don’t have to decide where to put the generator
	No such a technical, barrier
New discover/ Serendipity	
	Realize that I could control four of them separately and the time
	New findings helps trigger the interest on the interface
	That you can merge the effect, that one on top of each other.
Consistent metaphor	
	Things are consistent
	Keep the metaphor of objects
Visual feedback help you understand the sound	
	It changes in like opacity
	Saturation
	It fades away
	Use visual feedback to help
Difficulty on learning sound/graphics	
	Remember it through different colors
Record history	
Readiness time	
	The time delay thing means you kind of have to wait for it to happen
	So you don’t know whether you’d like it or not.
	it’s not affect something at that moment because you see there will be some time
Memory	Not quite sensitive
	Bad memory to remember what I played
	Want to remember each effect
Affordance	I didn’t notice that.
	need to wait until the bar is appeared.
	was more difficult to see what effect I has, the way how I draw it.
	It was easier to see what the effects do, and here I need to hear it to find out
Control	A bit hard to find how to controls this system
	You can’t adjust whether it’s slower or faster, apart from these two states
	Because it was the only part that I couldn’t control a lot.
	Because you can change the time, you can change the pitch so you’ve got a lot of control
	You don’t know how small, how fast the temple will be if you do certain kind of gesture.
	It’s a bit difficult to make music in a way which you really thinking of.
	I feel I have more control.
	You know the time because you can control that as well.
	So you can make it go very fast and reach your objects and also you can even drag your objects
	but it was difficult to re-arrange things.
	There was less timing control
	The sequencer as I said before, because I can’t control it really.
Misleading concepts	
	Deletor and eraser are the same things. So I don’t know it can make the volume bigger.
	To control it should be changed
	In my understanding, I think the adding and erasing are the same thing
	I totally didn’t get it.
	I thought to draw longer to let it be touched by more generators.
Exploration	
	Try and error.

	Play around it to see what else I could do.
	I want to find out if anything else has got new stuff, show me more.
	to try out what the different things do
	to find out whether it makes a difference
	I tried out what happens if I use many on the same place
	To try out how I can change different things.
	I think you can experiment a lot so it is easy to be creative .
	The way I proceed it was like kind of random
	Then I adjust thing, like oh maybe I try this, oh, this sounds good, I'm gonna leave it, or delete it, or something like that
	Trying and listening, think along the process
Interaction difficulty	
	Have to control the length and the thickness in one go
	It's not everything in one
	Second because it's more straight forward
	It's one thing at one time.
	that's not very convenient
	The dots are easier to handle.
	If you actually know what you want to do, it's hard to achieve that specific thing if you know
	that's very difficult is to time things, like to have different notes play at the same time or to define
	I don't need to know exactly how to change the tone
Pre-conception	
	That waiting, pre-conception, it was quite interesting
	So you have like a curve of how you imagine it.
Consistent graphics	
	Grapic consistency affect the acceptance on sound.
	the sequencer is kind of out of it force, out of this concept.
	Everything is so linear
	It is very clear on how to arrange it
	Because everything is concentric in a way.
Graphic/ visual	
	Mapping
	Misleading
	Everything is about geometry
	it's really visual that way, it's really helpful.
	It looks very future, more science.
	I love the triangle. Symmetry
	I like it's linear, it's like… It's very clear with the horizontal XXX for my understanding.
	I like that the other one is more clean at the design, and it's more like geometric,
	having the sequencer at the center, it was kind of weird because like the other one was all based on central
	that's what I would thought initially anyway, because it fades out, and for me, that makes a lot of sense.
Freedom	
	Because the other one was more free style
	I think you can experiment a lot so it is easy to be creative .
	you can decide how many generators you want, as many as you want, probably,
	the other one you only have four, so all in all this has less constraints
Plan Ahead	
	You can anticipate when that is gonna happen
	So you can really compose what's gonna happen latter.
	I see like when something is gonna happen ahead. So that's cool
	But for the previous one, I can't pre-prepare a lot.
	I have pre-designed structure. And then I trigger it.
Strategy of making music, not by previous knowledge, but by what newly learned	
	So you explore it, and you can use it that you learned.
	How to be as musi
	Cause I stop worrying about that, start using different mechanism to control it, which was deleting.
	Because it's like a learning thing, how the effectors work, you play around with it, so yeah, I like it
Visual approach	
	first it was supper nice just to play with the images, like forgetting about the audio itself, but just drawing with the thing
Combination of sound	
	It was interesting to manipulate the sequencer
	That's something very nice to combine with the other free space generation.
Structure music	
	It's easier to maybe archistrit the sound together.
	Graphic/interface
	That help me a bit

	So I tried to organize the way that one effect is dominate on one generator.
Play live	It's nice to create loops, and also think to play live
	I'm changing it while playing, more than composing, you know.
	It's quite fun to move the things around while it is playing. So that's kind of cool.
	I move the other stuff more in the second one, while the first one is very static. So maybe I like parts of moving.
	I think it's more natural for me to play with it in real time. So for example if I want to add or delete, to increase the pitch,
	I like the other one better when you drag the generators, because it was within the interface
Create	Create mini musica
	So in that way, I'm have to figure out some weird strategy.
	It would be interesting to then add something that's only added, I don't know, every 10 seconds.
	But this was easier, to create like the music concept
Base sound	
	I think it was useful for me to have a starting sound.
	Like, not starting from 0 completely, but having some base so that I can play different effects on it.
	So it's kind of predetermine what I feel like I should use.
	there was no indication in the interface of what I should do, I like that as well.
	Because it gives like, a more clear grid of how to use the things.
Lost	And this I was a bit lost and don't know what to do.
Manage sound elements.	
	I think the four generators are very useful. You have four different bit to control different sound elements.
	you can control different rate so you can maybe one you can control beat and one you can control tone
	you can have different generators, different size and for one effect. So it makes the beat interesting and sound better.
	This one you can combine them, the two different generator, so the beats will be dynamic.
	But that even you only have the four generators, you can create different beats, but you can't combine them.
	Sometimes you just need to re-arrange notes, I guess, especially if you don't know how it sounds like, like what the spacing
	it's like to see these lines creating this kind of space, which I really like because it's a bit architectural.
	because it's easy to then apply all the different editing things.
More freedom on rhythm	
Space	
	Easy to run out of space
	if you need to space it out, if you have the long ones. Yeah, where do you put the other ones.
	But I just had to delete them, so I had this problem where I could touch them and add more stuff over there.
	I just had to delete them, so you just run out of stuff.
Feedbck	Because I don't know what it would sound like when I draw it.
	I don't know, so I have to wait, listen to it after I draw it
Expressiveness	
	I felt like I have only three choices, or something, you know, and I was like I want more than that.
	But I find the ranges weren't large enough for what I need to do.
	Now that two states of the effects, you can drag it big or small, so it's like two states
Repeatable	
	Repeatable is a big thing I think, for me.
	Fair enough you might fancy sound you like, but how would you do something again
	But it can still be very hard to be repeatable, you might have to become very skilled and knowledgeable,
	Doesn't have to be like there you go, repeatable, cause that's just simple and boring.
Random	
	Just grab something and create something.
Novice	
	And I have no experience about this kind of creative application.
	I don't know what I'm doing.

A.4 Visualisation of Interaction


1 Explore - Combination of two
1 Create - Begin with sequencer
2 Explore - Combination of three
2 Create - Begin with sequencer
3 Explore - One by one
3 Create - Begin with sequencer
4 Explore - Combination of two
4 Create - Sequencer in middle
5 Explore - Combination of two
5 Create - Sequencer in middle

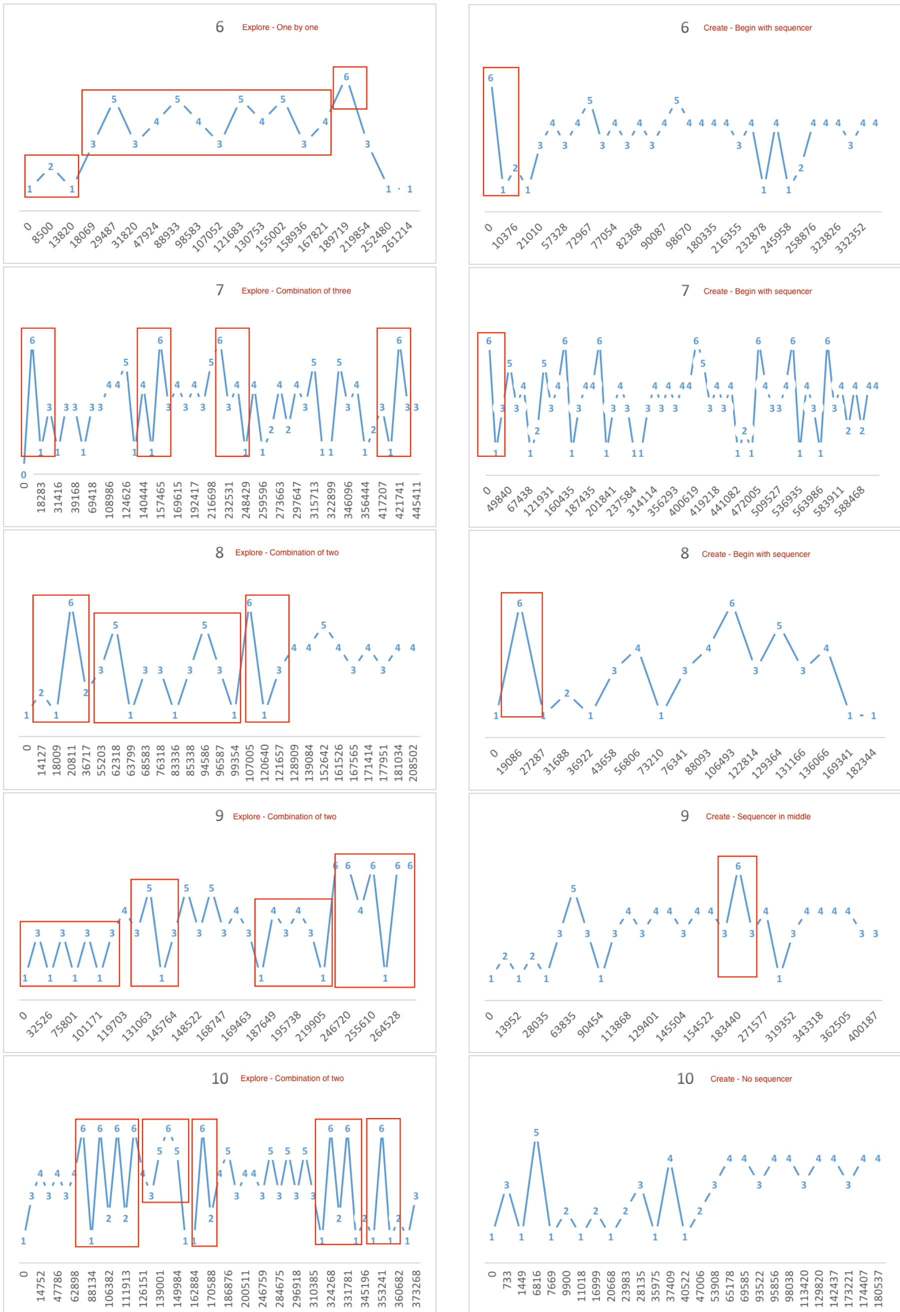

Figure A.1: Visualisation of Interaction Log Data with P_{react}
(Left Column - Explore Session, Right Column - Creative Session)

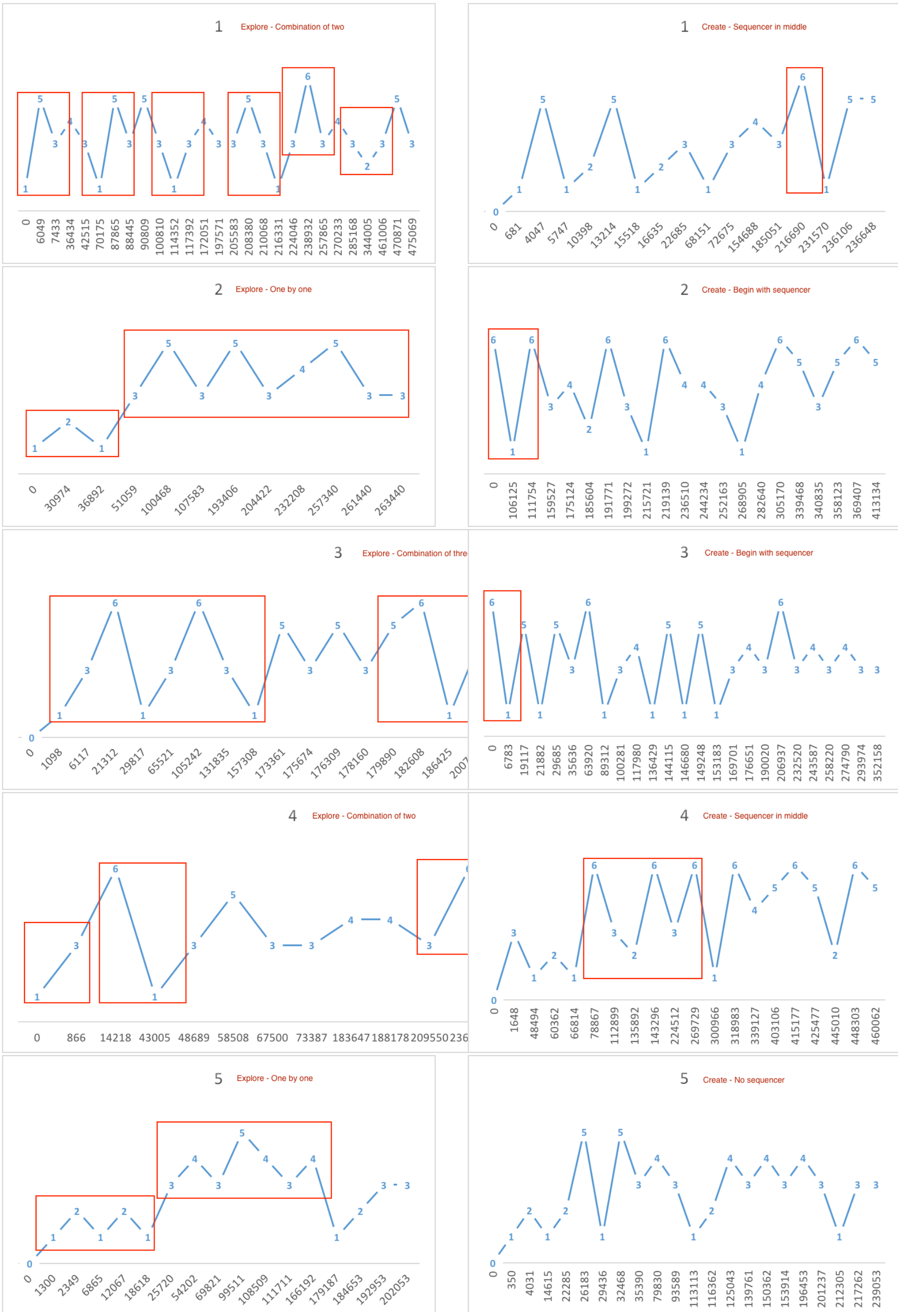
1 Explore - Combination of two
1 Create - Sequencer in middle
2 Explore - One by one
2 Create - Begin with sequencer
3 Explore - Combination of thre
3 Create - Begin with sequencer
4 Explore - Combination of two
4 Create - Sequencer in middle
5 Explore - One by one
5 Create - No sequencer

Figure A.2: Visualisation of Interaction Log Data with P_{paint}
(Left Column - Explore Session, Right Column - Creative Session)

Appendix B

Study II Material

B.1 Questionnaire

Study Questionnaire

Welcome! Thank you for taking part in our study!

If you have any further question please get in touch with Yongmeng Wu at yongmeng.wu@qmul.ac.uk

NOTE: This research study has successfully completed the Research Ethics Approval. Code QMREC1553.

*Required

1. **Full name** *

____

2. **E-mail address** *

____

3. **How many musical applications or games do you have on your phone or computer** *

   Mark only one oval.

   - ◯ None
   - ◯ 1-3
   - ◯ 4-6
   - ◯ 7-10
   - ◯ More than 10

4. **How often do you usually play musical applications with your phone?**

   Mark only one oval.

   - ◯ Never
   - ◯ 1-3 hours per week
   - ◯ 3-5 hours per week
   - ◯ More than 5 hour per week

5. **I am very creative to create a piece of music.** *

   Mark only one oval.

	1	2	3	4	5	6	7	
Strongly disagree	◯	◯	◯	◯	◯	◯	◯	Strongly agree

Free Exploration One

In this session we will ask you to rate the statements below addressing your experience in the session of free exploration.

6. **I was curious about the prototype.** *
Mark only one oval.

	1	2	3	4	5	6	7	
Strongly disagree	◯	◯	◯	◯	◯	◯	◯	Strongly agree

7. **This prototype was aesthetically appealing.** *
Mark only one oval.

	1	2	3	4	5	6	7	
Strongly disagree	◯	◯	◯	◯	◯	◯	◯	Strongly agree

8. **I found this prototype confusing to learn.** *
Mark only one oval.

	1	2	3	4	5	6	7	
Strongly disagree	◯	◯	◯	◯	◯	◯	◯	Strongly agree

9. **The timeline helped me to understand my interaction.** *
Mark only one oval.

	1	2	3	4	5	6	7	
Strongly disagree	◯	◯	◯	◯	◯	◯	◯	Strongly agree

10. **I have found different ways of playing with the prototype.** *
Mark only one oval.

	1	2	3	4	5	6	7	
Strongly disagree	◯	◯	◯	◯	◯	◯	◯	Strongly agree

11. **It was easy for me to explore many different music ideas, possibilities, or outcomes, using this musical box.** *
Mark only one oval.

	1	2	3	4	5	6	7	
Strongly disagree	◯	◯	◯	◯	◯	◯	◯	Strongly agree

12. **I felt frustrated while playing with this musical box.** *
Mark only one oval.

	1	2	3	4	5	6	7	
Strongly disagree	◯	◯	◯	◯	◯	◯	◯	Strongly agree

13. **I could not do some of the things I wanted to do on this prototype.** *
Mark only one oval.

	1	2	3	4	5	6	7	
Strongly disagree	⬭	⬭	⬭	⬭	⬭	⬭	⬭	Strongly agree

14. **When I was playing with the prototype, I lost track of the world around me.** *
Mark only one oval.

	1	2	3	4	5	6	7	
Strongly disagree	⬭	⬭	⬭	⬭	⬭	⬭	⬭	Strongly agree

15. **Playing with this musical box was worthwhile.** *
Mark only one oval.

	1	2	3	4	5	6	7	
Strongly disagree	⬭	⬭	⬭	⬭	⬭	⬭	⬭	Strongly agree

Creative Improvisation One

In this session we will ask you to rate the statements below addressing your experience in the session of improvisation.

16. **I was curious about the creation task.** *
Mark only one oval.

	1	2	3	4	5	6	7	
Strongly disagree	⬭	⬭	⬭	⬭	⬭	⬭	⬭	Strongly agree

17. **The timeline helped me to organise my composition.** *
Mark only one oval.

	1	2	3	4	5	6	7	
Strongly disagree	⬭	⬭	⬭	⬭	⬭	⬭	⬭	Strongly agree

18. **I had enough time to plan what I want to play.** *
Mark only one oval.

	1	2	3	4	5	6	7	
Strongly disagree	⬭	⬭	⬭	⬭	⬭	⬭	⬭	Strongly agree

19. **I felt frustrated while creating with this prototype.** *
Mark only one oval.

	1	2	3	4	5	6	7	
Strongly disagree	⬭	⬭	⬭	⬭	⬭	⬭	⬭	Strongly agree

20. **The timeline offered support to implement different music ideas and possibilities.** *
Mark only one oval.

	1	2	3	4	5	6	7	
Strongly disagree	⬭	⬭	⬭	⬭	⬭	⬭	⬭	Strongly agree

21. **I kept finding new ways of playing with the sound in this prototype.** *
Mark only one oval.

	1	2	3	4	5	6	7	
Strongly disagree	⬭	⬭	⬭	⬭	⬭	⬭	⬭	Strongly agree

22. **I could not do some of the things I needed to do on this prototype.** *
Mark only one oval.

	1	2	3	4	5	6	7	
Strongly disagree	⬭	⬭	⬭	⬭	⬭	⬭	⬭	Strongly agree

23. **I was very creative with the music.** *
Mark only one oval.

	1	2	3	4	5	6	7	
Strongly disagree	⬭	⬭	⬭	⬭	⬭	⬭	⬭	Strongly agree

24. **When I was creating with the music box, I lost track of the world around me.** *
Mark only one oval.

	1	2	3	4	5	6	7	
Strongly disagree	⬭	⬭	⬭	⬭	⬭	⬭	⬭	Strongly agree

25. **The prototype allowed me to be expressive on music.** *
Mark only one oval.

	1	2	3	4	5	6	7	
Strongly disagree	⬭	⬭	⬭	⬭	⬭	⬭	⬭	Strongly agree

26. **I think I produced a piece of music with good quality.** *
Mark only one oval.

	1	2	3	4	5	6	7	
Strongly disagree								Strongly agree

Comparative Questions

In this session we will ask you to compare the experience with or without the scrollable timeline feature.

27. **Please choose the which interface you feel the following statements are most appropriate to:** *
Mark only one oval per row.

	Prototype One	Prototype Two
I enjoyed my self most		
I explored more music ideas		
I felt I was more expressive		
The interface was frustrating		
I felt more creative		
I felt more satisfied with the result		

28. **In what way do you think the timeline helped your improvisation?** *
Tick all that apply.

- [ ] Plan ahead of time
- [ ] Record the history
- [ ] Reuse the previous music ideas
- [ ] Anticipate future musical events
- [ ] Structure the composition
- [ ] Other: ______________________

B.2 Statistical Test Results

Factor	Agreement Mean	p-value
Interest (ES1, CS1)	Explore >Create	.196
Feedback (ES4, CS5)	Explore >Create	.146
Exploration (ES5, CS6)	Explore >Create	.617
Expressiveness (ES6, CS10)	**Explore >Create**	**.008**
Challenge (ES7, CS4)	Explore >Create	1.000
Control (ES8, CS7)	Explore >Create	.396
Focus Attention (ES9, CS9)	Explore >Create	.806
Results worth effort (ES10, CS11)	**Explore >Create**	**<.001**

Table B.1: Test results of feedback comparison by task session

	Independent Sample Test				Paired Sample Test	
	Mnn & Mne	Mnn & Mce	Mne & Mcn	Mcn & Mce	Mnn & Mcn	Mne & Mce
ES1	.653	.823	.685	.318	.305	.389
ES2	.082	.313	.223	.554	.658	**.039**
ES3	.312	.133	.692	.411	.368	.643
ES4	.260	.393	.775	.388	.095	.491
ES5	.731	.664	.719	.300	.339	.269
ES6	.457	.640	.536	.745	.851	.615
ES7	.770	.890	.670	.787	.894	.777
ES8	.901	.581	.544	.796	.660	.377
ES9	.568	.620	.223	.325	.551	1.000
ES10	.800	1.000	.557	.807	.647	.586
CS1	.695	.818	1.000	.628	.723	.429
CS2	.306	.292	.857	1.000	.180	.870
CS3	.547	.914	.801	.328	.276	.392
CS4	.892	1.000	.264	.205	.180	.857
CS5	.564	.207	.398	.754	.085	.266
CS6	.635	.854	.520	.671	.713	.732
CS7	.399	.911	.722	.612	.490	.152
CS8	.427	.581	.151	.863	.693	**.034**
CS9	.194	.643	**.030**	.197	.096	.096
CS10	.438	.770	.175	.284	.410	.570
CS11	.453	.421	.558	.525	.823	1.000

Table B.2: P-value of feedback comparison by prototypes

	Independent Sample Test Mnn&Mcn vs Mne&Mce p, Mean comparison	Paired Sample Test Mnn&Mne vs Mcn&Mce p, Mean comparison
ES1	.647, Mnn&Mcn $<$ Mne&Mce	.846, Mnn&Mne $>$ Mcn&Mce
ES2	.106, Mnn&Mcn $<$ Mne&Mce	.679, Mnn&Mne $>$ Mcn&Mce
ES3	.186, Mnn&Mcn $<$ Mne&Mce	.356, Mnn&Mne $<$ Mcn&Mce
ES4	.812, Mnn&Mcn $>$ Mne&Mce	.388, Mnn&Mne $>$ Mcn&Mce
ES5	.567, Mnn&Mcn $>$ Mne&Mce	.870, Mnn&Mne $>$ Mcn&Mce
ES6	.430, Mnn&Mcn $>$ Mne&Mce	.877, Mnn&Mne $<$ Mcn&Mce
ES7	.683, Mnn&Mcn $>$ Mne&Mce	.802, Mnn&Mne $<$ Mcn&Mce
ES8	.927, Mnn&Mcn $>$ Mne&Mce	.334, Mnn&Mne $>$ Mcn&Mce
ES9	.261, Mnn&Mcn $>$ Mne&Mce	.679, Mnn&Mne $<$ Mcn&Mce
ES10	.717, Mnn&Mcn $>$ Mne&Mce	.491, Mnn&Mne $<$ Mcn&Mce
CS1	.898, Mnn&Mcn $<$ Mne&Mce	.880, Mnn&Mne $<$ Mcn&Mce
CS2	.425, Mnn&Mcn $<$ Mne&Mce	.260, Mnn&Mne $<$ Mcn&Mce
CS3	.934, Mnn&Mcn $<$ Mne&Mce	.747, Mnn&Mne $>$ Mcn&Mce
CS4	.428, Mnn&Mcn $>$ Mne&Mce	.350, Mnn&Mne $<$ Mcn&Mce
CS5	.832, Mnn&Mcn $<$ Mne&Mce	.036, Mnn&Mne $<$ Mcn&Mce
CS6	.516, Mnn&Mcn $<$ Mne&Mce	.604, Mnn&Mne $>$ Mcn&Mce
CS7	.740, Mnn&Mcn $>$ Mne&Mce	.817, Mnn&Mne $<$ Mcn&Mce
CS8	.598, Mnn&Mcn $>$ Mne&Mce	.136, Mnn&Mne $<$ Mcn&Mce
CS9	.064, Mnn&Mcn $>$ Mne&Mce	.015, Mnn&Mne $<$ Mcn&Mce
CS10	.192, Mnn&Mcn $>$ Mne&Mce	.319, Mnn&Mne $<$ Mcn&Mce
CS11	.312, Mnn&Mcn $>$ Mne&Mce	.877, Mnn&Mne $>$ Mcn&Mce

Table B.3: P-value of feedback comparison by independent variables

Study II: Statistical Test Results for Questionnaire Feedback

Note: 1. The highlighted texts are the significant test results.

2. For details of ES1-ES10, CS1-CS11 please refer to Table 5.2 and 5.3.

General feedback stats from explore session:

	Version	N	Mean	Std. Deviation	Std. Error Mean	Version	Mean	Std. Deviation	Std. Error Mean
ES1	Mnn	12	6.17	1.030	.297	Mcn	5.83	1.193	.345
	Mne	12	6.00	.739	.213	Mce	6.25	.754	.218
ES2	Mnn	12	5.00	1.414	.408	Mcn	5.17	1.697	.490
	Mne	12	5.83	.718	.207	Mce	5.50	.905	.261
ES3	Mnn	12	3.17	1.030	.297	Mcn	3.50	1.382	.399
	Mne	12	3.75	1.658	.479	Mce	4.00	1.537	.444
ES4	Mnn	12	5.67	1.073	.310	Mcn	4.92	1.443	.417
	Mne	12	5.08	1.379	.398	Mce	5.33	.778	.225
ES5	Mnn	12	5.17	1.267	.366	Mcn	5.50	1.168	.337
	Mne	12	5.33	1.073	.310	Mce	4.92	1.505	.434
ES6	Mnn	12	5.17	1.193	.345	Mcn	5.08	1.084	.313
	Mne	12	4.75	1.485	.429	Mce	4.92	1.379	.398
ES7	Mnn	12	3.17	1.403	.405	Mcn	3.25	1.485	.429
	Mne	12	3.00	1.348	.389	Mce	3.08	1.505	.434
ES8	Mnn	12	4.42	1.929	.557	Mcn	4.17	1.403	.405
	Mne	12	4.50	1.243	.359	Mce	4.00	1.706	.492
ES9	Mnn	12	5.42	1.165	.336	Mcn	5.58	.669	.193
	Mne	12	5.17	.937	.271	Mce	5.17	1.267	.366
ES10	Mnn	12	6.25	.866	.250	Mcn	6.33	.651	.188
	Mne	12	6.17	.718	.207	Mce	6.25	.965	.279

General feedback stats from create session:

	Version	N	Mean	Std. Deviation	Std. Error Mean	Version	Mean	Std. Deviation	Std. Error Mean
CS1	Mnn	12	5.92	.900	.260	Mcn	5.75	1.545	.446
	Mne	12	5.75	1.138	.329	Mce	6.00	.853	.246
CS2	Mnn	12	4.67	1.875	.541	Mcn	5.42	1.084	.313
	Mne	12	5.33	1.155	.333	Mce	5.42	1.505	.434
CS3	Mnn	12	5.33	2.348	.678	Mcn	4.67	1.614	.466
	Mne	12	4.83	1.586	.458	Mce	5.25	1.215	.351
CS4	Mnn	12	2.92	1.564	.452	Mcn	3.67	1.435	.414
	Mne	12	3.00	1.414	.408	Mce	2.92	1.379	.398
CS5	Mnn	12	4.50	1.567	.452	Mcn	5.33	1.614	.466
	Mne	12	4.83	1.193	.345	Mce	5.17	.835	.241
CS6	Mnn	12	5.08	1.311	.379	Mcn	4.92	1.832	.529
	Mne	12	5.33	1.231	.355	Mce	5.17	.835	.241
CS7	Mnn	12	4.75	1.960	.566	Mcn	4.33	1.557	.449
	Mne	12	4.08	1.832	.529	Mce	4.67	1.614	.466
CS8	Mnn	12	4.17	1.749	.505	Mcn	4.42	1.240	.358

	Mne	12	3.67	1.231	.355	Mce	4.50	1.087	.314
CS9	Mnn	12	5.50	1.168	.337	Mcn	5.92	.996	.288
	Mne	12	4.83	1.267	.366	Mcn	5.25	1.422	.411
CS10	Mnn	12	4.50	1.446	.417	Mce	5.00	1.651	.477
	Mne	12	3.92	2.109	.609	Mcn	4.33	1.303	.376
CS11	Mnn	12	4.58	1.730	.499	Mce	4.42	1.379	.398
	Mne	12	4.00	2.000	.577	Mcn	4.00	1.758	.508

1. Comparison by task session: compare feedback on statements from different task session addressing the same factor. (3-way mixed ANOVA)

Note: the terms ‘task’, ‘playingpoint’ and ‘record’ in the following tables represent to the three variables described in Section 5.3.1. ‘task’ represents two task sessions, explore and create; ‘playingpoint’ represents changeable playing point, whether or not the participant was able to start playing from the previous or the future records on the timeline; ‘record’ represents editable records, whether or not the participant was able to edit (to cut off or extend) the previous and the future records on the timeline.

1.1 Control: ES8 (I could not do some of the things I wanted to do on this prototype.*) & CS7 (I could not do some of the things I needed to do on this prototype.*)

Source	playingpoint	task	Type III Sum of Squares	df	Mean Square	F	Sig.
playingpoint	Linear		.510	1	.510	.265	.612
playingpoint * Record	Linear		.844	1	.844	.438	.515
Error(playingpoint)	Linear		42.396	22	1.927		
task		Linear	.844	1	.844	.748	.396
task * Record		Linear	.094	1	.094	.083	.776
Error(task)		Linear	24.813	22	1.128		
playingpoint * task	Linear	Linear	1.260	1	1.260	.951	.340
playingpoint * task * Record	Linear	Linear	2.344	1	2.344	1.769	.197
Error(playingpoint*task)	Linear	Linear	29.146	22	1.325		

1.2 Exploration: ES5 (I have found different ways of playing with the prototype.) & CS6 (I kept finding new ways of playing with the sound in this prototype.)

Source	Playingpoint	task	Type III Sum of Squares	df	Mean Square	F	Sig.
playingpoint	Linear		.260	1	.260	.242	.627
playingpoint * Record	Linear		.844	1	.844	.785	.385
Error(playingpoint)	Linear		23.646	22	1.075		
task		Linear	.260	1	.260	.258	.617
task * Record		Linear	1.260	1	1.260	1.247	.276
Error(task)		Linear	22.229	22	1.010		
playingpoint * task	Linear	Linear	.094	1	.094	.044	.836
playingpoint * task * Record	Linear	Linear	.844	1	.844	.397	.535
Error(playingpoint*task)	Linear	Linear	46.813	22	2.128		

1.3 Expressiveness: ES6 (It was easy for me to explore many different music ideas, possibilities, or outcomes, using this musical box.) – CS10 (The prototype allowed me to be expressive on music.)

Source	playingpoint	task	Type III Sum of Squares	df	Mean Square	F	Sig.
playingpoint	Linear		1.500	1	1.500	1.017	.324
playingpoint * Record	Linear		.042	1	.042	.028	.868
Error(playingpoint)	Linear		32.458	22	1.475		
task		Linear	7.042	1	7.042	8.469	.008
task * Record		Linear	.667	1	.667	.802	.380
Error(task)		Linear	18.292	22	.831		
playingpoint * task	Linear	Linear	1.042	1	1.042	.536	.472
playingpoint * task * Record	Linear	Linear	.167	1	.167	.086	.772
Error(playingpoint*task)	Linear	Linear	42.792	22	1.945		

1.4 Feedback: ES4 (The timeline helped me to understand my interaction.) & CS5(The timeline offered support to implement different music ideas and possibilities.)

Source	playingpoint	task	Type III Sum of Squares	df	Mean Square	F	Sig.
playingpoint	Linear		.667	1	.667	.565	.460
playingpoint * Record	Linear		.375	1	.375	.318	.579
Error(playingpoint)	Linear		25.958	22	1.180		
task		Linear	2.042	1	2.042	2.269	.146
task * Record		Linear	.167	1	.167	.185	.671
Error(task)		Linear	19.792	22	.900		
playingpoint * task	Linear	Linear	4.167	1	4.167	8.000	.010
playingpoint * task * Record	Linear	Linear	3.375	1	3.375	6.480	.018
Error(playingpoint*task)	Linear	Linear	11.458	22	.521		

1.5 Focus Attention: ES9 (When I was playing with the prototype, I lost track of the world around me.) & CS9 (When I was creating with the music box, I lost track of the world around me.)

Source	playingpoint	Task	Type III Sum of Squares	df	Mean Square	F	Sig.
playingpoint	Linear		1.500	1	1.500	3.314	.082
playingpoint * Record	Linear		.042	1	.042	.092	.764
Error(playingpoint)	Linear		9.958	22	.453		
task		Linear	.042	1	.042	.062	.806
task * Record		Linear	.667	1	.667	.992	.330
Error(task)		Linear	14.792	22	.672		
playingpoint * task	Linear	Linear	.667	1	.667	1.882	.184
playingpoint * task * Record	Linear	Linear	.042	1	.042	.118	.735

Error(playingpoint*task)	Linear	Linear	7.792	22	.354		

1.6 Challenge: ES7 (I felt frustrated while playing with this musical box.*) & CS4 (I felt frustrated while creating with this prototype.*)

Source	playingpoint	task	Type III Sum of Squares	df	Mean Square	F	Sig.
playingpoint	Linear		1.042	1	1.042	1.046	.318
playingpoint * Record	Linear		1.042	1	1.042	1.046	.318
Error(playingpoint)	Linear		21.917	22	.996		
task		Linear	.000	1	.000	.000	1.000
task * Record		Linear	.167	1	.167	.123	.729
Error(task)		Linear	29.833	22	1.356		
playingpoint * task	Linear	Linear	.375	1	.375	.208	.652
playingpoint * task * Record	Linear	Linear	1.042	1	1.042	.579	.455
Error(playingpoint*task)	Linear	Linear	39.583	22	1.799		

1.7 Interest: ES1(I was curious about the prototype.) & CS1 (I was curious about the creation task.)

Source	playingpoint	task	Type III Sum of Squares	df	Mean Square	F	Sig.
playingpoint	Linear		1.137E-13	1	1.137E-13	.000	1.000
playingpoint * Record	Linear		1.500	1	1.500	1.467	.239
Error(playingpoint)	Linear		22.500	22	1.023		
task		Linear	1.042	1	1.042	1.774	.196
task * Record		Linear	.042	1	.042	.071	.792
Error(task)		Linear	12.917	22	.587		
playingpoint * task	Linear	Linear	.042	1	.042	.103	.752
playingpoint * task * Record	Linear	Linear	.042	1	.042	.103	.752
Error(playingpoint*task)	Linear	Linear	8.917	22	.405		

1.8 Results Worth Effort: ES10 (Playing with this musical box was worthwhile.) – CS11 (I think I produced a piece of music with good quality.)

Source	playingpoint	task	Type III Sum of Squares	df	Mean Square	F	Sig.
playingpoint	Linear		1.137E-13	1	1.137E-13	.000	1.000
playingpoint * Record	Linear		.042	1	.042	.022	.882
Error(playingpoint)	Linear		40.958	22	1.862		
task		Linear	96.000	1	96.000	55.640	.000
task * Record		Linear	1.042	1	1.042	.604	.445
Error(task)		Linear	37.958	22	1.725		
playingpoint * task	Linear	Linear	.167	1	.167	.090	.767
playingpoint * task * Record	Linear	Linear	.042	1	.042	.022	.882
Error(playingpoint*task)	Linear	Linear	40.792	22	1.854		

2. Compare feedback from different prototype modes

Independent Samples Test

2.1 Mnn vs Mne (Explore Session)

		Levene's Test for Equality of Variances		t-test for Equality of Means			
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
ES1	Equal variances assumed	2.316	.142	.456	22	.653	.167
	Equal variances not assumed			.456	19.948	.654	.167
ES2	Equal variances assumed	7.682	.011	-1.820	22	.082	-.833
	Equal variances not assumed			-1.820	16.314	.087	-.833
ES3	Equal variances assumed	4.560	.044	-1.035	22	.312	-.583
	Equal variances not assumed			-1.035	18.386	.314	-.583
ES4	Equal variances assumed	.702	.411	1.156	22	.260	.583
	Equal variances not assumed			1.156	20.748	.261	.583
ES5	Equal variances assumed	.367	.551	-.348	22	.731	-.167
	Equal variances not assumed			-.348	21.418	.731	-.167
ES6	Equal variances assumed	.962	.337	.758	22	.457	.417
	Equal variances not assumed			.758	21.028	.457	.417
ES7	Equal variances assumed	.012	.912	.297	22	.770	.167
	Equal variances not assumed			.297	21.965	.770	.167
ES8	Equal variances assumed	5.084	.034	-.126	22	.901	-.083
	Equal variances not assumed			-.126	18.795	.901	-.083
ES9	Equal variances assumed	.606	.445	.579	22	.568	.250
	Equal variances not assumed			.579	21.040	.569	.250
ES10	Equal variances assumed	.115	.738	.257	22	.800	.083
	Equal variances not assumed			.257	21.267	.800	.083

2.2 Mnn vs Mce (Explore Session)

		Levene's Test for Equality of Variances		t-test for Equality of Means			
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
ES1	Equal variances assumed	1.170	.291	-.226	22	.823	-.083
	Equal variances not assumed			-.226	20.158	.823	-.083
ES2	Equal variances assumed	2.895	.103	-1.032	22	.313	-.500
	Equal variances not assumed			-1.032	18.710	.315	-.500
ES3	Equal variances assumed	.991	.330	-1.560	22	.133	-.833
	Equal variances not assumed			-1.560	19.217	.135	-.833
ES4	Equal variances assumed	1.897	.182	.871	22	.393	.333
	Equal variances not assumed			.871	20.067	.394	.333
ES5	Equal variances assumed	.134	.718	.440	22	.664	.250
	Equal variances not assumed			.440	21.380	.664	.250
ES6	Equal variances assumed	.758	.393	.475	22	.640	.250
	Equal variances not assumed			.475	21.556	.640	.250
ES7	Equal variances assumed	.062	.806	.140	22	.890	.083

	Equal variances not assumed			.140	21.893	.890	.083
ES8	Equal variances assumed	.900	.353	.561	22	.581	.417
	Equal variances not assumed			.561	21.676	.581	.417
ES9	Equal variances assumed	.008	.930	.503	22	.620	.250
	Equal variances not assumed			.503	21.844	.620	.250
ES10	Equal variances assumed	.292	.594	.000	22	1.000	.000
	Equal variances not assumed			.000	21.746	1.000	.000

2.3 Mne vs Mcn (Explore Session)

		Levene's Test for Equality of Variances		t-test for Equality of Means			
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
ES1	Equal variances assumed	6.138	.021	.411	22	.685	.167
	Equal variances not assumed			.411	18.348	.686	.167
ES2	Equal variances assumed	15.573	.001	1.254	22	.223	.667
	Equal variances not assumed			1.254	14.815	.229	.667
ES3	Equal variances assumed	.762	.392	.401	22	.692	.250
	Equal variances not assumed			.401	21.306	.692	.250
ES4	Equal variances assumed	.171	.683	.289	22	.775	.167
	Equal variances not assumed			.289	21.954	.775	.167
ES5	Equal variances assumed	.099	.756	-.364	22	.719	-.167
	Equal variances not assumed			-.364	21.845	.719	-.167
ES6	Equal variances assumed	2.492	.129	-.628	22	.536	-.333
	Equal variances not assumed			-.628	20.128	.537	-.333
ES7	Equal variances assumed	.100	.755	-.432	22	.670	-.250
	Equal variances not assumed			-.432	21.799	.670	-.250
ES8	Equal variances assumed	.007	.933	.616	22	.544	.333
	Equal variances not assumed			.616	21.684	.544	.333
ES9	Equal variances assumed	.600	.447	-1.254	22	.223	-.417
	Equal variances not assumed			-1.254	19.890	.225	-.417
ES10	Equal variances assumed	.000	1.000	-.596	22	.557	-.167
	Equal variances not assumed			-.596	21.796	.558	-.167

2.4 Mcn vs Mce (Explore Session)

		Levene's Test for Equality of Variances		t-test for Equality of Means			
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
ES1	Equal variances assumed	4.703	.041	-1.023	22	.318	-.417
	Equal variances not assumed			-1.023	18.572	.320	-.417
ES2	Equal variances assumed	8.707	.007	-.601	22	.554	-.333
	Equal variances not assumed			-.601	16.785	.556	-.333
ES3	Equal variances assumed	.000	1.000	-.838	22	.411	-.500
	Equal variances not assumed			-.838	21.754	.411	-.500
ES4	Equal variances assumed	1.130	.299	-.880	22	.388	-.417

	Equal variances not assumed			-.880	16.901	.391	-.417
ES5	Equal variances assumed	.391	.538	1.061	22	.300	.583
	Equal variances not assumed			1.061	20.721	.301	.583
ES6	Equal variances assumed	2.270	.146	.329	22	.745	.167
	Equal variances not assumed			.329	20.835	.745	.167
ES7	Equal variances assumed	.002	.962	.273	22	.787	.167
	Equal variances not assumed			.273	21.996	.787	.167
ES8	Equal variances assumed	.627	.437	.261	22	.796	.167
	Equal variances not assumed			.261	21.214	.796	.167
ES9	Equal variances assumed	1.367	.255	1.007	22	.325	.417
	Equal variances not assumed			1.007	16.683	.328	.417
ES10	Equal variances assumed	1.118	.302	.248	22	.807	.083
	Equal variances not assumed			.248	19.297	.807	.083

Paired Samples Test

2.5 Mnn vs Mcn (Explore Session)

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	ES1_Mnn - ES1_Mcn	.333	1.073	.310	-.348	1.015	1.076	11	.305
Pair 2	ES2_ Mnn - ES2_Mcn	-.167	1.267	.366	-.972	.639	-.456	11	.658
Pair 3	ES3_ Mnn - ES3_Mcn	-.333	1.231	.355	-1.115	.449	-.938	11	.368
Pair 4	ES4_ Mnn - ES4_Mcn	.750	1.422	.411	-.154	1.654	1.827	11	.095
Pair 5	ES5_ Mnn - ES5_Mcn	-.333	1.155	.333	-1.067	.400	-1.000	11	.339
Pair 6	ES6_ Mnn - ES6_Mcn	.083	1.505	.434	-.873	1.040	.192	11	.851
Pair 7	ES7_ Mnn - ES7_Mcn	-.083	2.109	.609	-1.423	1.257	-.137	11	.894
Pair 8	ES8_ Mnn - ES8_Mcn	.250	1.913	.552	-.965	1.465	.453	11	.660
Pair 9	ES9_ Mnn - ES9_Mcn	-.167	.937	.271	-.762	.429	-.616	11	.551
Pair 10	ES10_Mnn - ES10_Mcn	-.083	.669	.193	-.508	.341	-.432	11	.674

2.6 Mne vs Mce (Explore Session)

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	ES1_Mne - Q1_Mce	-.250	.965	.279	-.863	.363	-.897	11	.389
Pair 2	ES2_Mne - ES2_Mce	.333	.492	.142	.020	.646	2.345	11	.039
Pair 3	ES3_Mne - ES3_Mce	-.250	1.815	.524	-1.403	.903	-.477	11	.643
Pair 4	ES4_Mne - ES4_Mce	-.250	1.215	.351	-1.022	.522	-.713	11	.491
Pair 5	ES5_Mne - ES5_Mce	.417	1.240	.358	-.371	1.205	1.164	11	.269
Pair 6	ES6_Mne - ES6_Mce	-.167	1.115	.322	-.875	.542	-.518	11	.615
Pair 7	ES7_Mne - ES7_Mce	-.083	.996	.288	-.716	.550	-.290	11	.777

Pair 8	ES8_Mne - ES8_Mce	.500	1.883	.544	-.696	1.696	.920	11	.377
Pair 9	ES9_Mne - ES9_Mce	.000	1.044	.302	-.664	.664	.000	11	1.000
Pair 10	ES10_Mne - ES10_Mce	-.083	.515	.149	-.411	.244	-.561	11	.586

2.1 Mnn vs Mne (Create Session)

		Levene's Test for Equality of Variances		t-test for Equality of Means			
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
CS1	Equal variances assumed	.565	.460	.398	22	.695	.167
	Equal variances not assumed			.398	20.893	.695	.167
CS2	Equal variances assumed	3.960	.059	-1.049	22	.306	-.667
	Equal variances not assumed			-1.049	18.295	.308	-.667
CS3	Equal variances assumed	2.750	.111	.611	22	.547	.500
	Equal variances not assumed			.611	19.306	.548	.500
CS4	Equal variances assumed	.066	.799	-.137	22	.892	-.083
	Equal variances not assumed			-.137	21.780	.892	-.083
CS5	Equal variances assumed	.580	.454	-.586	22	.564	-.333
	Equal variances not assumed			-.586	20.550	.564	-.333
CS6	Equal variances assumed	.013	.912	-.482	22	.635	-.250
	Equal variances not assumed			-.482	21.912	.635	-.250
CS7	Equal variances assumed	.023	.882	.861	22	.399	.667
	Equal variances not assumed			.861	21.901	.399	.667
CS8	Equal variances assumed	1.069	.312	.810	22	.427	.500
	Equal variances not assumed			.810	19.747	.428	.500
CS9	Equal variances assumed	.008	.931	1.340	22	.194	.667
	Equal variances not assumed			1.340	21.854	.194	.667
CS10	Equal variances assumed	2.385	.137	.790	22	.438	.583
	Equal variances not assumed			.790	19.471	.439	.583
CS11	Equal variances assumed	.061	.807	.764	22	.453	.583
	Equal variances not assumed			.764	21.552	.453	.583

2.2 Mnn vs Mce (Create Session)

		Levene's Test for Equality of Variances		t-test for Equality of Means			
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
CS1	Equal variances assumed	.033	.857	-.233	22	.818	-.083
	Equal variances not assumed			-.233	21.936	.818	-.083
CS2	Equal variances assumed	1.042	.319	-1.081	22	.292	-.750
	Equal variances not assumed			-1.081	21.017	.292	-.750
CS3	Equal variances assumed	6.254	.020	.109	22	.914	.083
	Equal variances not assumed			.109	16.498	.914	.083
CS4	Equal variances assumed	.244	.626	.000	22	1.000	.000
	Equal variances not assumed			.000	21.659	1.000	.000
CS5	Equal variances assumed	4.022	.057	-1.301	22	.207	-.667
	Equal variances not assumed			-1.301	16.781	.211	-.667

		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
CS6	Equal variances assumed	3.921	.060	-.186	22	.854	-.083
	Equal variances not assumed			-.186	18.658	.855	-.083
CS7	Equal variances assumed	1.655	.212	.114	22	.911	.083
	Equal variances not assumed			.114	21.221	.911	.083
CS8	Equal variances assumed	2.283	.145	-.561	22	.581	-.333
	Equal variances not assumed			-.561	18.393	.582	-.333
CS9	Equal variances assumed	.280	.602	.471	22	.643	.250
	Equal variances not assumed			.471	21.197	.643	.250
CS10	Equal variances assumed	.000	1.000	.297	22	.770	.167
	Equal variances not assumed			.297	21.765	.770	.167
CS11	Equal variances assumed	.018	.894	.819	22	.421	.583
	Equal variances not assumed			.819	21.994	.421	.583

2.3 Mne vs Mcn (Create Session)

		Levene's Test for Equality of Variances		t-test for Equality of Means			
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
CS1	Equal variances assumed	.926	.346	.000	22	1.000	.000
	Equal variances not assumed			.000	20.224	1.000	.000
CS2	Equal variances assumed	.013	.911	-.182	22	.857	-.083
	Equal variances not assumed			-.182	21.912	.857	-.083
CS3	Equal variances assumed	.022	.884	.255	22	.801	.167
	Equal variances not assumed			.255	21.993	.801	.167
CS4	Equal variances assumed	.039	.845	-1.146	22	.264	-.667
	Equal variances not assumed			-1.146	21.995	.264	-.667
CS5	Equal variances assumed	.684	.417	-.863	22	.398	-.500
	Equal variances not assumed			-.863	20.258	.398	-.500
CS6	Equal variances assumed	.364	.552	.654	22	.520	.417
	Equal variances not assumed			.654	19.251	.521	.417
CS7	Equal variances assumed	.988	.331	-.360	22	.722	-.250
	Equal variances not assumed			-.360	21.443	.722	-.250
CS8	Equal variances assumed	.003	.960	-1.487	22	.151	-.750
	Equal variances not assumed			-1.487	21.999	.151	-.750
CS9	Equal variances assumed	.138	.714	-2.328	22	.030	-1.083
	Equal variances not assumed			-2.328	20.838	.030	-1.083
CS10	Equal variances assumed	1.739	.201	-1.401	22	.175	-1.083
	Equal variances not assumed			-1.401	20.805	.176	-1.083
CS11	Equal variances assumed	1.219	.281	-.594	22	.558	-.417
	Equal variances not assumed			-.594	19.531	.559	-.417

2.4 Mcn vs Mce (Create Session)

		Levene's Test for Equality of Variances		t-test for Equality of Means			
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
CS1	Equal variances assumed	2.623	.120	-.491	22	.628	-.250

	Equal variances not assumed			-.491	17.135	.630	-.250
CS2	Equal variances assumed	.834	.371	.000	22	1.000	.000
	Equal variances not assumed			.000	19.989	1.000	.000
CS3	Equal variances assumed	.942	.342	-1.000	22	.328	-.583
	Equal variances not assumed			-1.000	20.438	.329	-.583
CS4	Equal variances assumed	.220	.644	1.305	22	.205	.750
	Equal variances not assumed			1.305	21.965	.205	.750
CS5	Equal variances assumed	4.101	.055	.318	22	.754	.167
	Equal variances not assumed			.318	16.491	.755	.167
CS6	Equal variances assumed	3.234	.086	-.430	22	.671	-.250
	Equal variances not assumed			-.430	15.380	.673	-.250
CS7	Equal variances assumed	.153	.700	-.515	22	.612	-.333
	Equal variances not assumed			-.515	21.971	.612	-.333
CS8	Equal variances assumed	.311	.583	-.175	22	.863	-.083
	Equal variances not assumed			-.175	21.629	.863	-.083
CS9	Equal variances assumed	1.042	.318	1.330	22	.197	.667
	Equal variances not assumed			1.330	19.700	.199	.667
CS10	Equal variances assumed	.000	1.000	1.098	22	.284	.667
	Equal variances not assumed			1.098	20.868	.285	.667
CS11	Equal variances assumed	.634	.434	.646	22	.525	.417
	Equal variances not assumed			.646	20.818	.525	.417

2.5 Mnn vs Mcn (Create Session) (Paired Samples Test)

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	CS1_Mnn - CS1_Mcn	.167	1.586	.458	-.841	1.174	.364	11	.723
Pair 2	CS2_ Mnn - CS2_Mcn	-.750	1.815	.524	-1.903	.403	-1.431	11	.180
Pair 3	CS3_ Mnn - CS3_Mcn	.667	2.015	.582	-.614	1.947	1.146	11	.276
Pair 4	CS4_ Mnn - CS4_Mcn	-.750	1.815	.524	-1.903	.403	-1.431	11	.180
Pair 5	CS5_ Mnn - CS5_Mcn	-.833	1.528	.441	-1.804	.137	-1.890	11	.085
Pair 6	CS6_ Mnn - CS6_Mcn	.167	1.528	.441	-.804	1.137	.378	11	.713
Pair 7	CS7_ Mnn - CS7_Mcn	.417	2.021	.583	-.867	1.701	.714	11	.490
Pair 8	CS8_ Mnn - CS8_Mcn	-.250	2.137	.617	-1.608	1.108	-.405	11	.693
Pair 9	CS9_ Mnn - CS9_Mcn	-.417	.793	.229	-.920	.087	-1.820	11	.096
Pair 10	CS10_Mnn - CS10_Mcn	-.500	2.023	.584	-1.785	.785	-.856	11	.410
Pair 11	CS11_Mnn - CS11_Mcn	.167	2.517	.726	-1.432	1.766	.229	11	.823

2.6 Mne vs Mce (Create Session) (Paired Samples Test)

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	CS1_Mne - CS1_Mce	-.250	1.055	.305	-.920	.420	-.821	11	.429

Pair 2	CS2_Mne - CS2_Mce	-.083	1.730	.499	-1.182	1.016	-.167	11	.870
Pair 3	CS3_Mne - CS3_Mce	-.417	1.621	.468	-1.447	.613	-.890	11	.392
Pair 4	CS4_Mne - CS4_Mce	.083	1.564	.452	-.911	1.077	.185	11	.857
Pair 5	CS5_Mne - CS5_Mce	-.333	.985	.284	-.959	.292	-1.173	11	.266
Pair 6	CS6_Mne - CS6_Mce	.167	1.642	.474	-.877	1.210	.352	11	.732
Pair 7	CS7_Mne - CS7_Mce	-.583	1.311	.379	-1.417	.250	-1.541	11	.152
Pair 8	CS8_Mne - CS8_Mce	-.833	1.193	.345	-1.592	-.075	-2.419	11	.034
Pair 9	CS9_Mne - CS9_Mce	-.417	.793	.229	-.920	.087	-1.820	11	.096
Pair 10	CS10_Mne –CS10_Mce	-.417	2.466	.712	-1.984	1.150	-.585	11	.570
Pair 11	CS11_Mne - CS11_Mce	.000	2.796	.807	-1.777	1.777	.000	11	1.000

3. Compare feedback by independent variables

3.1 Compare non-changeable with changeable prototypes: Mnn&Mne vs Mcn&Mce (Paired Samples Tests)

3.1.1 Exploration Session

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	ES1_Mnn&Mne - ES1_Mcn&Mce	.042	1.042	.213	-.398	.482	.196	23	.846
Pair 2	ES2_ Mnn&Mne - ES2_ Mcn&Mce	.083	.974	.199	-.328	.495	.419	23	.679
Pair 3	ES3_ Mnn&Mne - ES3_ Mcn&Mce	-.292	1.517	.310	-.932	.349	-.942	23	.356
Pair 4	ES4_ Mnn&Mne - ES4_ Mcn&Mce	.250	1.391	.284	-.337	.837	.881	23	.388
Pair 5	ES5_ Mnn&Mne - ES5_ Mcn&Mce	.042	1.233	.252	-.479	.562	.166	23	.870
Pair 6	ES6_ Mnn&Mne - ES6_ Mcn&Mce	-.042	1.301	.266	-.591	.508	-.157	23	.877
Pair 7	ES7_ Mnn&Mne - ES7_ Mcn&Mce	-.083	1.613	.329	-.764	.598	-.253	23	.802
Pair 8	ES8_ Mnn&Mne - ES8_ Mcn&Mce	.375	1.861	.380	-.411	1.161	.987	23	.334
Pair 9	ES9_ Mnn&Mne - ES9_ Mcn&Mce	-.083	.974	.199	-.495	.328	-.419	23	.679
Pair 10	ES10_Mnn&Mne - ES10_ Mcn&Mce	-.083	.584	.119	-.330	.163	-.700	23	.491

3.1.2 Creation Session

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	CS1_Mnn&Mne - CS1_Mcn&Mce	-.042	1.334	.272	-.605	.522	-.153	23	.880
Pair 2	CS2_ Mnn&Mne - CS2_ Mcn&Mce	-.417	1.767	.361	-1.163	.330	-1.155	23	.260
Pair 3	CS3_ Mnn&Mne - CS3_ Mcn&Mce	.125	1.872	.382	-.666	.916	.327	23	.747
Pair 4	CS4_ Mnn&Mne - CS4_ Mcn&Mce	-.333	1.711	.349	-1.056	.389	-.954	23	.350
Pair 5	CS5_ Mnn&Mne - CS5_ Mcn&Mce	-.583	1.283	.262	-1.125	-.042	-2.228	23	.036
Pair 6	CS6_ Mnn&Mne - CS6_ Mcn&Mce	.167	1.551	.317	-.488	.822	.526	23	.604
Pair 7	CS7_ Mnn&Mne - CS7_ Mcn&Mce	-.083	1.742	.356	-.819	.652	-.234	23	.817
Pair 8	CS8_ Mnn&Mne - CS8_ Mcn&Mce	-.542	1.719	.351	-1.268	.184	-1.544	23	.136

Pair 9	CS9_ Mnn&Mne - CS9_ Mcn&Mce	-.417	.776	.158	-.744	-.089	-2.632	23	.015
Pair 10	CS10_Mnn&Mne - CS10_ Mcn&Mce	-.458	2.206	.450	-1.390	.473	-1.018	23	.319
Pair 11	CS11_ Mnn&Mne - CS11_ Mcn&Mce	.083	2.603	.531	-1.016	1.182	.157	23	.877

3.2 Compare non-editable with editable prototypes: Mnn&Mcn vs Mne&Mce (Independent Samples Test)

3.2.1 Explore Session

Mnn&Mcn vs Mne&Mce		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
ES1	Equal variances assumed							.271	-.671	.421
	Equal variances not assumed			-.461	40.237	.647	-.125	.271	-.673	.423
ES2	Equal variances assumed	16.703	.000	-1.648	46	.106	-.583	.354	-1.296	.129
	Equal variances not assumed			-1.648	35.119	.108	-.583	.354	-1.302	.135
ES3	Equal variances assumed	1.924	.172	-1.342	46	.186	-.542	.404	-1.354	.271
	Equal variances not assumed			-1.342	43.110	.187	-.542	.404	-1.356	.272
ES4	Equal variances assumed	.193	.663	.239	46	.812	.083	.348	-.618	.784
	Equal variances not assumed			.239	44.790	.812	.083	.348	-.618	.785
ES5	Equal variances assumed	.000	.987	.577	46	.567	.208	.361	-.518	.935
	Equal variances not assumed			.577	45.753	.567	.208	.361	-.519	.935
ES6	Equal variances assumed	3.082	.086	.797	46	.430	.292	.366	-.445	1.028
	Equal variances not assumed			.797	43.766	.430	.292	.366	-.446	1.029
ES7	Equal variances assumed	.003	.956	.411	46	.683	.167	.406	-.650	.984
	Equal variances not assumed			.411	45.994	.683	.167	.406	-.650	.984
ES8	Equal variances assumed	.464	.499	.092	46	.927	.042	.453	-.871	.954
	Equal variances not assumed			.092	45.452	.927	.042	.453	-.871	.955
ES9	Equal variances assumed	.093	.761	1.138	46	.261	.333	.293	-.256	.923
	Equal variances not assumed			1.138	44.922	.261	.333	.293	-.256	.923
ES10	Equal variances assumed	.263	.610	.364	46	.717	.083	.229	-.377	.544
	Equal variances not assumed			.364	45.510	.717	.083	.229	-.378	.544

3.2.2 Create Session

Mnn&Mcn vs Mne&Mce		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
CS1	Equal variances assumed	.517	.476	-.129	46	.898	-.042	.324	-.694	.611
	Equal variances not assumed			-.129	43.890	.898	-.042	.324	-.695	.611
CS2	Equal variances assumed	.480	.492	-.805	46	.425	-.333	.414	-1.167	.500
	Equal variances not assumed			-.805	44.822	.425	-.333	.414	-1.167	.500
CS3	Equal variances assumed	3.102	.085	-.084	46	.934	-.042	.498	-1.044	.961
	Equal variances not assumed			-.084	41.146	.934	-.042	.498	-1.048	.964

CS4	Equal variances assumed	.840	.364	.800	46	.428	.333	.417	-.506	1.172
	Equal variances not assumed			.800	45.505	.428	.333	.417	-.506	1.173
CS5	Equal variances assumed	3.897	.054	-.214	46	.832	-.083	.390	-.868	.701
	Equal variances not assumed			-.214	38.894	.832	-.083	.390	-.872	.705
CS6	Equal variances assumed	1.968	.167	-.655	46	.516	-.250	.382	-1.019	.519
	Equal variances not assumed			-.655	39.892	.516	-.250	.382	-1.022	.522
CS7	Equal variances assumed	.073	.789	.334	46	.740	.167	.499	-.838	1.172
	Equal variances not assumed			.334	45.987	.740	.167	.499	-.838	1.172
CS8	Equal variances assumed	1.004	.322	.532	46	.598	.208	.392	-.581	.997
	Equal variances not assumed			.532	44.197	.598	.208	.392	-.581	.998
CS9	Equal variances assumed	.102	.750	1.901	46	.064	.667	.351	-.039	1.373
	Equal variances not assumed			1.901	44.125	.064	.667	.351	-.040	1.374
CS10	Equal variances assumed	.903	.347	1.323	46	.192	.625	.472	-.326	1.576
	Equal variances not assumed			1.323	45.402	.192	.625	.472	-.326	1.576
CS11	Equal variances assumed	.491	.487	1.022	46	.312	.500	.489	-.484	1.484
	Equal variances not assumed			1.022	44.528	.312	.500	.489	-.485	1.485

B.3 Thematic Analysis

Code System				**#**
Code System				680
	More expressive sound			0
		Need more abstract music notes		1
		Consider sounds more when knowledge grow		1
		Need choices on music		1
		Sound interact with each other		1
		Need audio feedback		3
	Inspiration source			0
		Serendipity-create strategy		3
		Rely on listen		6
		Use timing to introduce sound		2
		Imitate musician		1
		Less possibilities support concentration		4
		Creation of interaction		9
			Pause because can't go back	1
			Use smaller music notes to create	1
		Visual helps to explore sounds		2
		Rely on visual		3
		Visual guide music creation		6
		Creativity grows with understandbility		1
		Constraint encourages creativity		2
		More options leads to creativity		1
		Records trigger new ideas		5
		Unsure about what to do		1
	Explore			0
		Enjoy explore sounds		1
		Sound exploration		2
		Music ideas emerges from random exploration		6
		Creative process-random		2
		Creative process - explorative		3
		Exploration involves trial and error		1
		Explorative process		10
		Explore music ideas		4
	Compose			0
		Used timline more in composition		1
		Creative process is trial and error		1
		Creative proces is iterative		2
		Buttoms up process - from random explore to compose		3
		Top down process - with structure in mind and fill in music ide		2
		Concept of creating music		4
		Shift strategy		4
		Different creation strategies between versions		2
		Compose is more creative than play live		3
		Compose mode involves relisten		1
		Need relisten to create		2
		Build up a song		2
		Concept of composition		6
		prefer compose mode		6
		Composing is not in hurry		2
	Improvise			0
		Can't make mistake with non-changeable playing point		1
		Experimenting		5
		Creative process - looping		2
		Creative process-playing live		1
		Playing live		0
			Playing live is more simple to create	1
			Playing live need to think with sound playing	1
			Playing live more intuitive	2
			Playing live is easier because it's responsive	2
			Playing live is easier to learn	2
			Playing live in the beginning	2
			Playing live allows more concentration	2
			Play live is experimental	1
			Better result from playing live	2
			Reuse records as an efficient approach for play live	1

		Less worry about mistake when playing live		2
		Non-change play point force ability grow		1
		Less pressure when play live		1
		Playing live force plan music		1
		Enjoy playing live		13
		Playing live test ability		2
		Playing live need to be quick		2
		Timing matter more when playing live		1
		Playing live when confident		1
		Playing live need less previous information		1
		Play live is more controlable as it's responsive		1
		Playing live for novice is difficult to output good quality		3
		Have less confidence when play live		1
		Experiencing with different sounds when play live		1
		Playing live is more accurate		1
		Not used to live perform		2
	Use more future timeline			1
	Concept of playing live			3
	Prefer playing live			1
	Plan ahead and play live is very different way of playing			1
	Concept of improvise			1
Records				0
	Records help learn sounds			3
	Records remind the sound			3
	Records helps to create			5
	Records allow easy recreate previous ideas			1
	Reuse records			8
		Reuse ideas support exploration		1
		Reuse ideas support effciency		3
	Relisten result			2
		Check what was done		4
			Relisten as an approach to create	3
			Records support learn from mistake	1
			Relisten as an approach to correct mistake	2
			Relisten records to double check quality	6
			Relisten as an approach to evaluate previous creation	2
		Relisten is very important for learn and create		9
			Relisten as an approach to learn combination	1
Plan ahead				1
	Double edge sword - plan ahead			1
	Plan ahead saves time			1
	Plan ahead is easier than manul operation			1
	Plan ahead helps playing live			1
	Plan ahead is easier			4
	Plan ahead gives time to plan and adjust			1
	Plan ahead helps to create			3
	Plan ahead allows more creativity			2
	Enjoy planning ahead			4
	Rely on visual when plan ahead			1
	Less pressure when plan ahead			2
	Plan ahead helps to compose			1
	Plan ahead triggers imagination			1
	Use more plan ahead in second play			2
	Can't work on plan ahead			2
		Need auto synchronisation for planning ahead		2
		Need to secure timing when plan ahead		4
		Creating in the future is not enough time		2
		Not sure what's going to happen in future timeline		4
Timeline				0
	Interesting sounds don't make real music			1
	Visual			0
		Timeline allows to approach music visually		2
		Need visual support for timing		1
		Need visual to indicate sound length		2
		Need visual to help sync sounds		1
		Visual support recognise sound		3

		Visual remind interaction	5
		Visual indication support edit	2
		Visual is necessary only when edit	1
		Visual as a reference point	2
	Conflict between current and future		0
	Changeable playing point helps to orient through timeline		1
	Timeline provide control		1
	Timeline helps to implement		2
	Timeline as distributed cognition		3
		Indications of what is going on helps to compose	1
		Timeline indicate the timing	2
		Timeline indicate sound length	3
		Timeline helps to dintinguish sound	1
		Timeline remind the sound	4
		Timeline helps to anticipate	4
		Timeline allows more concentration	2
		Timeline helps to create	4
		Timeline indicate what's going on	11
		Timeline helps to plan	9
		Timeline helps to structure ideas	6
		Timeline helps to remember	1
	Timeline-previous support evaluate		4
	Timeline support to interact with music through structure		1
	Timeline-previous helps to explore		2
		Timeline helps understand sound combinations	2
		Highlight help to learn to play	2
		Timeline helps to learn how sounds play together	1
		Future timeline helps to explore	4
Skill set			0
	Need more time to learn		1
	Lack of skill with instrument		1
	Different skill sets for different playing mode		1
	Plan ahead rely on cognitive skill rather than physical skil		2
	Play live need more skill		2
	Cognitive skill for composing, physical skill for play live		1
Creative Process			17
Motivation			0
	Used to play live		1
	Task affect the choice of versions		1
	Enjoy exploring sound without task		1
Edit			0
	Exploring sound combination by editing		1
	Edit support to explore		1
	Edit support to play live		1
	Edit helps to ensure right timing		1
	Need for edit, delete		9
	Correct mistake		2
	Edit provide flexibility		2
	Didin't use edit		3
	Edit support more music combinations and possibilities		1
	It cause time to go back to edit		2
	Difficulty to edit		1
Playing Point			0
	Music making is easier with changeable play point & plan ahead		1
	Non-changeable playing point is less confusing		1
	Non-changeable playing point better than it seems		1
	Non-changeable playing point have more limits but get more idea		1
	Changeable playing point is easier to use		1
	Changeable playing point allows mix sound better		2
	Play back support create		1
	Non-changeable playing point is less control		3
	Changeable playing point doesn't matter so much		1
	Changeable playing point provide more choice		4
	Changeable playing point allows quick interaction		3
	Changeable playing point support more exploration		3
	Changeable playing point reduce rely on visual		1

	Changeable playing point reduce stress		1
	Change playing point is most important for creativity		2
	Change playing point is reasonable, but it create difficulty		1
	Change playing point leads to deeper music exploration		2
Playing mode			0
	Simple version get simpler interaction		1
	Different interaction modes between versions		10
	Simple version is more straight forward		1
Sound design			19
	Learn sound		1
	More music genres		1
	Sound design - smooth transition		1
Novice limitation			0
	Frustration		2
	Barriers-confusion		1
	Barriers-clumsy		2
	Barriers-memory on previous interaction		3
	Barriers-mapping		11
	Need tolerance/support for mistake		4
	Feel secure with stable timeline		1
	Barriers-timing		5
	Because I'm not a musician		7
	Barriers-memory		17
	Lack of confidence		3
	Don't want risk		2
	Need for safty		1
	Need time to think		1
	Afraid of mistake		1
	Can't think at the same time while mucis is playing		4
Benefit			0
	Learn how music is		1
	Find it's not hard		1
	Learn timing		4
	Learn concept of making music - collage		4
	Learn making music could be fun		2
	Lean making music is easy		1
	Learn what sounds compliment each other		3
Good Experience			3
	Like the shape of the box		1
	Lost track of time		1
	Playing with music provide appreciation		1
	Surprised with the experience		7
	Appreciate the results		3
	Exciting on editing		1
	Enjoy explorative result		3
	Exciting on the result		9
	Exciting on music ideas		5
Quality of output			0
	Dissatisfied with result because of unsure		1
	Support correctness		1
		Auto correcting or not	1
		To sync samples easily	2
		Enjoy auto-synchronisation	1
	Perfect previous idea		1
	Important to be able to perfect ideas		2
	Curious about the sound results		0
	Short/long samples secure quality		1
	Care about the music quality		5
	Pressure with messy result		1
Starting base			1
Readiness time			16
Interaction			0
	Pause cause discontinuty		1
	Precise control over timing		1
	Control over short samples		1
	Need more control over sound		4

	Control support music creation	1
	Interaction is easy	9
	Constraints leads to creation of interaction	2
Adapt to system		2
	Focus on timing when used to system	1
	Gain confidence with more understanding	2
	Getting more focused	1
	Ability grow	2
	Understanding shifting	2
	Satisfaction grow	2
	Knowledge grow	10

Code	Segment
Playing Point\Changeable playing point allows quick interaction	: Because it save time, because you don't need to wait.
Good Experience\Exciting on music ideas	Actually creating something, and the experiment of possibly creating something good.
Interaction\Creation of interaction	add like three things, and then make them equally long or something,
Novice limitation\Barriers-timing	And also I'm just naturally find it difficult to synchronise stuff for like mentally jungle things.
Playing live\Less worry about mistake when playing live	And because also for me when I play live, it doesn't matter that much if I made a small mistake. To me mistake would be oh, timing is wrong, or all the sound doesn't combine at all.
Edit\Need for edit, delete	And because I'm really bad on this, sometimes I want to delete somethings I made. And I think it's better to have this function because for a bad creator like me.
Novice limitation\Need tolerance/support for mistake	And because I'm really bad on this, sometimes I want to delete somethings I made. And I think it's better to have this function because for a bad creator like me.
Playing Point\Changeable playing point allows mix sound better	And I can move the timeline around to change from different points, the way you want your samples to mix with each other.
Records\Records helps to create	And I see oh this part is good, and then it helped me to create another one based on this, I think.
Interaction\Creation of interaction	And I think it's good, because when I want to extend it, I know that this part is good, and I want to make it last for a certain time, so I don't need to wait them to end to that point, I just extend it to the point I want, and cut it one by one. Sometimes I want them to fade out a little bit than before. And then I can add something new.
Good Experience\Surprised with the experience	And I think the result is better than I thought.
Quality\Important to be able to perfect ideas	And I'm very like, perfection, I like things to be perfect.
Records\Relisten result\Relisten is very important for learn and create\Relisten as an approach to learn combination	And in the future, I know how they work together.
Timeline\Timeline indicate what's going on	And it indicate which one I have chosen.
Records\Records help learn sounds	And kind of see how it all sounds together.
Benefit\Learn what sounds compliment each other	And matching different types of sounds.
Process\Experimenting	And so I was trying to explore whether it could be useful, implementing some expercility.
Records\Relisten result\Check what was done\Records support learn from mistake	And so if you made a mistake or something you didn't want to happen, you can then learn from it. And looking back on it, and think I'm not gonna do that again.
Playing mode\Different interaction modes between versions	And the last improvisation, I basically used the future, like I composed everything in the future. And then just wait it, and listen to it, and then if I needed to change it, I change it. So the last bit I was using like all done afterwards, in the future. That was good as well. I didn't think I would use that, but I wanted to try it, and it worked.
Plan ahead\Plan ahead helps playing live	And the last improvisation, I basically used the future, like I composed everything in the future. And then just wait it, and listen to it, and then if I needed to change it, I change it. So the last bit I was using like all done afterwards, in the future.
Edit\Need for edit, delete	And the only thing that I was trying to go, cause I wanted to have the sounds, I was trying to go back to change them, but I wouldn't really sure how to do that, that was the only thing.
Creativity\Constraint encourages creativity	And the second one, more of a task that you have to, I guess helps to get different ideas. Cause you know you have this limit.
Playing Point\Non-changeable playing point have more limits but get more idea	And the second one, more of a task that you have to, I guess helps to get different ideas. Cause you know you have this limit.
Timeline\Timeline helps to anticipate	And the time is gonna come on.
Timeline\Timeline helps to implement	And the timeline help me match order, start together. I think that was good.
Good Experience\Exciting on editing	And then adding things to it as well, when I was going back, so there was like, a bit boring at one point, I just added like a beat, when I was going back to it. Yeah.
Good Experience\Exciting on music ideas	And then adding things to it as well, when I was going back, so there was like, a bit boring at one point, I just added like a beat, when I was going back to it. Yeah.
Timeline\Visual guide music creation	And then after a while I was playing, and oh the shape are the same, so I'm just put all the squares or all the circles and see if it sounds nice for some reason. But I think I like better to just mix, the shape. R: Oh, so basically you feel the visual, you are directed by the visual in some way, is it? If I understand it right. P: I tried, but then. I just tried to, I don't know, pick up all the rectangle ones. Yeah, and then listen, but I didn't think it was better than other combination. So I was think, whatever. R: But that was one strategy you used?
Sound design	And then after that I started to make kind of long forms of sound of the sounds, you know, and put shorter versions lay it over, but with gaps in between on those layers. Because, I suppose I was trying to sort of, you know, especially with the timeline,
Good Experience\Exciting on the result	And then having something that actually sounded ok, sounded alright.
Plan ahead\Plan ahead gives time to plan and adjust	and then I can add things in the future, how I want it. It gives me time, to make, times to plan, and time to adjust, and add.
Novice limitation\Because I'm not a musician	And then I can't just do that with just visually cause i don't have a grid or some strong help with that. I'm just not musician so
Need audio feedback	And then I can't just do that with just visually cause i don't have a grid or some strong help with that. I'm just not musician so
Novice limitation\Barriers-memory on previous interaction	And then I liked it's playing but I forgoten, and then I'm putting in some other stuff, and then it's like oh that's gonna stop.
Edit\Need for edit, delete	And then I literatly, it was really difficult for me to delete quickly what I have done.
Records\Relisten result\Check what was done\Relisten records to double check quality	And then I want to re-listen to see if that sound was good or not. That's why I want to remove, I think is this sound. Yeah.
Rely on listen	and then it be like, oh, that wasn't sound what I wanted, or I felt like it was going on too long, so I could just cut it.
Records\Records helps to create	And then it helps me to link you know, what I want to do, I don't want it sound to messy.
Good Experience	And then it's exciting when the current time actually hits the thing and you feel like oh, that it does played what I thought it would play, or does it do something different.
Timeline\Timeline helps to plan	And then sometimes when that was going, then I started to build a new one.
Plan ahead	And then sometimes when that was going, then I started to build a new one.
Good Experience\Appreciate the results	And then they just, feel happy and satisfied with the feeling after when they hear it. So they can enjoy it, you know just creating in the moment and kind of appreciating what you've done.
Concepts\Concept of composition	And then this one I was trying to do it more like composed, so doing it kind of, putting something and then go back a bit, putting something and then go back a bit..
Playing live\Enjoy playing live	And then, in the last improvisation that I did, I try to play a little bit with it, and I understood a bit more, I knew how it works. But it still was more fun just to playing.
Process\Experimenting	And then, you just try to experiment and see if you can make any better.
Good Experience\Enjoy explorative result	And then, you just try to experiment and see if you can make any better.
Use timing to introduce sound	And there is another bit where I was sort of, I realise you could make a sound come on in now while pressing the button. So you could sort of do that one, do-do-do (figure demo), you know, you could have it playing. And then do it like an instrument too if you like.
Process\Explore music ideas	And this time I try to kind of just play part of the sound, and like kind of start and stop it quickly, to kind of create I suppose a different beat, or something like that.
Interaction\Creation of interaction	And this time I try to kind of just play part of the sound, and like kind of start and stop it quickly, to kind of create I suppose a different beat, or something like that.
Timeline\Visual is necessary only when edit	And when I played it over again, I would just sit there, I would just hear. And when I heard something I want to change, then I looked, saw the visual stuff. Only when I want to edit on
Plan ahead\Plan ahead helps to create	And when you scroll to the future, maybe you are like, I could make things up use the same beat again. You can plan ahead to change something, more exciting.
Records\Records trigger new ideas	And you can kind of improve them or change them.
Playing Point\Changeable playing point provide more choice	and you have more freedom to choose which part you want to listen.
Timeline\Timeline helps to plan	And you realise when they are. And it allows you to plan the future, so
Playing live\Playing live force plan music	anticipating what time to change and changing the samples, so I might stop and add more on top of each other. So stop one and add another or maybe stop a few.
Timeline\Timeline helps to implement	As you figure out what you want to do you can… R: plan something?
Benefit\Find it's not hard	At first I thought, oh, this is gonna be hard for me, but then when I did it, it was fine.
Process\Explorative process	at first I was just kind of seeing what the different sounds were, and then how I can make them work, and see if I could do like a different sound from each side, see if I can fit them all together, that kind of thing. But, yeah, just try different sequences of tracks.
Timeline\Visual as a reference point	At least I know I have put something on it.
Timeline\Timeline indicate what's going on	At least I know I have put something on it.
Knowledge grow	at some point I knew oh, this is how I'm gonna do it. Like the strategy, like a couple of (straights), plus go forward on the timeline, add something, then pause to, listen to it. And think about, what am I gonna, yeah. It was a bit more structured.
Satisfaction grow	at some point I knew oh, this is how I'm gonna do it. Like the strategy, like a couple of (straights), plus go forward on the timeline, add something, then pause to, listen to it. And think about, what am I gonna, yeah. It was a bit more structured.
Good Experience\Surprised with the experience	at the begining, I thought this wasn't working as I expected, so some interesting sound, some interesting music came out
Process\Creative process-random	basically, no, nothing. [laugh] I just like, found some kind of the rhythm that I like, and then I kept using them, and then.
Process\Creative process - looping	Because all I was trying to do was build up loops.
Concepts\Concept of improvise	Because all I was trying to do was build up loops. So I was, I don't know, in this task, I didn't want to edit anything. Because the task was improvise, trying to keep something going the whole time.
Novice limitation\Barriers-mapping	Because at first I don't know which button indicate the sound, because it actually indicate by the lines color, but the color isn't, because the line is so soft, so the color behind the line is not so light. Not so clear, so you had to see. Um, I think, and I'm confused with this. That's it.
Process\Creative Process	Because basically what I ended up doing is just forgetting about the timeline of going back and forth, it was just like started adding stuff on top of each other, or stopping them.
Novice limitation\Barriers-memory	Because first I don't remember how the things will sound. So I don't remember all the things.
Novice limitation\Because I'm not a musician	because for a bad creator like me.
Quality\Care about the music quality	Because for a new beginner, I think, for me, I'm more likely to make it a better, to review, maybe in the future I can output the music as my piece of creation. But if I do the improvise version, I can not make a very good music. So maybe I just play, and I didn't care about the quality.
Records\Relisten result\Check what was done\Relisten records to double check quality	Because for a new beginner, I think, for me, I'm more likely to make it a better, to review, maybe in the future I can output the music as my piece of creation. But if I do the improvise version, I can not make a very good music. So maybe I just play, and I didn't care about the quality.
Records\Relisten result\Relisten is very important for learn and create	Because for a new beginner, I think, for me, I'm more likely to make it a better, to review, maybe in the future I can output the music as my piece of creation.

Sustainer	Because for the timeline, I think you might have more time to use the thing. Get used to all the buttons, all the sound, that I might use it.
Process\Creative Process	because from the first time try using it, I find the beat that I like. But there is a lot of beats I forgot. So when I started to improvise it, I try to match it with all the sounds, and then I found that these two buttons are the ones I like.
Records\Relisten result\Relisten is very important for learn and create	Because I always want to listen to what I have done.
Novice limitation\Need tolerance/support for mistake	because I can't like, I can not delete things.
Plan ahead\Can't work on plan ahead	Because I can't remember the music of each key, so it doesn't seems to be useful for me to plan things in the future.
Plan ahead\Can't work on plan ahead	Because I couldn't really work on that dimension, I would say.
Records\Reuse records\Reuse ideas support effciency	Because I created a sound, in the past, and you can like, it was just being recorded for example, without having to re-create that again, I can just move to the past, and play from there, and then do it again.
Records\Reuse records	Because I created a sound, in the past, and you can like, it was just being recorded for example, without having to re-create that again, I can just move to the past, and play from there, and then do it again.
Process\Music ideas emerges from random exploration	Because I don't feel the time scale is in alignment to the beats. So at the beginning when I queue things, I just based on the feeling on my own.
Records\Records remind the sound	because I don't know, like I can't remember all the sounds, so sometimes, in the end, I think I scroll back in to the past, for instance to try, to quickly pause and then try one two sounds, remember oh, this is the sound. And then I could go back and add that to the mix, for instance.
Novice limitation\Barriers-memory on previous interaction	because I don't remember what I did
Playing live\Enjoy playing live	Because I enjoy at the moment right now.
Attractor	Because I enjoy at the moment right now.
Process\Exploration involves trial and error	Because I feel like with this, especially is like a trial and error, with sound.
Plan ahead\Can't work on plan ahead\Not sure what's going to happen in future timeline	Because I had no idea how it would sound.
Have choice on decision	because I have the choice to chose which music I can combine with what music, with what beat.
Edit\Difficulty to edit	Because I just added too much random things on the second one, I thought I could go back and edit it, but then it's more difficult than I thought it was.
Records\Records helps to create	Because I keep background music going on, so I just choose the piece at this blank at other places, and put new things on it.
Timeline\Visual support recognise sound	Because I recognise the symbols and colors of the keys, it's helping me, so I know which one I want to cut and extend and
Timeline\Timeline indicate what's going on	Because I recognise the symbols and colors of the keys, it's helping me, so I know which one I want to cut and extend and
Process\Creative proces is iterative	Because I think the creation process is an interative process, so I mean always to review on what I have done in the past, and do some alteration.
Concepts\Concept of creating music	Because I think the creation process is an interative process, so I mean always to review on what I have done in the past, and do some alteration.
Records\Relisten result\Check what was done\Relisten records to double check quality	Because I want to be sure that is a good sound.
Process\Creative Process	Because I was trying to continuely to put sounds in.
Novice limitation\Because I'm not a musician	Because I'm not a musician
Novice limitation\Barriers-memory	Because in the future I was having problems like annoying by memory, where were the buttons, one line was what button.
Novice limitation\Barriers-memory on previous interaction	Because in the previous one I went back and forth, so at some point I didn't really remember myself, whatever I have done.
Playing Point\Changeable playing point provide more choice	Because it gives you, you'd always want more options, because the creation, or the limits are endless for what you could do. That's the thing of being creative, you want to do something that, you don't want to be reduced to what you could do, because then it doesn't allow you to be as creative as you want. So with more options, and more choices you can be as creative as you want.
Less possibilities support concentration	Because it was sort of more, because I could, it sort of forced you to be more in the moment with making the music.
Timeline\Timeline remind the sound	Because it's loads of buttons, I don't know if I was this one or this one for example. Without hearing it, but by just clicking and highlighting, because I know the sound, where that sound is, it helps me figure out.
Plan ahead\Plan ahead is easier	Because not queueing things up made it, so that there was that kind of instantaneous interaction, but queueing it up meant that once you are there, you kind of freed up to think about other things, and you didn't have to worry about playing the button at the right point
Plan ahead\Less pressure when plan ahead	Because not queueing things up made it, so that there was that kind of instantaneous interaction, but queueing it up meant that once you are there, you kind of freed up to think about other things, and you didn't have to worry about playing the button at the right point
Plan ahead\Plan ahead allow rely on mental skill rather than physical skil	Because not queueing things up made it, so that there was that kind of instantaneous interaction, but queueing it up meant that once you are there, you kind of freed up to think about other things, and you didn't have to worry about playing the button at the right point
Focus on timing when used to system	Because now I'm more confortable with the device, I can actually focus on timing, rather than, I couldn't do that before
Interaction\Interaction is easy	Because once you press the button, I was like 'press the button'. But it was really fun.
Novice limitation\Afraid of mistake	because the future, although there is a timing thing, but sometimes there are mistake really easy.
Playing mode\Different skill sets for different playing mode	because there are some skills involved, there is skill involved in composing, but it's a kind of, it's the difference between say playing tennis and doing a crossword, like there is skill in a crossword, but you get the time to sit there and think about it, you don't have to do it in a hurry.
Mental skill for composing, physical skill for play live	because there are some skills involved, there is skill involved in composing, but it's a kind of, it's the difference between say playing tennis and doing a crossword, like there is skill in a crossword,
Edit\Need for edit, delete	Because there is always, there might always be something to change.
Concepts\Need relisten to create	Because with the second one, when I was making a track, I realized I want to listen to it again, and I couldn't do that.
Timeline\Timeline helps to plan	Because you can compose something that is a little more, you can do things that require more time to do, that in real time, you don't have the time to.
Timeline\Timeline helps to remember	Because you can see what you've done.
Playing mode\Different interaction modes between versions	because you can't change the playing point, can you? So you have to do things differently.
Concepts\Concept of composition	Because you composing yourself, yeah. And I think the second one, perhaps, you don't really feel what you have composed, because you can't go back and listen to it
Playing live\Reuse records as an efficient approach for play live	Because you could have like 4 sounds here, 2 sounds here, and instead of having to delete one by one, the other two, you can move here and then move here, and you are changing between 4 sounds and 2 sounds, instantly, you know. So that, before you couldn't do, because you had to, kind of create, very quickly delete two, then.
Playing live\Playing live need to be quick	because you had to, kind of create, very quickly delete two, then.
Timeline\Timeline-previous support evaluate	Because you know I couldn't sort of go back to re-evaluate what I've done.
Playing mode\Shift strategy	Before I was doing more current when I did it the first time. I was playing the current, but this time more future.
Playing mode\Different creation strategies between versions	Before I was doing more current when I did it the first time. I was playing the current, but this time more future.
Plan ahead\Use more plan ahead in second play	Before I was doing more current when I did it the first time. I was playing the current, but this time more future.
Records\Relisten result\Relisten is very important for learn and create	Being able to go back and listen to it again
Interaction\Need more control over sound	But again it's the control of the sound on the timeline could be improved. I think it would be really interesting to see. Cause at this moment my main problem was literuarely having control on what I was adding, and deleting, mostly deleting.
Knowledge grow	But also because I felt in this case that I have little bit more structure to what I was doing.
Novice limitation\Barriers-mapping	but basically the timeline goes like this, whereas this is wrapped in a multi-dimension,
Interaction\Interaction is easy	but basically these buttons are very easy to learn and it's quite interesting I think.
Task\Used to play live	But basically, I think I won't do it much because I'm used to do something along with the time.
Timeline\Need visual support for timing	but because I can't see whether the timing is correct,
Plan ahead\Can't work on plan ahead\Need to secure timing when plan ahead	but because I can't see whether the timing is correct,
Playing Point\Change playing point is most important for creativity	But definitely more effective from music purpose, the most interesting, the more maybe creative you can be with the first one.
Playing Point\Changeable playing point reduce stress	But here the timeline it does the work for you, so reduces stress that you would have.
Timeline\Visual indication support edit	But how would you do without the timeline, how can you like, well you can still extend, but how would you know? For example, I have one to extend this sound, like passed or before I reached the end of this sound, or something, without the timeline, I would never know.
Plan ahead\Can't work on plan ahead\Creating in the future is not enough time	But I did not manage in real time to have music playing, and queue things up.
Novice limitation\Barriers-memory	But I didn't always rememebr which one was which. Like, I started to remember that the sound I was really like was here, or these things. But, it was also a bit random.
Novice limitation\Need for safty	But I do prefer the first one. Still, it's like having safty of being able to go back.
Novice limitation\Feel secure with stable timeline	But I felt more secure thing with the second prototype, where I couldn't change the thing, the timeline. Because I think it was just like, you know, I didn't have to think about it. Because I knew that it was a stable thing that I can't change. So I could concentrate more on the future actually. And I recorded things in the future and I knew that the timeline would always, you know.
Playing live\Play live is more controlable as it's responsive	But I found it's less responsive compare to what I was expecting. Eventually I found more controlable the present time, I would say, you know. So yeah, I ended up using more about the feature than the scroll.
Knowledge grow	But I knew which sounds I liked now, when I done it, having used it.
Novice limitation\Barriers-memory	But I mean, in general, when I know, approximately what these things are, but won't. I can't remember all of the buttons, like which sound they give.
Process\Creative process - explorative	But I mean, in general, when I know, approximately what these things are, but won't. I can't remember all of the buttons, like which sound they give. So when I record things in the future, I know that these are short and these are long, and stuff like this, so I use it for producing certain rhythms, maybe, in the future.
Interaction\Interaction is easy	But I mean, the process of turning everything on and off is really easy.
Playing live\Enjoy playing live	But I probably at the most interesting things when I was playing on the timeline basically. R: You mean the current time? rather than going to queue things up?
Need more time to learn	But I think it does make sense, because I think it need more time to learn.
Plan ahead\Plan ahead saves time	But I think it, you don't need to wait that long, so you just jump to the future and do somethings.

Rely on listen	But I think it's better if I can hear what I am creating.
Need audio feedback	But I think it's better if I can hear what I am creating.
Playing live\Playing live is easier to learn	But I think the interface in this version is easier for me to learn.
Playing live\Playing live for novice is difficult to output good quality	But if I do the improvise version, I can not make a very good music. So maybe I just play, and I didn't care about the quality.
Plan ahead\Can't work on plan ahead\Not sure what's going to happen in future timeline	But if I put everything in the future, I don't know what exactly I have done.
Quality\Support correctness\Auto correcting or not	But if it's also sort of correcting, then I'm not sure if I'm doing it right.
Playing mode\Simple version get simpler interaction	But in the second prototype, it did make it a lot easier, do not have it. So I won't, I'm not gonna bother to use it.
Playing live\Enjoy playing live	But it kind of also force me to kind of interact with it in real-time, which was really good. That was really fun.
Interaction\Need more control over sound	But it will be good if you could change the volume of the individual sounds, for example, because while one of this one, I can't remember which one was it, the sample was ok, but it was too loud, and then it was basically hiding the other sounds. And it was extremely too loud.
Timeline\Visual guide music creation	But just, it was useful because sometimes I play a sound, I'd like pick a color, play a sound,
Novice limitation\Barriers-memory	But like, just like remembering which buttons do what.
Novice limitation\Lack of confidence	But maybe I lack the skill with the musical instrument
Novice limitation\Lack of skill with instrument	But maybe I lack the skill with the musical instrument
Playing live\Not used to live perform	But maybe that's because you know I have never played any musical instrument, or whatever, I think the other style is basically to use it like a musicial instrument. So yeah, I prefer not that way but kind of compose in advance.
Playing live\Playing live test ability	But maybe that's because you know I have never played any musical instrument, or whatever, I think the other style is basically to use it like a musicial instrument. So yeah, I prefer not that way but kind of compose in advance.
Novice limitation\Barriers-memory	But the problem is then, you have to remember the, what it is, you know. That was a littble bit of, like trying to kind of rememebr, it was hard.
Edit\Correct mistake	But the second one, because of the timing problem, I can't really like get the timing right, so probably they are a bit messy. Because basically the main point is that you can't change stuff, you can add stuff but not change stuff. So if with changing stuff, I can correct it, so that will be much better.
Playing live\Better result from playing live	But the thing that I made on the first one was somehow better.
Edit\Need for edit, delete	But the, bad thing is, this don't have a function of canceling thing, yeah, that's a bad thing.
Process\Serendipity-create strategy	but then I realise this second time, that you can kind of click on the start on long one, and then you can click on the start again, and without closing the previous time, and then it starts from the beginning, so I kind of like that, and I was using that a little bit, using the long ones a bit like they were short, you know, like just start, and then start, and then start, and then start, and then start, so it will go like, um, um, um, um.
Adapt to system	but then I would realise all that drum beat all the stuff gonna be quick. But then one thing you can do, cause I basically want that drum beat on the whole time, so you just put a start time, and…
Records\Records help learn sounds	But then when I started listening to it, you could kind of like, kind of heard points in the music where I want to put on another piece.
Records\Records trigger new ideas	But then when I started listening to it, you could kind of like, kind of heard points in the music where I want to put on another piece.
Quality\Pressure with messy result	But then when it doesn't sound good, it's like, I feel like a bit of pressure, I was like oh, it's being recorded, and this is a mess. The creation is no good.
Novice limitation\Barriers-memory	but there are many buttons, I need to try a lot of times to see which one it is. Sometimes I made mistakes.
Novice limitation\Barriers-mapping	but there are many buttons, I need to try a lot of times to see which one it is. Sometimes I made mistakes.
Novice limitation\Barriers-memory	But there is a lot of beats I forgot.
Timeline\Need visual to indicate sound length	but there was not like a clear way of knowing how long. I couldn't figure out. How long the sound is gonna play for? Just cause like a grid of like a time, or beat or something. So I could know equavalent two bar.
Readiness time	but you get the time to sit there and think about it, you don't have to do it in a hurry.
Concepts\Composing is not in hurry	but you get the time to sit there and think about it, you don't have to do it in a hurry.
Playing live\Playing live is more simple to create	But, in terms of creation, it was more simple, I think it was a lot simpler to like ok, you want add this, you want to take this away, but the other one, it gives you more variety, loads of things to do. To listen, to change, to go in the future, to make additions, you know, you could do that here as well, but I think it's just a little bit simpler.
Playing live\Playing live allows more concentration	But, in terms of creation, it was more simple, I think it was a lot simpler to like ok, you want add this, you want to take this away, but the other one, it gives you more variety, loads of things to do.
Novice limitation\Barriers-mapping	But, not the mapping. The mapping was like, always try to, which one was it? which one was it? Because it just takes me a while to immediately do that.
Novice limitation\Barriers-memory	But, sometimes I wouldn't be sure so I would just, you know. I think this is the one, so I'm gonna delete that. Then I tried, and sometimes it was exactly the one I wanted to, and sometimes it was NOT the one I wanted to take. Well, the music is composing itself.
Process\Sound exploration	By testing different one at different points. See how did they mix together.
Knowledge grow	Can I say I just know how to add, create music in the future now?
Timeline\Timeline helps to dintinguish sound	Cause before that it show me which specific ones are which, so it was easier to know what sounds i need to use. R: So it's easy for you to .. P: Dintinguish. R: remember P: Yeah, based on the shape and the color.
Novice limitation\Because I'm not a musician	Cause I don't understand music, so it's nice actually seeing it compose a bit.
Playing live\Playing live for novice is difficult to output good quality	Cause I just think when I was playing live, it was just a mess, it wasn't.. I didn't like the start, the start sounded really bad.
Timeline\Visual guide music creation	Cause I was looking at the lines, and want to figure out whether to stop.
Records\Relisten result\Relisten is very important for learn and create	Cause I wouldn't know, I have to hear something. I wanted to hear it, and then I would know if I like it. If I don't like it, take it off. That's why deleteing, works for me.
Rely on listen	Cause I wouldn't know, I have to hear something. I wanted to hear it, and then I would know if I like it. If I don't like it, take it off. That's why deleteing, works for me.
Quality\Care about the music quality	Cause ideally you want something sounds good you know, something, you can focus on, or, like a, you know, enjoy.
Concepts\Concept of playing live	cause it's more like you are playing lively, like just going to the future, what's going on. It doesn't really matter what's wrong in the previous part, and then you need to edit.
Interaction\Constraints leads to creation of interaction	Cause it's the only option.
Records\Relisten result\Check what was done	Cause when people use it they can check what they are doing. So it's like if they wanna change things they can go back, they can hear it again.
Records\Relisten result\Check what was done\Relisten as an approach to correct mistake	Cause you can re-listen. And if there is a button to cancel, you can cancel.
Novice limitation\Lack of confidence	Cause you can re-listen. And if there is a button to cancel, you can cancel.
Timeline\Visual support recognise sound	cause you can see which one is playing with which, with the other one.
Timeline\Timeline indicate what's going on	cause you can see which one is playing with which, with the other one.
Records\Reuse records\Reuse ideas support effciency	Cause you've created things you like in the past, you gonna just keep playing that.
Playing Point\Play back support create	Definitely being able to go back, to play all together. I think that's the most useful.
Playing mode\Different interaction modes between versions	Did you queue things up in the future? P: Not really in this one. No. I was more playing it, if I didn't like it, then going back and changing it.
Playing Point\Changeable playing point is easier to use	Easy to use, the interface.
Timeline\Timeline indicate what's going on	Especially going back, cause you can see which is on and which is off.
Sound design	especially near the end, I realise that you could sort of have the red ones could be kind of like, they sounded okay as a kind of continuous background.
Novice limitation\Barriers-mapping	even now I used it a bit, still could forget what sound the buttons do.
Novice limitation\Barriers-memory	even now I used it a bit, still could forget what sound the buttons do.
Playing with music provide appreciation	Exactly what I feel I could, because I think, especially with music, you know, as someone who is quite untrained, just playing around with it like that, does sort of you know, I can hearing the things, and having the sort of the reference of the timeline, which is a lot like a graph, and then the sounds. you know, it does gives me sort of appreciation of something
Good Experience\Appreciate the results	Exactly what I feel I could, because I think, especially with music, you know, as someone who is quite untrained, just playing around with it like that, does sort of you know, I can hearing the things, and having the sort of the reference of the timeline, which is a lot like a graph, and then the sounds. you know, it does gives me sort of appreciation of something
Playing live\Less pressure when play live	except that now I didn't pause and go back to try out like, oh, let's check what this sound was all about. So I just, I think I got less, I was less worry that you know, I add a sound, so you know, it can sound really cool, or it can sound really stupid. But I'll just accept that,
Process\Explorative process	exploring different sounds, and going actually this one sound better, so I go back and turn the other one off, and turn a new one on.
Concepts\Prefer playing live	first i thought i'm playing live, while i guess i could also do a composition and come back and do it again, but i wasn't really comfortable doing that. I don't know why. I like a lot to play it live, as a live thing.
Process\Creative process-random	firstly actually I from the white one, because they have kind of the feelings of what I want, and then choose the blue one, because it's just at my right hand. And then I choose green and red to put them together
Process\Creative Process	firstly, I kind of went through all the buttons, just to see which, is there some samples I don't like, for example I don't quite like this one. So, I try to fit it into, with the others, but doesn't really work. Yeah, so I chose the ones that I like, and then I kind of created a beat, like I like. And after the beats, just. This part is kind of decoration on top, these two parts. Yeah, I just chose to fit melody line in the end.
Readiness time	For example I want the red line and the yellow line, I want everything to pause, so that I can add a new sound…

Timeline\Timeline helps to plan	For example, you don't have any idea for like what you want to put, but you only got one sound, and then you can create one sound for a period of time, and then you can go back, and play it, and start try and decide which one and then add longer, or stuff.
Process\Explore music ideas	For example, you don't have any idea for like what you want to put, but you only got one sound, and then you can create one sound for a period of time, and then you can go back, and play it, and start try and decide which one and then add longer, or stuff.
Concepts\Concept of creating music	for improvising, it's the same, for creating a piece, like going back being able to go back and play back stuff, yeah
Readiness time	for instance one of the things I would say that is to go back into time, you need to scroll, scroll, scroll, so you need time to go back or to go forward. So that's affecting the performance.
Good Experience\Exciting on music ideas	For me it was just figuring everything out and see what I could make.
Plan ahead\Plan ahead is easier	for me, it makes it easier, because yeah, I don't feel I have the skill of musician to able to always kind of say, oh that now and press the button, or pull a string whatever. So it means that I can make that sound happen when I want it to happen. As opposed to relying on the skill of my hands to do it at the right time.
Playing live\Enjoy playing live	For this kind of creative instrument, I probably prefer the first one. Just live playing.
Playing live\Playing live in the beginning	forgetting about the timeline of going back and forth, it was just like started adding stuff on top of each other, or stopping them.
Plan ahead\Plan ahead allows more creativity	Future is more creative, it lets you kind of express different stuff, and helps you improvise and make really werid random stuff, so that's the new stuff. I supposed, I think in terms of the brain, like creative, I think the second one.
Timeline\Timeline helps to plan	going ahead, and then just go, leave the music playing, add or remove things in the future
Records\Relisten result\Check what was done\Relisten as an approach to create	Going back to the previous time. Since it's not static, I think when you play something you like, or you see something you like, you have to go back at some point or see how to change it to the future.
Novice limitation\Can't think at the same time while mucis is playing	Hearing the music made me, absorbed in the music at that time, and it was difficult even with the pitches there to kind of project what was gonna happen.
Timeline\Timeline helps understand sound combinations	how all the beats are actually past, whereas with a lot of other machines you'll have to guess it
Playing live\Not used to live perform	how I felt a bit better about doing things, to create things in the future, and then listen to it. Cause I'm not used to live perform.
Timeline\Timeline helps to create	how I felt a bit better about doing things, to create things in the future, and then listen to it. Cause I'm not used to live perform.
Timeline\Timeline indicate what's going on	how it's going
Edit\Didin't use edit	I actually forgot to do that. But that's the only thing that I didn't try out.
Novice limitation\Barriers-confusion	I always confuse which one is the previous, and which one is the future.
Records\Relisten result\Check what was done\Relisten as an approach to evaluate previous creation	I am always like want to add something and hear it again to say if it is what I want to do.
Playing live\Play live need more skill	I assume more difficult cause you can't change the playing point so you can't go back.
Timeline\Timeline-previous helps to explore	I can explore what I have done, and add new things or delete something.
Timeline\Timeline allows more concentration	I can free out mental space to do other things, you know, to put more attention to other part of the task.
Timeline\Timeline allows to approach music visually	I can hearing the things, and having the sort of the reference of the timeline, which is a lot like a graph, and then the sounds.
Concepts\Need relisten to create	I can not go back, so I don't know what it sounds like, the music.
Interaction\Creation of interaction	I can turn off both at the same time, and get a new one on.
Novice limitation\Barriers-memory	I can't remember how to operate these buttons. And yeah, I just explore the music of each button. Most of them I can't remember.
Process\Creative process - explorative	I created it live, just kind of more exploratary saw what happen, and then I created something in the future, then saw how the outcome was.
Need audio feedback	I did try, yeah. But I wasn't sure, I was trapped over, I wasn't sure how the sounds.
Sound design	I did. I try to sort of have one longer, or few longer, sort of being kind of background, and then the others are some shorter ones, and cutting them again and again. Just keep try to clip.
Plan ahead\Can't work on plan ahead\Need to secure timing when plan ahead	I didn't actually. It was probably more because, if I queue them up in the future, I wouldn't be able to get the time right.
Good Experience\Surprised with the experience	I didn't think I would use that, but I wanted to try it, and it worked.
Plan ahead\Plan ahead allow rely on mental skill rather than physical skil	I don't feel I have the skill of musician to able to always kind of say, oh that now and press the button, or pull a string whatever. So it means that I can make that sound happen when I want it to happen. As opposed to relying on the skill of my hands to do it at the right time.
Concepts\Plan ahead and play live is very different way of playing	I don't know completely why that's good, to make something in the future. I don't know, it's like a very different way of playing, I think.
Timeline\Timeline helps to structure ideas	I don't know how I would have done it at all without the timeline there, to kind of like, you know have that structure of where you want things to go. And it sort of really helped to feel like, you know, going backwards, and like editing previous stuff.
Plan ahead\Can't work on plan ahead\Need auto synchronisation for planning ahead	I don't know how this could be done, but where it would automatically fit in so that it's all in time. So sometimes when you did put stuff in advance, and you just like to plan to go there, and you also like have your beat going. The bit you've already put in in the future, when that starts, it's not in time, it's like slightly off beat.
Timeline\Highlight help to learn to play	I don't know which sound is what, so on the timeline when I click something, it goes to, it highlight the area that I want, and then I know.
Playing mode\Simple version is more straight forward	I don't know, the way of working was pretty straight forward. Because it's only go to the future and try to add things,
Process\Top down process - with structure in mind and fill in music ide	I don't remember the sounds as well. I just have a basic structure in my mind, try to implement.
Timeline\Timeline remind the sound	I don't remember what I did, playing with the buttons, so when I press this, I can know which sound it will be sound.
Edit\Need for edit, delete	I don't want that to be appear in my timeline.
Like the shape of the box	I even like the shape. Like it's really cool, rather than a basic keyboard. It's easily to be able to get to all, it's really easily. This, is difficult to time.
Interaction\Control support music creation	I feel like I can not change a lot of things. It's just that you playing, you just press the button. With the other one you can go back, re-listen, you can do more.
Benefit\Learn concept of making music - collage	I feel like I've become more aware about what sounds compliment each other. Cause I've never made music, so I feel like I understand what makes music sound likes.
Benefit\Learn what sounds compliment each other	I feel like I've become more aware about what sounds compliment each other. Cause I've never made music, so I feel like I understand what makes music sound likes.
Readiness time	I felt a bit better about doing things, to create things in the future, and then listen to it.
Less possibilities support concentration	I felt more kind of happy to just like, well you couldn't go backward, so you just, ok where this gonna go.
Knowledge grow	I finally put things in the future.
Knowledge grow	I found it easier than before the phase, because the practice.
Plan ahead\Double edge sword - plan ahead	I found it, at the same time, it double edge sword.
Sound design	I found one red one that I like, a sustain one, I think. And I was playing that one witht the short beats, I think. Put them together.
Interaction\Creation of interaction	I found that by changing the timeline, the samples can mix well with each other.
Playing Point\Changeable playing point allows mix sound better	I found that by changing the timeline, the samples can mix well with each other.
Timeline\Timeline-previous helps to explore	I go back to try out new sounds.
Gain confidence with more understanding	I got more confidence in the end, because I kind of understood more how I can use the different parts.
Playing mode\Different interaction modes between versions	I guess I use them differently. So maybe stop at this time, and maybe use on top of another one at this point.
Good Experience\Exciting on the result	I guess the most excited one, is kind of be surprised at the output of the sound.
Playing live\Timing matter more when playing live	I guess this one does matter more about timing.
Timeline\Visual as a reference point	I guess you got more visual information about where you are in the music. Yeah. Like a reference point.
Process\Creative Process	I had that in the beginning a little bit, like oh, I was adding a lot of things, and then I was worried about the timing, and then I just stopped for a bit, remove the sound.
Sound design	I had them on and off. I mainly had, either change which one was happening. So, I would ususally have a combination of long and short ones together, and I changed it for another long and short ones, and I go back to the one I liked again.
Playing Point\Non-changeable playing point is less control	I have no choice but to wait the time arrive this position, but this is maybe easier to use, not to jump to another position, and not confusing as the previous one.
Playing Point\Non-changeable playing point is less confusing	I have no choice but to wait the time arrive this position, but this is maybe easier to use, not to jump to another position, and not confusing as the previous one.
Sound design	I have one moment when I was listen to this one, because it was really long, and I had two notes, but I didn't realise, like previously, because the notes were pretty long. So now I decide oh yeah, I'm gonna use this because it's pretty cool. But i was a bit, like, the timing was still not really clear to me, so I was a bit worried about that. But anyway, yeah. I don't think that make much of a difference, ususally I use the shorter ones I think.
Novice limitation\Barriers-mapping	I have to test which sound is which sound. Even now I might, like confusing.
Records\Reuse records\Reuse ideas support effciency	I haven't successfully done it. But you can start building up some layers easier I think because you can quickly just come back and play it again. Instead of having to lay it out again, that you could like, you like a drum beat and I want to put something over it, you can more quickly do it with this one, cause you can go back.
Edit\Need for edit, delete	I just can only cut it to very short, but I can not totally delete it.
Sound design	I just extend it to the point I want, and cut it one by one. Sometimes I want them to fade out a little bit than before.
Novice limitation\Barriers-memory	I just have a bad memory.
Records\Relisten result\Check what was done	I just like going back and seeing all the sounds come up what was.
Playing live\Enjoy playing live	I just prefer to kind of go through and do it instantly I guess. R: Ok. Cool, so mostly playing lively. Right, so, next I will show you this …
Sound design	I just sort of try to create a longer one and a shorter one. I try to use them at the same time. I use multiple of shorter ones.
Process\Sound exploration	I just wanted to see how one sound would sound with other different beats, so I would only keep one button open and then switch it arounds to see.
Process\Explorative process	I just wanted to see how one sound would sound with other different beats, so I would only keep one button open and then switch it arounds to see.
Playing mode\Different interaction modes between versions	I kept on going back and forwards and stuff, whereas in this one, it felt different. I felt more kind of happy to just like, well you couldn't go backward, so you just, ok where this gonna go. So, yeah, it's sort of different.
Novice limitation\Don't want risk	I kind of have the feeling, if you do this in the future, it's hard to queue like on correct beat. Then when it's not aligned, it's just feel horrible.
Records\Relisten result\Check what was done\Relisten records to double check quality	I know how they work together. So when it play back, it will come at the right time.

Benefit\Learn timing	I learned about the time thing.
Playing Point\Change playing point is reasonable, but it create difficulty	I like the fact that you can go back and go forward, just make it the current time. Makes more sense to me. But it's just when I actually use it, it create some difficulty.
Good Experience	I like the last bit of the music when I found out how the sounds are.
Good Experience\Exciting on the result	I like the last bit of the music when I found out how the sounds are.
Records\Records trigger new ideas	I listen to the previous one, and I create something new.
Novice limitation\Need tolerance/support for mistake	I made these sounds, but these sounds is horrible, but then these sound is still on the timeline. And then I made a new sound, the new sound is much better, so I just want the new sound on the timeline. I don't want the horrible sound.
Records\Relisten result\Relisten is very important for learn and create	I mean I know what I liked, or if I wanted to have one sound go away and then come back again.
Playing live\Have less confidence when play live	I mean it's maybe hard to have confidence in what I'm doing as well.
Playing live\Playing live when confident	I mean sometimes when I felt confident enough I was playing on the current time
Novice limitation\Barriers-memory	I mean, you don't remember which one it is.
Novice limitation\Lack of confidence	I mean, I don't have any musical experience, I don't play any instrument. So I, in general I don't feel confident.
Playing live\Playing live need less previous information	I only went to the future.
Interaction\Creation of interaction\Pause because can't go back	I pause it, often, because I noted if I play, then I can't come back anymore, so I have to be careful when I play.
Quality\Care about the music quality	I pause it, often, because I noted if I play, then I can't come back anymore, so I have to be careful when I play.
Readiness time	I pause it, often, because I noted if I play, then I can't come back anymore, so I have to be careful when I play.
Playing live\Enjoy playing live	I prefer the first one, because live, and then I just press it and a bit straight over.
Concepts\prefer compose mode	I prefer the previous one.
Plan ahead\Can't work on plan ahead\Need to secure timing when plan ahead	I queue something up in the future, I queued it, and I queued something up for that, I thought that will come soon. But I was just waiting for a while, I wasn't sure when does it actually gonna come on.
Timeline\Future timeline helps to explore	I queue that up just because I was more interested in this button, so I wanted to see what it do.
Records\Relisten result\Check what was done\Relisten records to double check quality	I re-listened all of them, my. R: Oh, so you re-listen? When you start, you re-listen what you've done? P: Yeah, I was listening at the beginning, and then I went back, and I re-listen. R: Why do you want to re-listen it? P: To see if it sounds good.
Interaction\Creation of interaction	I realise you could make a sound come on in now while pressing the button. So you could sort of do that one, do-do-do (figure demo), you know, you could have it playing. And then do it like an instrument too if you like.
Timeline\Timeline helps to structure ideas	I should be able to structure the ideas.
Novice limitation\Barriers-mapping	I still haven't learned the mapping of which one was what to get to like the fourth red sound. And I thought, then one part of it went done and I was like it supposed to be on, I don't think it wrong.
Plan ahead\Can't work on plan ahead\Need to secure timing when plan ahead	I still havn't properly figure out the rhythm. So often, I queued it up, but I will be slightly our of sync.
Good Experience\Exciting on the result	I suppose getting it to actually sound like something, rather than just a load of noise.
Process\Explorative process	I suppose I started with some stuff, cause there is particularly this one I quite like, this kind of like tech-noy, but then that didn't fit with some of the other sounds. So I started at one point to go back and go along to try this one on and turn that one off. So basically pretty much try and error.
Timeline\Timeline indicate what's going on	I suppose it was easy for me to see what was playing. Cause I know the lights turn on which one was playing, or whatever, but I suppose it's easier for me to see it on the actual timeline, what was going on.
Playing live\Playing live is easier because it's responsive	I suppose it's really easy to do at the current time, cause you can actually hear it.
Playing mode\Shift strategy	I suppose it's the same, in a way, except I wasn't just playing it as it was going, I was actually, I wasn't playing just one long piece of music, I was trying actually, it was shorter, but I was trying to make the sound, I was going back and make the sound ok, sound better, in the actually, in the short part I did, yeah. Rather than just one long experimental music, yeah.
Playing mode\Different interaction modes between versions	I suppose it's the same, in a way, except I wasn't just playing it as it was going, I was actually, I wasn't playing just one long piece of music, I was trying actually, it was shorter, but I was trying to make the sound, I was going back and make the sound ok, sound better, in the actually, in the short part I did, yeah. Rather than just one long experimental music, yeah.
Playing mode\Different interaction modes between versions	I suppose one thing I did try and do was kind of like, cause before I got the loops, I was playing the whole sound. And this time I try to kind of just play part of the sound, and like kind of start and stop it quickly, to kind of create I suppose a different beat, or something like that.
Process\Experimenting	I suppose that you can experiment with different ones
Good Experience\Exciting on the result	I suppose when you do just get something that actually sounds ok. When you get something that is, to perform not just a big mass of sound. Actually kind of fits in with the beat in the melody and, that kind of stuff, in the tune.
Plan ahead\Plan ahead is easier	I think actually, planning ahead is easier. So the future is actually good.
Quality\Short/long samples secure quality	I think all of the features helped to, for me to understand how I can create things. So it was good that these are short, these are long, so even without knowing what exactly they play, and knowing these two give like certain correctlistic to some music I want to produce.
Process\Explorative process	I think at first I just layed out some of the sounds, to sort of hear what they sounded like.
Sound design	I think at the end what happened was that the leads were always leads. And then leads I use them either to compliment, to put something, or when I was going from one lead to another lead. Maybe that was the support from this one for a second, and then another lead, and stuff like that. If I was to take away this, and add this, in between maybe there is, kind of like a support
Playing live\Playing live is more accurate	I think current is more accurate, cause you can stop whenever you want. You listen and you are like, ok stop here, I wanna add something.
Playing live\Better result from playing live	I think for me doing that kind of live stuff, it was easier to get like a good sound out of it.
Plan ahead\Enjoy planning ahead	I think going into the future. I definitely think going into the future, because somebody who is awesome at this for example, could compose a whole thing ahead of time, and just wait, you knowl like, it just more satisfied for the person who has created it for example.
Playing live\Enjoy playing live	I think I enjoy much more for the first one
Readiness time	I think I have to be a lot quicker. Yeah, because I can't go back, so when I have a sound and I want to put another sound over it, this one, at the same time, I have to be very quick with that.
Playing mode\Compose is more creative than play live	I think I just messing around with it. But in this one, I was actually trying to make sounds, cause I was trying to go back and change things. I think editing is quiting important. Yeah.
Concepts\prefer compose mode	I think I probably prefer more, you know, the kind of composing and then listening.
Playing live\Enjoy playing live	I think I won't do it much because I'm used to do something along with the time.
Playing mode\Shift strategy	I think I've seen more hearing. I improvise more through hearing. Last time I improvise more through seeing.
Playing Point\Changeable playing point provide more choice	I think if I can change the time and jump to the time where I want, it's better, you know there is more choice for me.
Plan ahead\Plan ahead allows more creativity	I think if you can, cause I felt if I was able to use my imagination, again, for me, it makes it easier
Plan ahead\Plan ahead triggers imagination	I think if you can, cause I felt if I was able to use my imagination, again, for me, it makes it easier
Concepts\Concept of composition	I think if you want to create an actual piece of music, I mean, yeah, cause it helps like, add things at certain times. The way I was doing it, I mean, if I'm just playing it at the current time, I could just add at that point, but if you actually composing a piece of music, it would help you to change things like that, at different times I think.
Plan ahead\Plan ahead helps to compose	I think if you want to create an actual piece of music, I mean, yeah, cause it helps like, add things at certain times. The way I was doing it, I mean, if I'm just playing it at the current time, I could just add at that point, but if you actually composing a piece of music, it would help you to change things like that, at different times I think.
Rely on listen	I think is a lot more that I'm listening, a lot more. Because I can't go back, so I'm listening, and I'm kind of trying to think where I can put in the sounds. So yeah I'm listening to it rather than relying on the fact that I can go back, and listen to it again.
Concepts\Concept of playing live	I think it depends on, like playing live means also if other people are here, if it's a performance then I can't just stop or go back do the things.
Timeline\Visual guide music creation	I think it help me because sometimes was like oh, I have a lot of red, what if I tried to add another one that, you explained me that it's gonna be a different type, so it can be more rich or
Plan ahead\Can't work on plan ahead\Not sure what's going to happen in future timeline	I think it is strange to just jump to the future, because you don't know what is going to happen in the middle of things.
Timeline\Timeline helps to structure ideas	I think it lets you structure things in a way, so you can say I want this sound to happen before this amount of time, and then I want the other sound to happen for the same amount of time. So it lets you to do things like that, of like having, being able to approach a piece kind of more mathematicly
Process\Explore music ideas	I think it makes a big difference, because you can go back, you can create something, and you are not so, like kind of, you are not so much in a hurry in a way, because you kind of build up things, and then change them and then just go back, and build in the stuff that you have been creating, or something, like that.
Good Experience\Exciting on the result	I think it was the best for me. Like, I felt like I actually created something, rather than just a little bit, a little bit, a little bit, and then it didn't look. So I was starting to compose, like a natural structured composition.
Concepts\Concept of composition	I think it was the best for me. Like, I felt like I actually created something, rather than just a little bit, a little bit, a little bit, and then it didn't look. So I was starting to compose, like a natural structured composition.
Benefit\Learn how music is	I think it would be useful, like to think of music now, how it is.
Playing live\Playing live is easier to learn	I think it's probably slightly easier. Because, I don't know, I didn't spent as much time jumping back and forwards.
Playing Point\Change playing point leads to deeper music exploration	I think it's the go back and forth, because you can see how everything sounds together, and then change it if you need to
Satisfaction grow	I think it's when I found finally could get soemthing on it. It means I can choose something on it, it's not random choose.
Consider sounds more when knowledge grow	I think now I understand the box a bit more. I think I was considering sounds more. So I wasn't playing them all together, so I had one sound on for a long time, and then after that I wanted to add more sounds. But before I was just adding everything, so I'd say maybe I did more on the music.
Interaction\Need more control over sound	I think sometimes I want to make the volume different, you know.
Process\Creative process - explorative	I think that's in the end how I felt a bit better about doing things, to create things in the future, and then listen to it.
Creativity\Constraint encourages creativity	I think the second one pushes you to be more creative.

Playing live\Playing live test ability	I think the second one really test your ability. I kind of find it's more enjoyable I think.
Playing live\Enjoy playing live	I think the second one really test your ability. I kind of find it's more enjoyable I think.
Process\Music ideas emerges from random exploration	I think there was one or two bits that I like. They worked well together. So I did that a few times. So yeah, I got few ideas from there. That was good.
Creativity\Creativity grows with understandbility	I think this one. Just because you understand it more, so you know all the sounds, so you can change it about.
Timeline\Timeline provide control	I think through out the whole thing, I was using the scroll feature more than anything else. Cause it gives you so much control, you can go anywhere on the timeline, you can do whatever you want. So it's like the main thing, this is the main thing, the most important thing. yeah.
Playing Point\Change playing point is most important for creativity	I think to be creative probably is the timeline, just change the timeline in different position.
Timeline\Need visual to help sync sounds	I think visually it would be useful to have some kind of grid.
Timeline\Highlight help to learn to play	I think what helps me was the highlight for sure. Learn, I mean, learn how, because it helps me to learn how to play this.
Good Experience\Exciting on the result	I think when I played it back, and it sounded ok. So I was like, OK.
Playing live\Enjoy playing live	I think works better for me, actually. Because, um, not better in that, maybe I was doing more simple stuff, but it was sounding better.
Novice limitation\Can't think at the same time while mucis is playing	I thought it was quite good, because sometimes the music was bit like, it was difficult to concentrate to figure out what button to press next.
Readiness time	I thought it was quite good, because sometimes the music was bit like, it was difficult to concentrate to figure out what button to press next.
Timeline\Timeline helps to anticipate	I thought it was useful because I will see the all shapes go towards it. So it was interesting to see them move, so you knew how much time you had.
Good Experience\Exciting on music ideas	I thought this wasn't working as I expected, so some interesting sound, some interesting music came out
Plan ahead\Use more plan ahead in second play	I tried more in the future to edit, and to see what will happen
Novice limitation\Barriers-memory	I tried to you know to cut the notes off, but I feel, I can't remember which button to press.
Sound design	I tried to, I don't know which one it was, but there were two tracks that I left, they were really long, really big. And then they were like the foundation to composition, and then I got not itself small beats, they could be long as well, I just added a little bit of them. One after another, and yeah, that's what I did. I use more short ones I think. The long beats I used just twice. They were the main thing, and then I got lots of the short ones. Lots of them, I just put them in between, together.
Plan ahead\Can't work on plan ahead\Need auto synchronisation for planning ahead	I try to put for instance some instruments in the future. When it started, actually, it started but, for instance not on time, the fact that it's kind of free on the timeline.
Interaction\Creation of interaction	I try to put multiple short ones and multiple long ones at the same time, and see what would happen.
Knowledge grow	I understand it by my own, and I think the red line obviously means the current time, and the yellow line is where you want to edit it.
Used timline more in indepth creatopm	I used the timeline more cause before I was just pressing all the button, so it was excite to see what's the sounds were.
Records\Records trigger new ideas	I want to do something in the future, but the thing I want to do is based on my previous record. But I can do the same, I just need to go into the future and choose button.
Edit\Didin't use edit	I want to edit when I see the prototype, but this is the first time when I actually properbly try and use it, and I din't want to edit it at all. So that was interesting to me. I don't know.
Timeline\Rely on visual	I wanted to see different patterns and layers, so I started by just playing with the, not listening to it, but just like seeing if I could just put in different little bits, patterns of different beats.
Timeline\Visual helps to explore sounds	I wanted to see different patterns and layers, so I started by just playing with the, not listening to it, but just like seeing if I could just put in different little bits, patterns of different beats.
Process\Explore music ideas	I wanted to see different patterns and layers, so I started by just playing with the, not listening to it, but just like seeing if I could just put in different little bits, patterns of different beats. Just to see what happened. But then when I started listening to it, you could kind of like, kind of heard points in the music where I want to put on another piece. But I wasn't really successful with that, because I guess I wasn't that familar with that, I'll be like oh yeah I will put a, and then I just choose a random sound to put on top of it. But then that wouldn't be the sound that…
Process\Top down process - with structure in mind and fill in music ide	I wanted to see different patterns and layers, so I started by just playing with the, not listening to it, but just like seeing if I could just put in different little bits, patterns of different beats.
Sound design	I wanted to use the long samples, like, No. I wanted to use the short samples, longer. And I wanted to use the long samples, shorter.
Records\Relisten result	I was gonna say listen to the sound result, but in the timeline.
Process\Creative proces is iterative	I was just playing and then go back, and forward again once I'm happy with it.
Timeline\Timeline-previous support evaluate	I was just playing and then go back, and forward again once I'm happy with it.
Playing live\Playing live in the beginning	I was just playing around with it.
Timeline\Timeline allows more concentration	I was like more focused on the timeline.
Process\Creative Process	I was like trying to have it, so I had one beat the whole way, and then I try to add different elements in the future
Getting more focused	I was more focused, I was like ok, 1, 2, 3, 4…
Readiness time	I was playing at the current time, but I was trying to like, having it so in the future, I could hear different sound together. But I suppose I could done that at the actually time. But I was thinking if it was to play back, I want it to have it in certain places, so I was trying to slides. I suppose I could just done it all in current time.
Playing Point\Changeable playing point doesn't matter so much	I was surprised, cause I thought not being able to jump back and forth would be a big problem. But it turned out that it didn't really matter so much. So not that one. I was surprised by how much that didn't matter.
Good Experience\Surprised with the experience	I was surprised, cause I thought not being able to jump back and forth would be a big problem. But it turned out that it didn't really matter so much. So not that one. I was surprised by how much that didn't matter.
Process\Creative Process	I was trying to create, that kind of, ur, a little bit more changes in the filter, that I couldn't do, that I thought I couldn't do in the present, I was trying to make more, a little bit more complicated
Edit\Correct mistake	I was trying to edit it. Instead of doing it on the go, I was trying to edit it.
Novice limitation\Because I'm not a musician	I was trying to imitate what I can, you know, I'm not a musician, but I was trying to imitate what I think I see when I look at the musicial mitation
Imitate musician	I was trying to imitate what I can, you know, I'm not a musician, but I was trying to imitate what I think I see when I look at the musicial mitation
Interaction\Creation of interaction\Use smaller music notes to create	I was trying to just like, use the first, very first kind of note, or the sound of the loop.
Understanding shifting	I was trying to, but then I realise it was total pause, so I didn't want that either. Like, sometimes I wanted that, but sometimes I wanted more like ur, um, almost like a partial pause, something like that,
Concepts\prefer compose mode	I would prefer to stop everything, go somewhere, add sounds, and then go back and listen to the
Quality\Support correctness\To sync samples easily	I would probably be more enjoyed to be synchronised. Automatically synchronised, so if you press the button, and it's not synchronised, it will almost like, put into layers into synchronised, if that make sense. And then start playing.
Quality\Support correctness\Enjoy auto-synchronisation	I would probably be more enjoyed to be synchronised. Automatically synchronised, so if you press the button, and it's not synchronised, it will almost like, put into layers into synchronised, if that make sense. And then start playing.
Timeline\Timeline indicate sound length	I would say the dashes, that tell you how long each sound is.
Quality\Care about the music quality	I'd like to go back and make it sound actually ok. So I'd like the whole piece sound ok, not just a bit of it.
Records\Relisten result\Check what was done	I'd like to hear what I've done. It lets me to be sure, maybe.
Timeline\Visual indication support edit	I'd say more like edit better. Because I remembered which sound I liked, I could see on the, which bar it's on. That allow me to choose it.
Process\Music ideas emerges from random exploration	I'll be like oh yeah I will put a, and then I just choose a random sound to put on top of it. But then that wouldn't be the sound that
Timeline\Timeline helps to plan	I'll say it helps me to, you know, plan something, before I can hear them
Playing mode\Different interaction modes between versions	I'm always playing everything, sort of at that time. Since if I changed it in the future, if I put things in the future I didn't like, I can go back and change it again. So I sort of did everything at that time instead of queue it up really.
Playing Point\Changeable playing point support more exploration	I'm more likely to actually lay out more sounds on top each other.
Process\Creative process - looping	I'm spending most of my time in like, so the timeline is here, I spend my time in like here, and I was just like going here and then started again here.
Knowledge grow	I've try different ways, and finally I figured out how to edit them.
Playing live\Playing live for novice is difficult to output good quality	if I could go back in time, then play with it once, I think for actually creating a nice song, it would be really good to have the timeline. When you say timeline, do you mean you can go back and forth?
Timeline\Timeline helps to anticipate	if I want to anticipate something, if I want to plan ahead, say ok I like in two seconds, the sounds gonna start. That something it's useful.
Timeline\Timeline helps to plan	if I want to plan ahead, say ok I like in two seconds, the sounds gonna start.
Concepts\Concept of composition	If I were to make a composition, I would actually want to go, like after I'm done, sort of done, I want to go back and relisten to it, to change it, you know. Actually, in that sense it would make sense to able to go back into the past.
Records\Relisten result\Relisten is very important for learn and create	if it was play back, it would sound like, I was kind of like, recognising which sound is which button.
Interaction\Pause cause discontinuty	if you are in the middle of something, if you cut music off, it create some discontinuty.
Changeable playing point helps to orient through timeline	In fact using these ones was really helpful for orienting myself with the timeline.
Playing live\Play live need more skill	in real time I have to use my senses, and my ability to react and press it when it's supposed to be pressed.
Playing mode\Compose mode involves relisten	in the previous one I queued things up in the future, and then listen to it again to see if it's too far apart or too close together.
Process\Creative Process	in the second prototype what I did was like, ok, so the, I was playing here, so I went to here and then I start playing this and this, two at the same time. And then I left that recorded for a while. You know what I mean. And then when this goes to here, and it starts playing both at the same time. I don't know if I could have done it with the other one.
Good Experience\Surprised with the experience	In this one, you have this timeline sort of go where it is going, which I thought it would be really limiting, but it actually didn't make as much difference as I thought it would.
Playing mode\Different interaction modes between versions	In this version, I will put things in the future. In that version, I will put things in the past.
Playing live\Non-change play point force ability grow	Interface is a little frustrating just that you can't change the playing point, but maybe I have to estimate what time do I change this.
Records\Reuse records	is to go backwards in time, and select a piece of timeline, and loop in that. So if you like some part that you have done, just loop on to that, and have that, you know what I mean, like, make it as a loop pool, separetly and continue to play, that will be good. Doing loops is always good, I think, in my opinion.
Good Experience\Surprised with the experience	Is when I figure out finally how to add something in the future. And then I found it's a easy work to do.
Edit\Edit support more music combinations and possibilities	it adds another order of magnitude if you can kind of cut the things a little bit and change what they are. Then, you know, you got that many more combinations, or possibilities.
Playing Point\Non-changeable playing point is less control	it also made it, it's difficult to know how much, it took me off to get the control, so having got the controls, it's difficult to know,
Edit\Didin't use edit	It didn't come up in my head that I wanted to do it.

Timeline\Visual support recognise sound	it does a bit because at some point I notice like I was looking at it from the fact that some parts have been playing for a long while, I could see that oh, yeah, this has been going on so probably this is the sound, or it can help me recognise the sound sometime, so that I knew which one to turn off for instance.
Playing live\Playing live more intuitive	it felt a little bit more intuitive.
Timeline\Timeline indicate what's going on	it indicate where I am and how long have I edit some music, I think. In this way it truly helped me.
Playing Point\Changeable playing point allows quick interaction	It is quite important because in this future I need to wait a long time than before one.
Playing Point\Changeable playing point provide more choice	it just gives a lot more freedom
Playing Point\Changeable playing point support more exploration	it just gives a lot more freedom
Task\Task affect the choice of versions	It just really depends if I really want to create something, at the end I wanted to be good, probably the second one. And if I really just want to playing live, like music flow, so would be the first one. I think I enjoy much more for the first one, but yeah, if I want to create something more serious, I will choose the second one.
Timeline\Timeline helps to structure ideas	It makes the structure more obvious, you know, of the music.
Timeline\Timeline as distributed cognition	It means that there is a bunch of stuff that I don't have to remember. Because it's now there, which means I can free out mental space to do other things, you know, to put more attention to other part of the task.
Timeline\Visual remind interaction	it really helps to sort of, helps you notice of what you are doing
Playing live\Playing live allows more concentration	it sort of forced you to be more in the moment with making the music.
Knowledge grow	it was a tiny bit more order because I was using the same buttons.
Process\Experimenting	it was experimenting
Process\Serendipity-create strategy	it was experimenting and I put one, and then I pressed another button, and then I put started all at the same time.
Timeline\Timeline helps to plan	It was good mix. Cause then I can, it helps me think what i want to do as well. If i want to like, have melody and get some sharp drums in and then, yeah.
Records\Reuse records	It was like, you can reuse ideas. And you can kind of improve them or change them. So that's really useful,
Less possibilities support concentration	it was more like less possibilities, and actually made me more focused on just.
Interaction\Interaction is easy	It was really intuitive, I could tell, if you maybe have experience with this kind of thing before, or you knew more about music, you'd be better.
Concepts\Concept of composition	it's a time sequence, so it's just a way that music is created.
Benefit\Lean making music is easy	It's easy.
Edit\Exploring sound combination by editing	It's I wanted to extend like a base sound, for example, I wanted to have that running the whole way, or something, and then I wanted to see how with the base sound, how different sounds work together, so then I was cutting this,
Edit\Edit provide flexibility	It's just that ability to, if you do something, but then you find a better sound, or you want to change it slightly. You have that flexibility to go back, and to kind of go back and fit with it and play with it a bit more,
Playing live\Play live is experimental	it's not just one long timeline, of like experimental music
Playing mode\Compose is more creative than play live	it's not just one long timeline, of like experimental music, it's actually creating a piece of music which you can go back and change, rather than. So it's actually, so the start would be good as well as the end, rather than just having, start loads of different sounds, and then try to work it out toward the ends.
Novice limitation\Barriers-timing	It's probably because it's really difficult to time everything perfectly.
Enjoy explore sounds	it's really nice just to explore different sounds, it's really cool. So yeah, I really like that.
Attractor	it's really nice just to explore different sounds, it's really cool. So yeah, I really like that.
Process\Music ideas emerges from random exploration	it's that I don't have control on the sound itself, so my only way of working on this is combination on the sounds or on the timeline. So I was planning in advance what's gonna happen. And even if I didn't remember the sound itself, I was more workly on the button rather than the, and then if the sound was ok, I remember, you know, there are like, and major more, and melodies, some short some long. Trying to work in that way.
Interaction\Constraints leads to creation of interaction	it's that I don't have control on the sound itself, so my only way of working on this is combination on the sounds or on the timeline. So I was planning in advance what's gonna happen.
Novice limitation\Barriers-memory	It's working properly, just like sometimes I'm not sure which, I forget which line is which line.
Process\Explorative process	Just experimenting with how the sounds work together. And until I got one sound that I feel sound alright. At the start my sounds, why it won't get together, because it's just, I was just testing it,
Frustration	Just I think I can not express my ideas, it is.
Ability grow	Just I think my ability to kind of to use it got better because more time.
Sustainer	just like I recon you would probably get into it, and you could build up structures really nicely.
Timeline\Timeline helps to structure ideas	Kind of give you structure or idea, then you add things or delete things.
Plan ahead\Rely on visual when plan ahead	Last time I improvise more through seeing. Because the timeline wasn't there, you can't change the timeline, so it had to be more visual, go ahead to do. Without the timeline had to work more. But here the timeline it does the work for you, so reduces stress that you would have.
Playing Point\Changeable playing point reduce rely on visual	Last time I improvise more through seeing. Because the timeline wasn't there, you can't change the timeline, so it had to be more visual, go ahead to do. Without the timeline had to work more. But here the timeline it does the work for you, so reduces stress that you would have.
Edit\Edit support to explore	Like extending the sounds to get it longer. Or reducing that sound. And extending another sound maybe. Like I said, just trying.
Records\Relisten result\Relisten is very important for learn and create	like I feel like maybe the first time when I hear it it sounds good and when I go back, I might think actually I want to change this because it will sounds better with the next section that I've composed.
Sound design	Like I had that, this one I think, just a couple of times to add it in as part of a beat, to make a different sound actually;
Process\Serendipity-create strategy	Like I had that, this one I think, just a couple of times to add it in as part of a beat, to make a different sound actually;
Interaction\Interaction is easy	Like it's really cool, rather than a basic keyboard. It's easily to be able to get to all, it's really easily.
Benefit\Learn making music could be fun	Like that it could be fun, I didn't realise that.
Timeline\Timeline remind the sound	Like when you listen to a specific track or button, and it gets highlighted. So if I like that one and I can't remember which button it was, just see which one was playing, from that sound I guess.
Records\Relisten result\Check what was done\Relisten as an approach to evaluate previous creation	listen to it again to see if it's too far apart or too close together.
Rely on listen	Listening to what I'm doing. Trying to feeling the box. Try to understand what I can get out of the box.
Playing live\Enjoy playing live	Literally, just play, you know, with the flow.
Playing live\Playing live is easier because it's responsive	live, I could just count and doing, na, na, na, start, you know.
Timeline\Timeline helps to create	Maybe definitely it gives you more space for exploring your composition part, you know.
Timeline\Timeline helps to learn how sounds play together	maybe it can help me sort of learn how things will play together
Records\Records trigger new ideas	Maybe just different ideas that maybe I can do something differently.
Good Experience\Enjoy explorative result	maybe that's because I'm quite, you know I have tried more in the last time, and I think in the second time, the possibilities, I think I have found in the las time I have used in the second one, but last time I think I had more fun, because I'm quite new when.
Good Experience\Appreciate the results	More like relistening, and hearing the sound, appreciating the sound, you know
Readiness time	Most of the time, I switched forward, so I can pause in the future, and then saw what happened.
Interaction\Interaction is easy	Mostly because you can actually rup it with your hands, so still, I think it might be something interesting in the button, and in the way you reach the buttons with your hand.
Playing mode\Use more future timeline	Much more in this one. Because I knew in my head that I couldn't go back, so that I thought in this one I had to queue a lot more.
Process\Creative process is trial and error	My creation process actually is still like a trial and error thing
Process\Creative process-playing live	My, just adding sounds like on going. When I was playing one, I will add others. And remove some. Add others, and remove. Try to remove all of them, and then play a different sound.
Frustration	No, I didn't like it mostly because I wouldn't able to do what I want. So basically I was trying to do something, and then it wasn't doing what I wanted.
Process\Creative Process	Not like, some of them, I was just want it from the begin to the end. And some of them, I found that I want the begining of the sound, instead of the whole sound. So I press that, becuse like, you know when you press you hold there right, so I was like start and stop, start and stop. It depends on how long I want it, or which bit I want it. That's what I did.
Understanding shifting	now I find out that you can just add sounds by scrolling. And know that you gonna lay them out, so that you can just keep them on, and keep playing.
Process\Experimenting	Now I put randomly
Benefit\Learn making music could be fun	Now I quite interested. I feel like I'm looking into it.
Benefit\Learn timing	Oh, the main thing is, listen to beat. I learned to listen to beat, timing. Because like, some of the beat is four beats, and then if you want to, like put everything together, like smooth, in a good timing. Like for example you want to have the first one, two, three, four, you want to add other sound, so you would like, most people like me, and they would prefer like one, two, three, four, and add another two, two, three, four… I don't know why, sometimes it's gonna be like, a bit messy.
Timeline\Future timeline helps to explore	One of the main reason I did it was because I wanted to kind of get ideas, when I queue stuff up in the future, I don't know what it's gonna sound like. So if I hear it and I find something I like, that I thought maybe I could use that again. It's just random. So yeah, it's just about finding new ideas. But if I doing the current, I know what it sounds like, and it's like you know, the same thing. But if I do random stuff in the future, I can hear stuff I don't even know what it would sound.
Records\Relisten result	One thing is really good was being able to go back and listen, definitely. That was I suppose the biggest thing.
Records\Records helps to create	or I want to add something into it or take something away, and see how can I improve it in the future.
Records\Reuse records	Or more like reusing, here I can reuse the ideas in the since that I can, the idea that I came up first, I can go back and change it, so I can use what I have, in that since, yeah.
Edit\Edit provide flexibility	Or to make them longer, or to produce the gaps, this kind of things.
Readiness time	P: I guess it helped a bit. But the thing is, like the things I want to queue in the future, sometimes is not a one events. And before I can figure all the events, how to align everything and the timeline just R: reach? P: Yeah, the future become the past. R: So you don't have enough time in some sense.
Timeline\Timeline indicate sound length	P: It helps cause like when there was a time I wanted to match the tracks all together. So the timeline help me establish how long I want each track.
Timeline\Timeline helps to create	P: It helps cause like when there was a time I wanted to match the tracks all together. So the timeline help me establish how long I want each track.

Process\Creative Process	P: It, I think it makes a big difference, because you can go back, you can create something, and you are not so, like kind of, you are not so much in a hurry in a way, because you kind of build up things, and then change them and then just go back, and build in the stuff that you have been creating, or something, like that. So you could like, do something like, start creating something, even if it's not totally finish, you can play it, and then kind of try to improve it and then play it back, you know. So you can kind of, you see a repeat idea that you were trying to do.
Process\Creative Process	P: No, no I know. But it's something I enjoy to do with this, that I set a certain rhythm, or a group of sounds playing together, how do I move on from that, because that is repeating, right, it's the same thing over and over. How do I go from that to something else. Try new playable thing. R: Right. How did you use that to do something like that? P: And then I just, maybe I said, ok, I think I remember that these is the sound, so I'm trying to take it out. And see, what I listen and maybe add something else, and make. It was like, deciding which one is the top leading thing, and say oh, he is leading the thing, maybe I'm gonna put another one that is also leading and then I'm gonna take that off, or the other way around, that I'm gonna change what is at the buttom, and see what changes and then I'm gonna change the lead or these type of thing.
Process\Explorative process	P: Ok, so being to change the play point. What I ended up with was just like, I go back here that mark aound with stuff, so that was never gonna be part of the song. You just have like this, garbage, over here, just like, and then you could just like, and then you can start building up something that you can come back to, and play again. So you can like, make a loop. And then put something on top of it and come back. So it's kind of easier to start building up a song. And also experiment cause you can have something in the timeline that you can just skip over. Or then go back to put some stuff in, to kind of...
Process\Explorative process	P: One of the main reason I did it was because I wanted to kind of get ideas, when I queue stuff up in the future, I don't know what it's gonna sound like. So if I hear it and I find something I like, that I thought maybe I could use that again. It's just random. So yeah, it's just about finding new ideas. But if I doing the current, I know what it sounds like, and it's like you know, the same thing. But if I do random stuff in the future, I can hear stuff I don't even know what it would sound.
Timeline\Indications of what is going on helps to compose	particularly with the composing thing, you can see which sound is on and off at each time, and yeah, that helps a lot.
Edit\It cause time to go back to edit	Possibily, for instance one of the things I would say that is to go back into time, you need to scroll, scroll, scroll, so you need time to go back or to go forward. So that's affecting the performance.
Novice limitation\Can't think at the same time while mucis is playing	Rather than current, because then the sound, I'm not planning, it's happening at the same time. There is lots of sound. Too many sounds at once. To think as well.
Playing live\Playing live need to think with sound playing	Rather than current, because then the sound, I'm not planning, it's happening at the same time. There is lots of sound. Too many sounds at once. To think as well.
Records\Reuse records	reuse different ideas and then make new stuff.
Timeline\Timeline helps to anticipate	See the length of the note, when the sound end.
Timeline\Timeline indicate sound length	See the length of the note, when the sound end.
Gain confidence with more understanding	So a little bit, more confident
Process\Buttoms up process - from random explore to compose	So did you queue things up in the future? P: I think I did in the beginning. I did a lot random stuff. And then later on, I did current stuff.
Process\Music ideas emerges from random exploration	So first I was trying with different keys, and I found one that I liked. And then I put it on the background. And then I was just randomly choose some to put into the future, and listen what happen. And then to come up with better ideas about how to put things.
Process\Explorative process	So first I was trying with different keys, and I found one that I liked. And then I put it on the background. And then I was just randomly choose some to put into the future, and listen what happen. And then to come up with better ideas about how to put things.
Edit\It cause time to go back to edit	So I guess that my problem is not really, because I just put too much random things together. It doesn't really sounds well, and it cause time to go back.
Playing live\Less worry about mistake when playing live	So I just, I think I got less, I was less worry that you know, I add a sound, so you know, it can sound really cool, or it can sound really stupid.
Can't make mistake with non-changeable playing point	So I knew which one I wanted, so I wasn't making mistakes, because I can't really change, once it's done, it's done.
Novice limitation\Need time to think	So I need to pause to figure out what I need to do next.
Records\Relisten result\Relisten is very important for learn and create	So I need to, if I want to create a very good piece of music, I have to go back to review what I have done, and I have to edit them. But if I put everything in the future, I don't know what exactly I have done.
Edit\Need for edit, delete	So I need to, if I want to create a very good piece of music, I have to go back to review what I have done, and I have to edit them.
Concepts\Concept of creating music	So I need to, if I want to create a very good piece of music, I have to go back to review what I have done, and I have to edit them.
Interaction\Creation of interaction	So I notice that you find this way of playing, you can start and stop everything together,
Sound design	So I started with the green like bo-chi-bo-chi [sing], add a red one and add a white one. Because some of the white ones was like bit of short, I think this, or this. They would add instead of a actual base drums, they would add like a tiny gaobell, or it's like a caoball, like a highhat or something. So to me it's more of like a detail. So I would add them later.
Less possibilities support concentration	So I think it was just more, not being able to go back, and sort of like you know, constantly re-evaluate the thing made the process more immersive, and like it was easier to sort of get into it more, because you didn't have option of. Yeah, you just sort of have to. So I think that made it more, a more immersive experience,
Novice limitation\Because I'm not a musician	so I think it's mostly because I'm not very musical at all.
Records\Relisten result\Check what was done\Relisten records to double check quality	So I want to hear it again and see if, I did all good
Process\Creative Process	So I was actually all the time, like sort of going into the future, then like listening, listening, thinking oh I'm gonna add this sound, if I would know what it was, no, I want add it, otherwise I would just trying add a random sound. And then, wait and until a good moment and pause it. Then use the red button, I think, to get the timeline straight
Sound design	so I was looking at when main exactly one stop, so I could just start a new one at the same time.
Timeline\Visual remind interaction	so I was looking at when main exactly one stop, so I could just start a new one at the same time.
Plan ahead\Plan ahead helps to create	So I was planning in advance what's gonna happen.
Timeline\Visual remind interaction	So I would have realise that I had put a drum beat quite that long. And then I liked it's playing but I forgoten, and then I'm putting in some other stuff, and then it's like oh that's gonna stop.
Timeline\Timeline remind the sound	so if like two sounds on at the same time, playing both at the same time, what are they sounds like together.
Edit\Need for edit, delete	So if you are not happy with somehting, and you wanted to change it, you can change it, but you can't get rid of it.
Playing live\Playing live more intuitive	So in the present, it was easier to remember that, because you just press it, you know. So you remember is this one does this.
Process\Buttoms up process - from random explore to compose	So is that in the begining you are like exploring, in the end you know what you want, and then you pause it and then you put something that you want.
Timeline\Timeline allows to approach music visually	So it lets you to do things like that, of like having, being able to approach a piece kind of more mathematicly, I suppose, which you know, again, not a musician,
Records\Reuse records	So it was a lot better being able to put the cursor, the current time back, and skip it back, and then play it through something, and skip it back,
Quality\Support correctness	So it was good that these are short, these are long, so even without knowing what exactly they play, and knowing these two give like certain correctlistic to some music I want to produce.
Unsure about what to do	so it was still like, I was unsure.
Dissatisfied with result because of unsure	so it was still like, I was unsure. So which is why I wasn't really happy with my creation.
Records\Records remind the sound	So it's a constant reminder of what I've, not what I've done, but the sound from before.
Concepts\Build up a song	So it's kind of easier to start building up a song.
Plan ahead\Less pressure when plan ahead	So it's not that much pressure on them, they created something in the future, and then they can create more.
Playing live\Enjoy playing live	So like when you play lively sounds, I find that was fun. That was probably more fun just because you are experiencing with different sounds.
Playing live\Experiencing with different sounds when play live	So like when you play lively sounds, I find that was fun. That was probably more fun just because you are experiencing with different sounds.
Timeline\Timeline support to interact with music through structure	So maybe it makes a little bit easier to kind of interact with the music. The think in that way, because you got like a structure to work with the timeline.
Plan ahead\Plan ahead helps to create	So maybe scroll to the future to see what shall I do at this point, or what shall I clear.
Sound design	So one thing I was doing, so having one sample going on top of another sample this long, and have another sample going from there.
Sound design	so that it sounds like flowing,
Quality\Care about the music quality	So that would be really good for actually making something that is musical.
Records\Records remind the sound	So the only reason for me to go back was to just quickly listen to the sound, and remember what it was,
Edit\Edit support to play live	so there still has a way to do it live, like you can edit, so that the four would start at the same time. You could do it in the other one, but you'll fight against the clock.
Process\Creative Process	so what I did first was like, oh, quickly listen to couple of the samples, like oh yeah, this one I'm gonna use, this one I'm not gonna use, then I started out with the beat, and then I added like a base, or this melodic sample that sound like do-do-do[sing], and then I try to add some tinny details.
Timeline\Timeline-previous support evaluate	So what I had is like, oh, here was a piece of black with all kind of sounds and then I was like oh, yeah, this is not good. So I'm gonna throw it away.
Edit\Edit helps to ensure right timing	So when it play back, it will come at the right time. That's the main thing I was thinking of,
Plan ahead\Enjoy planning ahead	So yeah, I prefer not that way but kind of compose in advance.
Process\Music ideas emerges from random exploration	So yeah, it's just about finding new ideas. But if I doing the current, I know what it sounds like, and it's like you know, the same thing. But if I do random stuff in the future, I can hear stuff I don't even know what it would sound.
Playing Point\Changeable playing point allows quick interaction	so you could like getting into a pattern that you have created, and then go ahead and kind of, this thing I was trying to do about the stopping some sounds and not the others, you could do it very easy. Because you could have like 4 sounds here, 2 sounds here, and instead of having to delete one by one, the other two, you can move here and then move here, and you are changing between 4 sounds and 2 sounds, instantly, you know.
Playing mode\Compose is more creative than play live	So you feel it's more secure, in some sense.
Process\Creative Process	so you know when you queue and immediately go through a bit, when you have enough of that, you can delete the sound and then make another sound. So like just change it over.
Starting base	so you start by queuing things up, because you kind of created a structure for starting. And then you are playing current.
Process\Creative Process	so you start by queuing things up, because you kind of created a structure for starting. And then you are playing current.
Records\Records helps to create	So you think that helps you to create? P: um-hm. (yes) R: because you know what's happened.
Sound interact with each other	So, for example you have one sample at this point, and another sample that point, it just like, it can make interact with each other in different ways.
Novice limitation\Can't think at the same time while mucis is playing	So, yeah, what is difficult for me is both the time keep is still playing, and then to add some stuff in the future.
Quality\Support correctness\To sync samples easily	some of them are like, so the beat ones, there is no way to get them in sync easily. But
Process\Creative Process	sometimes if I want a break in between, so then I will go to the future to put sound in, whilst the other sounds are playing, so then I could see how it transition to the next one.

Interaction\Need more control over sound	Sometimes the only thing that I think I would have like to do is change the volume of the different things. Because I found these things quite loud, compared to I think these things.
Novice limitation\Barriers-timing	sometimes when you start a track, or you've got one playing, so you start one, you've got to be perfectly on time to press the button to actually get it to start. Like an actual line up on time, … for instance, so the beat go to the music, type of thing. And some of them just didn't line up at all, I guess.
Novice limitation\Barriers-memory	sorry, one thing, obviously because there are 16 samples, I forgot, like, you know, Oh, what was the sound again. So I tried it out sometimes.
Readiness time	Specially because you are chased by time.
Timeline\Timeline helps to create	that they all make interesting sounds, but none of them has a timeline, so you have to just sort of, yeah, it's quite difficult to make real music, unless maybe you have a metrolo or something. And then that it's not, so yeah, I do think the timeline is helpful.
Concepts\Interesting sounds don't make real music	that they all make interesting sounds, but none of them has a timeline, so you have to just sort of, yeah, it's quite difficult to make real music, unless maybe you have a metrolo or something. And then that it's not, so yeah, I do think the timeline is helpful.
Records\Relisten result\Check what was done\Relisten as an approach to create	That you can not go back and listen, that you can not go move around and listen to the sound.
Timeline\Timeline indicate what's going on	the bar that show you which one is playing
Novice limitation\Barriers-mapping	the connection between the lines and the buttons wasn't that clear.
Ability grow	The difference that I was more used to the tool. So I could do a little bit more than I knew before.
Concepts\prefer compose mode	The first one, the composing
Knowledge grow	the last minute or so I started to be like oh, ok.
Sound design	The long samples serves like underneath thing that could kind of keep it going. The short samples kind of build up on the top.
Novice limitation\Barriers-mapping	The ones that were playing, that was my, all the time my problem. Seeing the lines, and it was, ok, I want to stop that line, but I don't know where that line
Novice limitation\Barriers-mapping	The only thing where I think I took a bit longer was that I figured out which button is which line here. Because here everything is top to button and here is, you know, it's the square.
Concepts\prefer compose mode	The other one.
Timeline\Future timeline helps to explore	The possibilities to go to the future, the thing that kind of, allows you to do more
Task\Enjoy exploring sound without task	the previous one I like it more because it was the first time. so I could play, and just without having, to have a composition or something, just playing and listen to the sound, that was nice, and discover the sounds and stuff
Timeline\Timeline helps to plan	The sames the future thing, like, you can plan as well.
Playing Point\Change playing point leads to deeper music exploration	the second one, I kind of tell myself that I can add whatever I want and I just to try if it doesn't work I can always go back.
Timeline\Rely on visual	The shape is really helpful, because basically the shape is kind of move along with the beat, so sometimes I forget when I want to get in or stuff, and I'll look at the shape.
Timeline\Visual guide music creation	The shape is really helpful, because basically the shape is kind of move along with the beat, so sometimes I forget when I want to get in or stuff, and I'll look at the shape.
Interaction\Control over short samples	the short ones, I wanted almost more controls with them. Like kind of stopping, and starting, stopping and starting.
Novice limitation\Barriers-clumsy	The thing is I wasn't fast enough to do what I want to do, you know, because I was a littble bit clumsy. But it definitely, I think it was really good, that you can, especially, I mean, if you are good at this, I think you can do nicely. R: You can go further, like just scroll further and plan.
Timeline\Timeline as distributed cognition	The think in that way, because you got like a structure to work with the timeline. Otherwise you have to sort of imagine it in your head.
Timeline\Timeline indicate the timing	the timing is important when things go off and on. So I can have two sounds work together, I can turn off both at the same time, and get a new one on.
Benefit\Learn concept of making music - collage	The way that, I didn't realise having never made music before, like how much is to do with kind of god reaction, or at least, sort of like just thinking about, just like you would feel that would be something you would put there. I didn't realise that was, well, I never, yeah.
Novice limitation\Barriers-clumsy	Then again, that's me. I'm usually very messy in reordering things. So that might just be me, so.
Novice limitation\Barriers-timing	Then I don't know when it's gonna start. Like I don't have a cue for the time.
Playing mode\Shift strategy	Then I realise I wasn't that good at doing that. So then I started to play more in the present.
Timeline\Timeline indicate the timing	Then I would try to use the timeline to get sort of the timing right.
Sound design\Learn sound	then if the sound was ok, I remember,
Concepts\Concept of playing live	Then live playing is like, I'm just making some music, it's just there in the moment and then I'm gonna throw it away I don't care anymore. So it's like, yeah, just playing.
Records\Reuse records	then you can start building up something that you can come back to, and play again.
Readiness time	then you pause it and then you put something that you want.
Playing Point\Music making is easier with changeable play point & plan ahead	there are similar things now, but those things don't have this future, and coming back and forth. So it's just more easy, it's a lot more easier
Concepts\prefer compose mode	there is more freedom, and I think it's confirm to my habits.
Playing Point\Non-changeable playing point is less control	there is more you can manipulate.
Interaction\Interaction is easy	there were some very intuitive part.
Quality\Perfect previous idea	They can adjust everything properly
Timeline\Rely on visual	think it became more based in a way, it became more based on the screen. I was looking more at the screen than at the, I was thinking less of the buttons and more of the screen.
Interaction\Precise control over timing	this timeline didn't has a, I can not do a precise editing. Only based on my feeling about the time, I don't know how long is this, for a particular length is this.
Timeline\Need visual to indicate sound length	this timeline didn't has a, I can not do a precise editing. Only based on my feeling about the time, I don't know how long is this, for a particular length is this.
Plan ahead\Can't work on plan ahead\Not sure what's going to happen in future timeline	To create something in the future, and then go back, and maybe work on, but then how do I know that thing I created in the future is gonna work?
Concepts\Concept of creating music	to create something, you have to kind of be almost, not a 100%, but to know what to do, what I'm doing, like how to do it exactly.
Timeline\Timeline-previous support evaluate	To figure out if I make things right, if I create some music appropriate.
Plan ahead\Enjoy planning ahead	To go ahead, and then like, remove all the sounds at the same time. Like planning ahead.
Records\Relisten result\Check what was done\Relisten as an approach to create	To make the sound sound better, I suppose.
Plan ahead\Enjoy planning ahead	To plan, like to add add remove some sounds, like by ahead, not at the moment.
Rely on listen	To see if it sounds good.
Timeline\Timeline helps understand sound combinations	two sounds on at the same time, playing both at the same time, what are they sounds like together.
Concepts\Build up a song	ust like I recon you would probably get into it, and you could build up structures really nicely.
Timeline\Timeline helps to structure ideas	ust like I recon you would probably get into it, and you could build up structures really nicely.
Novice limitation\Barriers-mapping	ut sometimes I found a little bit confusing, because the button is all around the side. And there doesn't mention which one is which kind of sound. And you might like, oh, I want that sound, but wait a second, which sound is which.
Novice limitation\Barriers-memory	ut sometimes I found a little bit confusing, because the button is all around the side. And there doesn't mention which one is which kind of sound. And you might like, oh, I want that sound, but wait a second, which sound is which.
Records\Records allow easy recreate previous ideas	Very diffcult re-create whereas this seems like to be easier to make something, and then say I want to make something similar to that.
Timeline\Timeline indicate what's going on	we can see which notes are on, which notes are off.
Sound design	Well just to make a smooth transition. You can't just stop the thing first and then add. That was just my way of thinking the things. So if I add something I feel is fine, I go back and stop something else.
Sound design\Sound design - smooth transition	Well just to make a smooth transition. You can't just stop the thing first and then add. That was just my way of thinking the things. So if I add something I feel is fine, I go back and stop something else.
Lost track of time	Well when you said I can stop, I don't even realise that's 10 minutes already.
Good Experience\Surprised with the experience	Well, at first I found it's kind of frustrating. Because you know I couldn't sort of go back to re-evaluate what I've done. But it kind of also force me to kind of interact with it in real-time, which was really good. That was really fun.
Novice limitation\Need tolerance/support for mistake	what are the sounds I'm gonna use, because once I put them in there, they are gonna be there. So I have to be very careful.
Process\Creative Process	What I ended up with was just like, I go back here that mark aound with stuff, so that was never gonna be part of the song. You just have like this, garbage, over here, just like, and then you could just like, and then you can start building up something that you can come back to, and play again. So you can like, make a loop. And then put something on top of it and come back. So it's kind of easier to start building up a song. And also experiment cause you can have something in the timeline that you can just skip over. Or then go back to put some stuff in, to kind of… Yeah, I don't know, you can imaging like, kind of what a DJ actually does, when they, they are in their headphones basically, so the crowd will be hearing what's coming up the speakers, but usually DJ has headphones on mixing the next part. So kind of imagining, it's like I'm using the big back there to just experiment (in the ways), and then I will put them in the actual thing, and then I'll press play again.
Playing Point\Changeable playing point support more exploration	What I ended up with was just like, I go back here that mark aound with stuff, so that was never gonna be part of the song. You just have like this, garbage, over here, just like, and then you could just like, and then you can start building up something that you can come back to, and play again. So you can like, make a loop. And then put something on top of it and come back. So it's kind of easier to start building up a song. And also experiment cause you can have something in the timeline that you can just skip over. Or then go back to put some stuff in, to kind of…
Good Experience\Exciting on music ideas	When I create something event that sounds really, you know, pretty, with each other, and the beats is..
Timeline\Future timeline helps to explore	when I explored which sound the different parts gave back, I used the future to record like structures
Readiness time	When I first started, this time, I just paused it so that I can queue everything up.
Playing live\Playing live need to be quick	When I first started, this time, I just paused it so that I can queue everything up. But I did not manage in real time to have music playing, and queue things up.
Good Experience\Exciting on the result	When I kind of in the trial one for this one, I felt like I finally managed to make something that I like, so I can get into. I understood how it works.
Timeline\Visual helps to explore sounds	when I kind of realise I havn't listen to all the sounds, then I was just laying them out on top of each other, so I could see it. Yeah, but that was just a way of I exploring the sounds.
Process\Explorative process	when I kind of realise I havn't listen to all the sounds, then I was just laying them out on top of each other, so I could see it. Yeah, but that was just a way of I exploring the sounds.
Good Experience	when I kind of understood what each of the buttons are doing. So that I could control it more.

Benefit\Learn timing	when I realise I was doing, I was using like musical notes, so I would like listen to the sound and it's always eight keys with music, I was using that to know when to introduce the new sound in the correct position.
Use timing to introduce sound	when I realise I was doing, I was using like musical notes, so I would like listen to the sound and it's always eight keys with music, I was using that to know when to introduce the new sound in the correct position.
Records\Reuse records	when I want to play the second sound, I just move the red line to this part, and then I just play it by pushing this black button.
Readiness time	When I was actually playing it, I didn't feel like I have enough time. It was like, oh, no. I havn't got enough layed out in the future as it is.
Good Experience\Exciting on the result	when it sounds good. Then I'm happy. I'm like yeah, this is good.
Timeline\Timeline indicate what's going on	when the sounds coming on, and which one it is as well. Yeah, by the colors and things.
Good Experience\Enjoy explorative result	When you find a bit that you like. It's like, oh, I think I like this one.
Records\Records help learn sounds	Whereas like, if a piano to record what and when you pressed the keys, you know, that would be more useful maybe, than a regular piano where you just have to either know, or learn. And, you know, I think this was doing that sort of bit, cause I can go back and I can see them.
Timeline\Visual guide music creation	whereas when I'm composing I can say oh, look this distance between this sound and this one is the same, you know. Because I can see on the graph
Playing Point\Non-changeable playing point better than it seems	which I thought it would be really limiting, but it actually didn't make as much difference as I thought it would
Need more abstract music notes	would probably approach that now if this gonna be some notes. So it's like I would try and play this whereas this is like I got a set of sounds, so you can not do really explore it, to see what it can do for you.
Sound design\More music genres	yeah you can have like different genres, cause you have like four buttons per different beat, you could have like different genres, you could have a jazz version, different jazz instruments, or you could have different drum kit, you can have drum kit version. Different kinds of drums, it's like 5 different drums that you can, that would be a good idea. Or you can have like three for all, you can have like drums here, jazz here, simple other stuff. So, it's like really… You can mix stuff around.
Quality\Important to be able to perfect ideas	Yeah, cause like it's for me personally, it's more important that you can fix everything, and kind of get everything to match. And get everything perfect. And you can't do that unless you can go back. So you can do it over and over and over and over, you can make it perfect, more perfect.
Novice limitation\Barriers-timing	Yeah, if I only want to play a sound for a certain time. For some reason, I had difficult time to ending it, at certain time.
Sound design	Yeah, or like a drone, or like a base or something. And then you could have like the shorter ones in little burst over the top. So, yeah I was using them differently.
Records\Relisten result\Check what was done\Relisten as an approach to correct mistake	Yeah, so you can hear what you did before and see what needs to be changed.
Records\Relisten result\Check what was done	Yeah, so you can hear what you did before and see what needs to be changed.
Benefit\Learn concept of making music - collage	Yeah. I know how the editor, the music editor work now. Kind of the basic concept of they did. Because for example, you provide CD, the singer, or the music, you need a long long way to process it. And basically I know that some of it are using the similar thing. Like they create background, the base, the drum, or the pinao, and they add stuff more and more together, is so basically I like the concept of that
Playing mode\Different interaction modes between versions	Yeah. Purely because on this one, I was kind of trying to do more. On the first one I was just kind of improvisation, and just kind of throwing stuff in.
Playing mode\Different creation strategies between versions	Yeah. Purely because on this one, I was kind of trying to do more. On the first one I was just kind of improvisation, and just kind of throwing stuff in.
Readiness time	Yes, because I think, oh yeah, I have to do this right in one go, you know. So I want to sometimes think a bit, oh yeah, now. I was trying to figure out which sound was which one.
Concepts\Composing is not in hurry	you are not so much in a hurry in a way, because you kind of build up things
Records\Reuse records\Reuse ideas support exploration	You can more quick try stuff out.
Timeline\Visual remind interaction	you can relisten to it, but also, you can sort of see what you did a bit more.
Records\Relisten result\Relisten is very important for learn and create	you can sort of see what you did a bit more. Whereas like, if a piano to record what and when you pressed the keys, you know, that would be more useful maybe, than a regular piano where you just have to either know, or learn.
Novice limitation\Don't want risk	You can't go back, so I don't want to risk. Because I don't know when it comes here how it would be.
Process\Buttoms up process - from random explore to compose	you could kind of hear, oh I gonna put a bit in here, and you could kind of, I can see how with practice you could really layer up things, you'd be able to see it.
Interaction\Interaction is easy	you don't need to look at it you can just press it, so you can really quickly easy to use.
Creativity\More options leads to creativity	you don't want to be reduced to what you could do, because then it doesn't allow you to be as creative as you want. So with more options, and more choices you can be as creative as you want.
Timeline\Visual remind interaction	you figure out how to start something together, and stop something together? P: yeah, using the timline, yeah.
Timeline\Timeline as distributed cognition	You got, you can sort of like, visually see where you are in the, you don't need to kind of keep that information in your head. It's like out there, so you can you know
Benefit\Learn timing	You have to figure out what's the best point, or which sample to use, or when to stop it.
Benefit\Learn what sounds compliment each other	You have to figure out what's the best point, or which sample to use, or when to stop it.
Interaction\Interaction is easy	you just choose buttons to create music, it's quite easy.
Benefit\Learn concept of making music - collage	You know you must found a key, a basic melody, and you can add different factors alligned, the different elements.
Novice limitation\Because I'm not a musician	you know, like I said I'm not a musician
Interaction\Creation of interaction	You would be able to do it, but you just have to do it far enough in the future, whereas here, so there still has a way to do it live, like you can edit, so that the four would start at the same time. You could do it in the other one, but you'll fight against the clock.
Adapt to system	You would be able to do it, but you just have to do it far enough in the future, whereas here, so there still has a way to do it live, like you can edit, so that the four would start at the same time. You could do it in the other one, but you'll fight against the clock.
Plan ahead\Can't work on plan ahead\Creating in the future is not enough time	You would be able to do it, but you just have to do it far enough in the future, whereas here, so there still has a way to do it live, like you can edit, so that the four would start at the same time. You could do it in the other one, but you'll fight against the clock.
Plan ahead\Plan ahead is easier	you'll have to sort of switch between things manully as it happens, rather than queueing it up as you could do here.
Plan ahead\Plan ahead is easier than manul operation	you'll have to sort of switch between things manully as it happens, rather than queueing it up as you could do here.

B.4 Close Frequent Sequential Patterns

Mnn-Exploraton

0	1	2	3	4	5	6	7	8	9	10	11
saosaosaosa	ssssssss	sasasos	ososasasos	osaosaosasa	sasasos	afopsa	pfpfp		safpf	saosaos	sososososo
sosaosa	sosososo	sasosao	sasososasa	saosaosaosa	sasosas	fsafop	saosa			osaosao	afsaf
osaosas	sosasas	asosaos	sasosaso	aosaosaosao	asasas	fpfpfp	sosos			osososo	
sososos	sasasas	sososos	saosa	osaosaosaos	ososos	opfpa				ssssss	
sasosa	ososas	sasasas		osaoasaosao	sososo	psafo					
sasasa	sasaso	osaoas		osaosaossao	sosaso	safof					
osasa	sasos	ssasas		ososaosaos	ssssss	fafof					
sasao	fsasa	sosass		osaosaosos	saasa	afofp					
osaso		ssosas		asaosaosao	asaas	fpsaf					
		saosa		ososasosa	aasas						
		sssos		saosasos	ossas						
				osaososa	ssass						
				aossaosa							
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				sasaso							
				sosasa							
				sosaoa							
				saoosa							
				asasa							

Mnn-Creation

0	1	2	3	4	5	6	7	8	9	10	11
saosaosaos	sosasosasaso	saosaos	safopsafop	oaosaoao	sasosasosaso	afofpfpfp	saosaosa	afofafofafo	aoaoaoaoao	saosas	sosososos
osaosaosa	osasosasasos	saossao	afopfsaf	osaoaoa	asosasosasos	fafofpfp	oooooo	sssssss	saosaosao	osasas	safsafsaf
saosasosa	sasosasosas	ssssss	psafopf	sossos	sosasosasosa	fpsafof		sssafs	osaosaosa	sasaso	sasasas
sosaosaos	osasasosa	ssssa	sfpafop	assoas	osasosasosas	psafofs		ssafss	saososao	sassos	sasasos
sasosaos	sosasasos	sasas	sofpsof	aoaosa	sosasosass	fopsafo		sasas	saoasa	ososos	sasosas
osasosas	sososos	sasos	psafops	aoaoao	ssasos	afofafo		afssp	osaoa	sososo	sosasos
osaosas	sasofs	ssaos	afpsafp	asasa		safofpf		sspaf		sasos	sasoso
sosasos	bsosos		fsafop	sasos		psafop		sofpf		asoss	osasa
sosasas	sasoso		afopfp	sosos		safopf		pfpaf		sssos	
osasoso	ssbsos		psofps	ssass		ssafof		pafss		ssosa	
sososas	safso		fpfps			pfpsaf		afops		sosas	
oaoaoao	sofsa		fsopf			safops		pssss		osass	
sassosa	fsosa		sapfo			sssafo		pfpfp		ssoso	
sososos			pfops			fafop		fssss		sosss	
osososo			sosos			fpafo					
sasaso						fpfps					
osaoso						fopfp					
sosass						pfsaf					
aosos						fsafo					
osoao											
asass											

Men-Exploration

0	1	2	3	4	5	6	7	8	9	10	11
ssssssssssss	saossaosaosa	sososos	saosaosaosa	spafpo	aosasasosa	fpfafp	sasasas	fpfofsaf	sssssss	fofafofafofa	sssss
spafoss	aossaosaosa	oosos	aosaosaosao	osafo	aosaosasa	afpfop		pfpfpfp	safpfof	ofafofafofaf	sssas
pafosss	ossaosaosao	ososa	osaosaosaos	fosss	osaaosa	fpafpf		ofsafo	ofpfpf	fafofafofafo	sasss
sofsss	ssaosaosaosa	sosoo	saosaosaosas		sasosao	pafpfo		safosa	fpfpfp	afofafofafof	pmpmp
ofsssp	saosaosaosao		saosaosasa		fpfpfpf	fsass		bpfpfp	sfpfp	spafofafof	sosss
fpfpf	aosaosaosaos		saoss		pfpfsas	sasss		safpf	ofsss	safofafo	sssso
ossss	osaosaosaosa		ssaos		aaosas	sssss		fosaf		afofafoo	
sspfp	saosaosasaos		psofp		saosaa					ofafop	
sspaf	aosaosasaosa				osasao					sspafo	
pfpfp	osaosasaosao				osopfp					ofpafo	
	saosasaosaos				opfpfp					sssss	
	saosaossaos				pfsasa					ssssp	
	saosasss				sosas					afoss	
	oaosaosa				sassa					oofaf	
	saosos				ososa					ssafo	
	ososos				saoos						
	aoaosa				ososo						
	sososa										
	sososo										
	sasoa										
	sassa										
	osaso										

Men-Creativity

0	1	2	3	4	5	6	7	8	9	10	11
pfpafops	saosaosa	osasasos	ssossss	ssssssssssss	sasosasosaso	afofpfs	sosososo	fpfpf	saosaosaosa	fofafofafofo	sssssssss
spafpos	osaosao	sasosas	sossss	sssssssa	asosasosasos	osososo	osososos	afosf	saosasa	afofafofafof	saosa
spspafp	sassaos	asosasa	sssssss	sssssafo	sosososos	ofspaf	sasosas	sfpaf		fofafofafofa	sasos
pspafpo	osaosas	sosasos	nrfsso	safosafo	sassasos	fspafo	ssssss			ofafofafofaf	sosas
pfpfpfp	saosass	sassss	ssssso	fopsafo	ssasosas	opsafo	sossos			ssssss	fsafs
afopfp	ssaosas	sososa	fpfps	ssafoss	sasososa	safops	osass			afofp	fssss
safoss	sosossa	sasoss	fpofs	safofp	sosasoso	afopsf	sssso			pfafo	
safpo	ssosos	sossas	sssos	safonr	pfpfpfp	ofsaf	sssos				
pspfp	sssss	sssss		nrssss	osasas	sfpaf	ssoso				
fopsp	ssssa	ssosa		safops	saosa	pafof	ssoss				
spafo	fpfpf			fofps	aosas	afofs	sosss				
opsaf	pfpfp			spafo	osass	fsafo	ososs				
psafo	ossas			ossss	sssas	safos					
sspaf	sasss			pssss		safof					
afpfo	ssass			fonrs							
fspsp											
afpof											

Vnc-Exploration

0	1	2	3	4	5	6	7	8	9	10	11
fsafo			afofpf	aoaoaoaoaoa	pfpfpf	ooabb	aosaosaosao	ssssss	saoaoaoaoao	saosaosaosa	sosasosa
sosos			fpafo	oaoaoaoaoaoa			osaosaosaos	sopsaf	aoaoaoaoaoa	aosaosaosao	sasosas
							ossaos	sssafo	oaoaoaoaoao	osaosaosaos	sasosos
							saosaa	ssssa	osososasa	ssaosaos	fsaso
							ssapf	sosas	aosaosaoa	osaoss	asaso
							sapfp	fpfss	osaosaoao	pfsaf	sasas
								ssops	aosaoaoao	fsafa	
								sofso	aosaoaos	afafp	
								safpf	aoaoaos	afaps	
								safop	oaoasos		
								fopfp	oasaoao		
									aoaosao		
									asaoaoa		
									oaoaoas		
									asaosao		
									aoaaoao		
									osasas		
									sasaoa		
									saoasa		
									aoasao		
									aoaoso		
									aosas		
									sosao		
									asoso		
									fafof		
									asass		
									aosos		

Mnc-Creativity

0	1	2	3	4	5	6	7	8	9	10	11
safopfs	sssssss	sasas	ssssssssssss	aoaoaoao	sssssssssss	fsafopfsaf	osaosaosaos	ssssssss	saosaosaosa	fabmfp	sassasa
osasaos	sosas		fopfpf	iopcpci	sasas	pfsafopf	pfpfpfpfp	sssafsso	aosasasa	safap	sasosos
ososasa			aoaoao		sasos	pfpfsa	fpsssss	spafsfo	ssaosao	ssafa	sososos
sasasas			pfsaf		sosas	sssss	ssssa	ssssafs	saosaoa	sssss	sasass
sososos			fpfsa					safpsa	sasasao		fdfdfd
sossoso			safpf					fopfss	aoaosa		sosas
pfsafo			fpfpf					pssss	aoaoao		
sososa			afopf						saoao		
saosas			fpfcf						sosos		
asasos			pfcfp						ososo		
sasoso									fpfnc		
safsa									ncrnp		
aosos											
osaso											

Mec-Exploration

0	1	2	3	4	5	6	7	8	9	10	11
	ssssssssssss	fpcpfp	ssssss	safondrf	ofpfpfp	ssssssssssss	sasasasa	ssssssss	saosaosaosa	pfsafpf	ssssss
	pfpfpfpfpfpf	pfpcp	ossss	ssafond	fpfpfpf	asasasasasas	osososo	assssss	saosaosaosa	sssssss	fpfpfp
	fpfpfpfpfpfp	sasos	sssfp	ndrpncr	fpfsa	sasasasasasa	sososos	sssssa	aosaosaosao	imimim	pfpfpf
	aosaoaoaoaoa			pncrnr	safpf	fpfpfp	sassss	sssass	osaosaosaosa	fpofp	popfpf
	osaoaoaoaoao			safop	sofpf	sosos	sssoss	sassss	osaosasaos		sasas
	saoaoaoaoaoa			afopn		ososo	sossss	ssssas	pfpfpfpfpf		fpfss
	aoaoaoaoaoao			pncrf		opsaf	ssssss	sssos	ssaosaos		ofpfp
	saoaosaoaoao			fpncr		psafo	fpfpfp	sosss	sosaosa		fpfpo
	aoaosaoaoaoa						ssasa	ssoss	osasas		pfopf
	oaosaoaoaoao						sssso	ossss	saosos		pfpfs
	aoaoaosaoaoa						ssass	mmmss	smsmsm		
	oaoaosaoaoao							sosos	saoss		
	aoaosaoaoaos								ossao		
	oaosaoaoaosa								sasos		
	aosaoaoaosao								asosa		
	osaoaoaosaoa										
	saoaoaosaoao										
	oaoaoaoaoaoa										
	oaoaoaoaoaop										
	oaoaoaosaoa										
	opfpfpfpf										
	aoaoaoaos										
	aopfpfpf										
	apfpfp										
	aosaos										
	sssaoa										
	ssaoao										
	fopfp										
	fpfpo										
	popop										
	oaoss										

Mec-Creativity

0	1	2	3	4	5	6	7	8	9	10	11
ssssssss	aoaoaoaoaoa	sasas	safosss	sssssssssss	sasofpf	sssssss		fosfaf	saosaosaosa	fafofaf	sssssss
fpfpsaf	oaoaoaoaoao	sasos	ssssa	safopssafo	pfpfpfp	pfpmfp		pfpof	aosaosaosao	ssssss	sssfpf
pfpfp	fpfpfpfpfp		ofpss	afospafo	ssasas	fpfpfp		sfafo	osaosaosaosa	fofafo	sofpf
safop	pfpfpfps		fssss	ssafopss	sasaso	pfpfpf		fosaf	osaosaosaos	fafop	fsafs
afopf	ssssssss		sssaf	ssafondr	sasos	safop		osfof	sosaosaosa	pfpfp	afsss
fpfpf	fopfpf		sssss	psafops	sssas	sfpaf			osasosa	afopf	fssss
pfpaf	pfpfo		sssso	fopssss	sssss	fpafp			sasosao	ssssp	
fpafo	pfopf		ofsss	ssssafo		fpifp			asaosa		
pafop	sasss			ssossss		fopfp			ososos		
				sssafon		fpfps			sassa		
				fofop		fofaf			ssaos		
				ncrss		afpop			pfpfp		
						fpfpa					
						pfpsf					
						fpsfp					
						mfpfp					
						afopf					

Appendix C

Study III Material

C.1 Questionnaire

Graphical Score Questionnaire

Thank you for participating in our study.
If you have any further question please get in touch with Yongmeng Wu at
yongmeng.wu@qmul.ac.uk
NOTE: This research study has successfully completed the Research Ethics Approval. Code QMREC1694.

Please rate your agreement on the following statement:

1. **I am creative in creating a piece of music.**
   Mark only one oval.

	1	2	3	4	5	6	7	
Strongly disagree	⬭	⬭	⬭	⬭	⬭	⬭	⬭	Strongly agree

Prototype 1 & 2

Please rate your agreement on the following statement below addressing your experience with the first prototype.

2. **The graphical score was visually pleasing**
   Mark only one oval.

	1	2	3	4	5	6	7	
Strongly disagree	⬭	⬭	⬭	⬭	⬭	⬭	⬭	Strongly agree

3. **The graphical score helped me to get inspirations of creating the music.**
   Mark only one oval.

	1	2	3	4	5	6	7	
Strongly disagree	⬭	⬭	⬭	⬭	⬭	⬭	⬭	Strongly agree

4. **I found it was difficult to interpret the graphical scores.**
   Mark only one oval.

	1	2	3	4	5	6	7	
Strongly disagree	⬭	⬭	⬭	⬭	⬭	⬭	⬭	Strongly agree

5. **I developed my own understanding of the graphical score.**
Mark only one oval.

	1	2	3	4	5	6	7	
Strongly disagree	◯	◯	◯	◯	◯	◯	◯	Strongly agree

6. **The graphical score helped me to create many different music ideas, possibilities, or outcomes.**
Mark only one oval.

	1	2	3	4	5	6	7	
Strongly disagree	◯	◯	◯	◯	◯	◯	◯	Strongly agree

7. **I looked at the graphical score frequently for inspirations.**
Mark only one oval.

	1	2	3	4	5	6	7	
Strongly disagree	◯	◯	◯	◯	◯	◯	◯	Strongly agree

8. **When I was playing with the prototype, I lost track of the world around me.**
Mark only one oval.

	1	2	3	4	5	6	7	
Strongly disagree	◯	◯	◯	◯	◯	◯	◯	Strongly agree

9. **The graphical score supported me to be expressive in music.**
Mark only one oval.

	1	2	3	4	5	6	7	
Strongly disagree	◯	◯	◯	◯	◯	◯	◯	Strongly agree

10. **I think I produced a piece of music with good quality.**
Mark only one oval.

	1	2	3	4	5	6	7	
Strongly disagree	◯	◯	◯	◯	◯	◯	◯	Strongly agree

11. **I was very creative with the piece of music.**
Mark only one oval.

	1	2	3	4	5	6	7	
Strongly disagree	◯	◯	◯	◯	◯	◯	◯	Strongly agree

Final questionnaire

Here are some more questions.

12. **During the playing process, how important is the graphical score for you?**

   Mark only one oval.

   - ( ) Very important
   - ( ) Moderately important
   - ( ) Neutral
   - ( ) Slightly important
   - ( ) Not at all important

13. **When was graphical score most important to you?**

   Tick all that apply.

   - [ ] All the time
   - [ ] Once I get the brief
   - [ ] During learning process
   - [ ] During music idea generation
   - [ ] When I don’t know what to do
   - [ ] Other: ______________________

14. **How did the graphical score help you?**

   Tick all that apply.

   - [ ] Activate related musical ideas in memory
   - [ ] Give examples to follow
   - [ ] Provide ideas on sample combinations
   - [ ] Provide inspirations on music structure
   - [ ] Other: ______________________

15. **Please choose the which interface you feel the following statements are most appropriate to:**

   Mark only one oval per row.

	Prototype 1	Prototype 2
I enjoyed my self most	( )	( )
I explored more ideas for the music I made	( )	( )
I felt I was more expressive	( )	( )
The interface was frustrating	( )	( )
I felt more creative	( )	( )
I felt more satisfied with the result	( )	( )
The graphical score helped me to get more inspirations	( )	( )

C.2 Statistical Test Results

	Gstraight	Gabstract
Q1	.040, Not Informed $>$ Informed	.737, Not Informed $>$ Informed
Q2	.888, Not Informed $<$ Informed	.142, Not Informed $>$ Informed
Q3	**.003, Not Informed $>$ Informed**	.529, Not Informed $>$ Informed
Q4	**.014, Not Informed $>$ Informed**	**.027, Not Informed $>$ Informed**
Q5	.365, Not Informed $<$ Informed	.341, Not Informed $>$ Informed
Q6	.775, Not Informed $>$ Informed	.169, Not Informed $>$ Informed
Q7	.896, Not Informed $>$ Informed	.547, Not Informed $>$ Informed
Q8	.453, Not Informed $<$ Informed	.803, Not Informed $>$ Informed
Q9	.272, Not Informed $>$ Informed	.083, Not Informed $>$ Informed
Q10	.663, Not Informed $>$ Informed	.320, Not Informed $>$ Informed
Q11	.359, Not Informed $>$ Informed	.107, Not Informed $>$ Informed

Table C.1: Statistical test results of group comparison: compare feedback from group not informed with design concept and feedback from group informed with design concept

	Combined Group	Not Informed	Informed
Q1	.054, $G_{straight} < G_{abstract}$	**.021**, $G_{straight} < G_{abstract}$	1.000, $G_{straight} = G_{abstract}$
Q2	1.000, $G_{straight} = G_{abstract}$	.166, $G_{straight} < G_{abstract}$	.082, $G_{straight} > G_{abstract}$
Q3	.121, $G_{straight} < G_{abstract}$	.884, $G_{straight} > G_{abstract}$	**.034**, $G_{straight} < G_{abstract}$
Q4	**.014**, $G_{straight} < G_{abstract}$	.169, $G_{straight} < G_{abstract}$	**.046**, $G_{straight} < G_{abstract}$
Q5	.817, $G_{straight} > G_{abstract}$	.067, $G_{straight} < G_{abstract}$	.241, $G_{straight} > G_{abstract}$
Q6	.510, $G_{straight} > G_{abstract}$	.881, $G_{straight} < G_{abstract}$	.354, $G_{straight} > G_{abstract}$
Q7	.700, $G_{straight} > G_{abstract}$	1.000, $G_{straight} = G_{abstract}$	.536, $G_{straight} > G_{abstract}$
Q8	.704, $G_{straight} < G_{abstract}$	.241, $G_{straight} < G_{abstract}$	.339, $G_{straight} > G_{abstract}$
Q9	.477, $G_{straight} > G_{abstract}$	.809, $G_{straight} < G_{abstract}$	.210, $G_{straight} > G_{abstract}$
Q10	.398, $G_{straight} < G_{abstract}$	.137, $G_{straight} < G_{abstract}$	.878, $G_{straight} < G_{abstract}$
Q11	.901, $G_{straight} < G_{abstract}$	.463, $G_{straight} < G_{abstract}$	.782, $G_{straight} > G_{abstract}$

Table C.2: Statistical test results of graphical score comparison: compare feedback on $G_{straight}$ and $G_{abstract}$ from different groups

Study III: Statistical Test Results for Questionnaire Feedback

Note: 1. The highlighted texts are the significant test results.

2. For detail on Q1-Q11 please refer to Table 7.2 and Table 7.3.

General feedback stats for the group playing without design information

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Q1Gstratight	4.25	12	1.712	.494
	Q1Gabstract	5.67	12	1.435	.414
Pair 2	Q2Gstratight	4.25	12	1.658	.479
	Q2Gstratight	4.75	12	1.485	.429
Pair 3	Q3Gstratight	5.25	12	.965	.279
	Q3Gabstract	5.17	12	1.642	.474
Pair 4	Q4Gstratight	4.83	12	1.467	.423
	Q4Gabstract	5.58	12	1.165	.336
Pair 5	Q5Gstratight	3.50	12	1.624	.469
	Q5Gabstract	4.08	12	1.730	.499
Pair 6	Q6Gstratight	4.25	12	2.261	.653
	Q6Gabstract	4.33	12	1.826	.527
Pair 7	Q7Gstratight	5.75	12	1.815	.524
	Q7Gabstract	5.75	12	.965	.279
Pair 8	Q8Gstratight	3.75	12	1.865	.538
	Q8Gabstract	4.17	12	1.697	.490
Pair 9	Q9Gstratight	4.17	12	2.167	.626
	Q9Gabstract	4.25	12	1.815	.524
Pair 10	Q10Gstratight	5.08	12	1.832	.529
	Q10Gabstract	5.50	12	1.508	.435
Pair 11	Q11Gstratight	4.92	12	1.975	.570
	Q11Gabstract	5.17	12	1.642	.474

General feedback stats for the group playing with design information

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Q1Gstratight	5.50	12	1.000	.289
	Q1Gabstract	5.50	12	.905	.261
Pair 2	Q2Gstratight	4.33	12	1.155	.333
	Q2Gstratight	3.83	12	1.467	.423
Pair 3	Q3Gstratight	3.25	12	1.865	.538
	Q3Gabstract	4.75	12	1.545	.446
Pair 4	Q4Gstratight	3.25	12	1.422	.411
	Q4Gabstract	4.42	12	1.240	.358
Pair 5	Q5Gstratight	4.17	12	1.899	.548
	Q5Gabstract	3.42	12	1.621	.468
Pair 6	Q6Gstratight	4.00	12	1.954	.564

	Q6Gabstract	3.33	12	1.614	.466
Pair 7	Q7Gstraight	5.67	12	1.231	.355
	Q7Gabstract	5.42	12	1.621	.468
Pair 8	Q8Gstraight	4.25	12	1.288	.372
	Q8Gabstract	4.00	12	1.537	.444
Pair 9	Q9Gstraight	3.33	12	1.371	.396
	Q9Gabstract	2.92	12	1.782	.514
Pair 10	Q10Gstraight	4.75	12	1.865	.538
	Q10Gabstract	4.83	12	1.697	.490
Pair 11	Q11Gstraight	4.17	12	1.946	.562
	Q11Gabstract	4.00	12	1.758	.508

1. **Creativity Comparison (Paired Samples Test) : Compare the feedback of Q0 and Q11 with different versions of graphical score**

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Q0 - Gstraight Q11	-1.250	2.625	.536	-2.358	-.142	-2.333	23	.029
Pair 2	Q0 - Gabstract Q11	-1.292	2.136	.436	-2.194	-.390	-2.962	23	.007
Pair 3	Gstraight Q11 - Gabstract Q11	-.042	1.628	.332	-.729	.646	-.125	23	.901

2. **Group Comparison (Independent Samples Test): compare the feedback of the group playing with and the group playing without design information.**

2.1 Gstraight

		Levene's Test for Equality of Variances		t-test for Equality of Means			
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
Q1	Equal variances assumed	4.146	.054	-2.184	22	.040	-1.250
	Equal variances not assumed			-2.184	17.722	.043	-1.250
Q2	Equal variances assumed	.871	.361	-.143	22	.888	-.083
	Equal variances not assumed			-.143	19.636	.888	-.083
Q3	Equal variances assumed	7.593	.012	3.299	22	.003	2.000
	Equal variances not assumed			3.299	16.500	.004	2.000
Q4	Equal variances assumed	.111	.742	2.685	22	.014	1.583
	Equal variances not assumed			2.685	21.979	.014	1.583
Q5	Equal variances assumed	.356	.557	-.924	22	.365	-.667
	Equal variances not assumed			-.924	21.482	.366	-.667
Q6	Equal variances assumed	.844	.368	.290	22	.775	.250
	Equal variances not assumed			.290	21.547	.775	.250
Q7	Equal variances assumed	.956	.339	.132	22	.896	.083
	Equal variances not assumed			.132	19.350	.897	.083
Q8	Equal variances assumed	3.116	.091	-.764	22	.453	-.500

	Equal variances not assumed			-.764	19.550	.454	-.500
Q9	Equal variances assumed	1.923	.179	1.126	22	.272	.833
	Equal variances not assumed			1.126	18.586	.275	.833
Q10	Equal variances assumed	.017	.897	.442	22	.663	.333
	Equal variances not assumed			.442	21.993	.663	.333
Q11	Equal variances assumed	.299	.590	.937	22	.359	.750
	Equal variances not assumed			.937	21.995	.359	.750

2.2 Gabstract

		Levene's Test for Equality of Variances		t-test for Equality of Means			
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
Q1	Equal variances assumed	4.211	.052	.340	22	.737	.167
	Equal variances not assumed			.340	18.546	.737	.167
Q2	Equal variances assumed	.503	.486	1.521	22	.142	.917
	Equal variances not assumed			1.521	21.997	.142	.917
Q3	Equal variances assumed	.105	.748	.640	22	.529	.417
	Equal variances not assumed			.640	21.918	.529	.417
Q4	Equal variances assumed	.206	.654	2.376	22	.027	1.167
	Equal variances not assumed			2.376	21.914	.027	1.167
Q5	Equal variances assumed	.140	.712	.974	22	.341	.667
	Equal variances not assumed			.974	21.908	.341	.667
Q6	Equal variances assumed	.024	.879	1.421	22	.169	1.000
	Equal variances not assumed			1.421	21.675	.169	1.000
Q7	Equal variances assumed	2.690	.115	.612	22	.547	.333
	Equal variances not assumed			.612	17.928	.548	.333
Q8	Equal variances assumed	.007	.933	.252	22	.803	.167
	Equal variances not assumed			.252	21.790	.803	.167
Q9	Equal variances assumed	.001	.973	1.816	22	.083	1.333
	Equal variances not assumed			1.816	21.992	.083	1.333
Q10	Equal variances assumed	.172	.682	1.017	22	.320	.667
	Equal variances not assumed			1.017	21.700	.320	.667
Q11	Equal variances assumed	.721	.405	1.680	22	.107	1.167
	Equal variances not assumed			1.680	21.899	.107	1.167

3. Graphical Score Version Comparisons: compare GS versions within groups of design information

3.1 Compare GS versions in general

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Q1 Gstraight - Q1 Gabstract	-.708	1.706	.348	-1.429	.012	-2.034	23	.054
Pair 2	Q2 Gstraight – Q2 Gabstract	.000	1.142	.233	-.482	.482	.000	23	1.000
Pair 3	Q3 Gstraight – Q3 Gabstract	-.708	2.156	.440	-1.619	.202	-1.609	23	.121

Pair 4	Q4 Gstratight – Q4 Gabstract	-.958	1.756	.359	-1.700	-.217	-2.673	23	.014
Pair 5	Q5 Gstratight – Q5 Gabstract	.083	1.742	.356	-.652	.819	.234	23	.817
Pair 6	Q6 Gstratight – Q6 Gabstract	.292	2.136	.436	-.610	1.194	.669	23	.510
Pair 7	Q7 Gstratight – Q7 Gabstract	.125	1.569	.320	-.538	.788	.390	23	.700
Pair 8	Q8 Gstratight – Q8 Gabstract	-.083	1.060	.216	-.531	.364	-.385	23	.704
Pair 9	Q9 Gstratight – Q9 Gabstract	.167	1.129	.231	-.310	.644	.723	23	.477
Pair 10	Q10 Gstratight - Q10 Gabstract	-.250	1.422	.290	-.850	.350	-.861	23	.398
Pair 11	Q11 Gstratight - Q11 Gabstract	-.042	1.628	.332	-.729	.646	-.125	23	.901

3.2 Compare GS in the group not Informed design concept

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Q1 Gstratight - Q1 Gabstract	-1.417	1.832	.529	-2.581	-.253	-2.679	11	.021
Pair 2	Q2 Gstratight – Q2 Gabstract	-.500	1.168	.337	-1.242	.242	-1.483	11	.166
Pair 3	Q3 Gstratight – Q3 Gabstract	.083	1.929	.557	-1.142	1.309	.150	11	.884
Pair 4	Q4 Gstratight – Q4 Gabstract	-.750	1.765	.509	-1.871	.371	-1.472	11	.169
Pair 5	Q5 Gstratight – Q5 Gabstract	-.583	.996	.288	-1.216	.050	-2.028	11	.067
Pair 6	Q6 Gstratight – Q6 Gabstract	-.083	1.881	.543	-1.278	1.112	-.153	11	.881
Pair 7	Q7 Gstratight – Q7 Gabstract	.000	1.809	.522	-1.149	1.149	.000	11	1.000
Pair 8	Q8 Gstratight – Q8 Gabstract	-.417	1.165	.336	-1.157	.323	-1.239	11	.241
Pair 9	Q9 Gstratight – Q9 Gabstract	-.083	1.165	.336	-.823	.657	-.248	11	.809
Pair 10	Q10 Gstratight - Q10 Gabstract	-.417	.900	.260	-.989	.155	-1.603	11	.137
Pair 11	Q11 Gstratight - Q11 Gabstract	-.250	1.138	.329	-.973	.473	-.761	11	.463

3.3 Compare GS in the group informed design concept

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Q1 Gstratight - Q1 Gabstract	.000	1.279	.369	-.813	.813	.000	11	1.000
Pair 2	Q2 Gstratight – Q2 Gabstract	.500	.905	.261	-.075	1.075	1.915	11	.082
Pair 3	Q3 Gstratight – Q3 Gabstract	-1.500	2.153	.622	-2.868	-.132	-2.413	11	.034
Pair 4	Q4 Gstratight – Q4 Gabstract	-1.167	1.801	.520	-2.311	-.023	-2.244	11	.046
Pair 5	Q5 Gstratight – Q5 Gabstract	.750	2.094	.605	-.581	2.081	1.241	11	.241
Pair 6	Q6 Gstratight – Q6 Gabstract	.667	2.387	.689	-.850	2.183	.968	11	.354
Pair 7	Q7 Gstratight – Q7 Gabstract	.250	1.357	.392	-.612	1.112	.638	11	.536
Pair 8	Q8 Gstratight – Q8 Gabstract	.250	.866	.250	-.300	.800	1.000	11	.339
Pair 9	Q9 Gstratight – Q9 Gabstract	.417	1.084	.313	-.272	1.105	1.332	11	.210
Pair 10	Q10 Gstratight - Q10 Gabstract	-.083	1.832	.529	-1.247	1.081	-.158	11	.878
Pair 11	Q11 Gstratight - Q11 Gabstract	.167	2.038	.588	-1.128	1.461	.283	11	.782

C.3 Thematic Analysis

	A	B	C	D	E
1	**Code System**				
2	Code System				
3		Intriguer	Intrigue people to understand what it was suggesting people to do, to see the result		
4			Triggers the motivation for exploring more of the box.		
5			Trigger interest to create		
6			Intrige player to create, challenge complex music		
7			Trigger thinking (trigger player to think about GS and response to it)		
8			abstract GS triggers player's motivation for exploring more of the box.		
9		Cornerstone	Help to start with a blank head		
10			Offer guidance		
11				Important for people with no experience	
12				Offer examples on how to play chunk.	
13		Catalysis	Allow music be more individual		
14			Contraints trigger creativity		
15			Help develop own idea		
16			The idea just come naturally.		
17		Aid	Help to identify buttons		
18			Intuitive aid		
19			Remind the sound, remember,		
20			Reminders of being creative		
21			Help set a goal for music output, creative input		
22			Reminders of taking care of the piece structure		
23			Feedback on music quality, interaction, right or wrong		
24			Get less lost		
25		Inspiring	More things to find		
26				More inspiring with slash material (V3)	
27			Offer ideas		
28				Give inspiration when don't know what to do or getting repeation	
29				Combinations	
30				Pattern that can be translate to sound sequence	
31				Concept of playing	
32				Rhythmic pattern	
33				Finish music	
34				How to put a sequence, how to combine the loops, where to plug in the drums	
35				How to mix, what to use, start or stop, etc.	
36				Offer structure on how to put the sound together.	
37			Help learn		
38			Help explore		
39			Help create		
40			Help develop ow	The idea just com	The idea just come naturally.
41			Enrich music styl	Help to create diff	Help to create different music
42			Offer solutions for problems		
43				Look at GS when something went wrong	
44				when player can't find position	
45				when sound is a bit in a mess	
46			Offer better sound idea when not satisfied with current result		
47				Playing live need to be quick	
48				Timing matter more when playing live	
49				Playing live when confident	
50				Playing live need less previous information	
51				Play live is more controlable as it's responsive	
52				Playing live for novice is difficult to output good quality	
53				Have less confidence when play live	
54				Experiencing with different sounds when play live	
55				Playing live is more accurate	
56				Not used to live perform	
57		Aesthetic	Beautiful		
58			More fun		
59		Loose impression			
60			Abstract thinking		
61				The abstractness of symbols is not clear what it’s trying to show	
62				Allow own interpretation, various interpretation	
63				make up interpretation	
64			Open, space for creativity		
65				No right or wrong	
66				Not specific, no pre-set ideas,	

	A	B	C	D	E
67				Encourage playing by gaining confidence to player.	
68			Get a loose impression or a feeling out of it when give it a glimpse.		
69				With V3 player doesn't develop a one to one mapping	
70			Glimpse, occasionally		
71					
72		Graphic style	Graphic element	Priority sequecne	
73				The 1st is color, 2nd shape, 3rd size, 4th relationship between graphics;	
74				Color give indications	
75				Shape, patterns and color	
76			Pick symbol	Try to see which one is look like really creative,	
77				Whether the symbols look good is important	
78				player are choosing based on the appearance.	
79		Approach	Play strategy	Approach for v2 and V3 are different	
80					Look at V2 more than V3
81					compose, take care of the whole piece with V3
82					improvisly play live with V2)
83					Follow V2, pick V3
84				Try and error, experimenting, randomness	
85					
86				Add onto previous	
87				On my own	
88				Ignore GS	
89					When have an idea in mind
90					Ignore GS when satisfied with current status
91			Quit follow		
92				Unsatisfactory result when following GS	
93				No control over GS	
94				Moving too fast	
95				Not understand GS	
96				Difficut to follow	
97			Rigorous follow, copy		
98			Glimpse, occasionally		
99			Play live		
100			Play back		
101			Plan ahead		
102		Scenario	Target audience	Different GS suit for different target audience because of their features.	
103			Task	GS serve different purpose, for performing	
104			Solo or group	V3 for solo playing and V2 for group.	
105			Teach & guide, with GS; Creative tool, without GS.		
106		Challenge	Distracting from focusing on music		
107			Determine	Imply to follow	
108			Hinder creativity		
109			Directed	Feel being directed by GS.	
110			Frustration	Can't achieve what wanted to do	
111			Visibility	Too small, moving too fast	
112		Enjoyment	Enjoy the first time of creating music, surprised by the fact that himself can create/ improvise.		
113			Enjoyed it more when have more experience		
114			Enjoy more when not follow GS;		
115			Follow GS hinder creativity		
116			Enjoy the process of making sense of GS.		
117			Enjoy GS		
118		Non-musician	Motivation	Control quality	
119			Learning curve		
120			Quality	Dissatisfied with result from GS	
121			Confidence		
122				Confidence developed through more use with prototype	
123				Surprised by the quality of the result.	
124				Confidence hindered when getting bad results	
125				I really have no experience with music, I'm not a musician.	
126				With a guarantee of music quality	
127			Ability		
128				Information Overwhelming	
129				Imagine music	
130				Multitask	
131				Fluency	
132				Fast enough	

	A	B	C	D	E
133				Sense of music	
134					Judge quality
135					Estimate interaction
136				Memorise sound, button	
137		SmartGS	Generated from previous play, corresponding to previous music		
138			Count down reminder		
139			Allow user control, modification as a comment, self input,		
140		Sound design	Expressiveness		
141				More sounds	
142				Allow customization on samples for more expressiveness	
143				There is not enough piano buttons to press	
144				The sound does not work as planned.restrictive,	
145			Piano and percussion		
146				Unsatisfactory piano	
147				Drum is fun to play with.	
148				Piano is more difficult to mix and combine together really nice.	
149		Stratight forward graphical score			
150			Help learn		
151				Shows you the way to do it.	
152			Intuitive		
153			Straight forward		
154			Easier to interpret, Simple		
155			Similar to timeline		
156			Comfortable		
157				Understood what's going on.	
158				Give example to follow.	
159			Give example		
160			Give more structure		
161			Enjoyment		
162			Good for beginner (V2)		
163			Logical		
164			systematic and organised		
165			Clear		
166			Prefer V2		
167			Softer		
168			More mysterious		
169			Specific		
170				instruction on what to play	
171			Poor visibility		
172			Less interesting because it's similar to timeline		
173			Limit freedom/expressiveness/creativity		
174			Oppressive		
175			Determine, Imply to follow, instruction,		
176			Unsatisfactory result		
177			Less useful information		
178			Consider only color		
179			Confusing		
180		Abstract graphical score			
181			More creative freedom		
182			Interpretation		
183				Reminder of taking care of general structure, of being creative (V3)	
184				Size to sample length, e.g. add a loop sample when seeing a big shape	
185				Size and shape to volume	
186				Position to volume	
187				Indication of timing	
188				key points, key sound butts.	
189			Make no sense, confusing		
190				Shapes confuse player when music goes in lines and dots on timeline.	
191				Hard to interpret	
192			Prefer V3		
193			Satisfactory result		
194			Visually appealing		
195			The shapes and the color made it easier to understand, identify buttons,		
196			Good for complex music, challenge (V3)		
197			Help build compele structure (V3)		
198			Faster to learn		

	A	B	C	D	E
199			More interesting to look at		
200			More relax		
201			Encouraging experimentation		
202			Experimental, more potential		
203			Bold		
204			Aggressive	Shouts people to follow, determine	
205			Easier to interpret		
206			Symbolism		
207					
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ID	Original Saying	Content Summary	Comments and reflection	Theme	Possible Design Suggestions
1.01	When I don't know what to play next, I will look at it	GS helped to get ideas when don't know what to do	Player look at graphical score when don't know what to play next, or when not satisfied with what has been create, or when something went wrong, to get some new inspiration.	Overcome fixation (GS)	
1.02	Just only when I'm like I don't know what I'm gonna do next, I want some new inspiration, I'll check that.	Look for inspiration when don't know what to play.		Look for inspiration (GS)	
1.03	When I'm not really satisfied with what I've create, I'll have a look.	Look at GS when not satisfied with result		Better quality (GS)	
1.04	...if there is something went wrong, for example I missed one point which I wanted to, it disrupted, and I can't find where it is, it's a bit in a mess. And at that point, I was thinking to look at the graphical score on the top.	Look at GS when something went wrong.		Help solve problem (GS)	
1.05	Em, when I have something in my mind, like what kind of music I want to create, I'm not going to look at the graphic.	Having an idea in mind, not look at GS.	Player not look at GS when have an idea in mind, or satisfied with current status.		
1.06	But when I'm happy on what I'm doing, I'll just keep doing.	When satisfied with the music, not look at GS.			
1.07	I think the second one (V2) is more mysterious.	V2 is more difficult to interpret	V2 is only line and dots, so people take color as a priority. But the color is distracting, and can be only mapped to buttons. Also the color combination is strange. So it does not provide useful information. It's mysterious, and difficult to interpret.	More difficult (V2)	
1.08	The second is not very, it didn't give me any useful ideas.	V2 do not offer useful ideas.		Less useful ideas (V2)	
1.09	So for the second one (V2), I just, considering the color, just which is corresponding to which button.	Just considering the color of V2.		Color offer indication	
1.1	But, I don't really found myself a good way to interpret it. Because it doesn't really provide a lot of useful information.	V2 is difficult to interpret and does not provide useful information.		More difficult (V2)	
1.11	Because that one you only have the line and dots. So the first reaction is the color.	V2 don't have much information as it's only line and dots. So people take color as a priority.		Less information (V2)	
1.12	And you can only look at the second one (V2) for its color. And the color is strange because sometimes it's a combination of green and red. Feels like they are not supposed to be together. It should be either these two [pointing to the red and the white], or these two [pointing to green and blue]. And when I looked at it, it's very distracting my thinking.	The combination of color in V2 does not make sense. Color is distracting thinking.		Distract thinking (V2)	
1.13	but I found it's difficult to interpret.	Difficult to interpret		Difficult to interpret (V2)	
1.14	Just feel if I follow the graphical, the things I get is strange. And then I gave up.	Gave up follow the score because not satisfied with the sound result.	Stop following the score because not satisfied with the sound result.	Dissatisfaction on result from following the score (V2)	
1.15	Yeah, with the later one (V2). Because the red-green red-green are little dots, and I thought it wouldn't sound nice at all. And then I stopped follow.	Stop follow because don't like the GS result.		Quit following score (V2)	
1.16	Because the first one (V3) is based on shapes.	V3 is based on shape	V3 is based on shapes, so player would take shape as a priority to And with V3 player doesn't develop a one to one mapping, but get a loose impression or feeling out of it when give it a glimpse.	Shape is more priority than color (V3)	
1.17	The first one (V3), because the first one you don't really notice the color.	With V3 you don't really notice color			
1.18	Sometimes when you see a big shape, I'm thinking maybe add a loop sample. But it's not like a one to one mapping thing. But you might think about that.	Musical idea get from GS V3.		No rigorous mapping	
1.19	Then the first one (V3) is more like a first impress, it's not really like I understand it as something. It's just a loose impression, I just saw 'oh there's a big square there I might just add another loop'.	A loose impression of V3		Loose impression (V3)	
1.2	Yeah, when you are thinking what to play or what to add, you won't be thinking the details. It's just you give it a glimpse and have some feeling out of it.	A loose impression, give It a glimpse and have some feeling out of it.		Glimpse	
1.21	in the beginning it went on well, I think the very first piece is kind of smooth.	Satisfied with the result with V3.	Satisfied with the result with V3.	Satisfaction (V3)	
1.22	Between these two, I think the first one (V3) is better.	Prefer V3 than V2	Prefer V3 than V2	Prefer V3	
2.01	Yeah, and the piano lacks [?], because it's not enough buttons to press.	Need more piano notes. Expressiveness.		Expressiveness	
2.02	In prototype 2 [V3] I kind of tried the piano but it didn't work as planned.	Piano is not satisfying.		Dissatisfaction on piano	
2.03	I think one has more to find the graphical score [V3], and the other one is like, it's hard to see even [V2].	V3 has more things to find, but V2 is difficult to see.		More thing to find (V3); Poor visibility (V2)	
2.04	{So in terms of the two graphical score, which one do you prefer?} This one [point to V3].	Prefer V3.		Prefer V3.	
2.05	If it's like no one know, a person doesn't know about and musical, they will maybe look at this, and understand like how to play.	GS helped non-musicians to understand how to play.		Help learn (understand how to play) (GS)	
2.06	So if it says, it just says do this, like you can do this, it gives you another option .	GS give options		Offer options (GS)	
2.07	{Why did you started to follow it?} I'm out of options. {You don't know what to play?} Yeah.	Follow the GS in the end when run out of options		Overcome fixation (GS)	
2.08	{Does that affect your playing?} Yeah, at the end of the prototype 2 [V3], definitely.	GS affect playing.			
2.09	Oh, I just don't know how to finish the music. So I just looked at it, and look at the graphical score,	Look at GS for ideas to finish the music.		Offer music ideas (GS)	
2.1	and when it goes high, I assume it's going more volume. And when it went low, it's less volume. When it's like a dot or something.	Interpretation of GS: Map the position of GS to volume		Interpretation on V3	
2.11	If it's big squares, the volume needs to be high. So when it's like a dot or something, it's need to be low.	Own interpretation about GS V3: map the size and shape of symbols to the volume of the sound.		Interpretation on V3	
2.12	Yeah, I added more loops, and more volume. So when it's low I less up the loops, maybe one or two.	Mapped to number of loops/ volumes to the position of the symbols.		Interpretation on V3	
2.13	Yeah, yeah, if it goes like this, [pointing to No. 0,1,2 of V3] it means like more volume when you, like steadily increase. Like the this. And when it goes so high, [pointing to No. 11, 12, 13 of V3] just like create it fast.	Own interpretation about GS V3: map the speed of creation of sound with the position of the symbols.		Interpretation on V3	
2.14	{Did you look at the graphical score frequently?} At the end I just follow the graphical score.	Follow the GS in the end.			
2.15	{So you think the second one [V3] definitely more inspiring?} Yeah.	V3 more inspiring.		More inspiring	
2.16	And it doesn't give any instructions. But this one [V3] did.	V3 give instructions.		Give instructions (V3)	
2.17	{How about this one (GS V2)?} I didn't even notice that one.	Didn't notice V2.		Poor visibility	
2.18	and the other one is like, it's hard to see even [V2].	It's hard to see.			
2.19	I didn't even see the graphical score [V2].	Ignored V2 GS.		Ignored V2	
2.2	Because this one (GS of V2) looks like the thing that go on the timeline, and like, I didn't even notice that because I thought they were like the loops or like that [pointing to green buttons].	V2 looks similar to timeline, so player do not notice it.	GS of V2 is too similar to the timeline, player feel less interested in the GS. And it does not give instructions.		Abstract visual has more potential to trigger user's imagination on mapping the visual parameter and sound parameter in their own way, that allows a sort of freedom and more creativity
2.21	{So you think this one looks really..} Similar. {Similar to the timeline we have, and that makes you less interested?} Yeah.	V2 looks similar to timeline, and it's not interesting.		Less interesting (V2)	
2.22	And it doesn't give any instructions.	V2 don't give instructions.		Less information (V2)	
3.01	I think that's the first time I created a bit in my life, so.	Surprised with the result.		Enjoyment	
3.02	I think it's like, there is a bit of learning curve. Cause there's like, so many different buttons that you need to like, learn.	Need to learn a lot of buttons.		Learning curve	
3.03	I mean, so I don't have any musical background at all, so like, it's kind of seeing which beats mixed on better with each other. And trying to like, pause that doesn't work and stays with those, maybe worked.	Exploring process - try and error.		Exploring process - try and error.	
3.04	{Ok. Do I understand right, so in the first one, you more like follow in the beginning} Yes. {And in the second one, you are more looking back when you are out of ideas?} Yes.	Follow V2 GS, but look at V3 GS occasionally.	Player tend to adpot different strategy for different versions.	Refer strategy	For different task, different GS should be adopot. (Both have different features)
3.05	I mean since I don't have any background. It's not really like I'm following any, like certain styles or any certain beat patterns that I know previously. It's just, whatever comes.	Non-musician usually don't have a structure in mind. Just playing whatever comes to their mind.		Randomness	
3.06	I think without the graphical score, you are just trying to see what each sound does, and how each sound, like sounds. And then with the graphical score you're maybe following a bit more, like, like I said, if you don't know what you're doing, then you look at the graphical score again, try to figure out.	Without GS support focusing on music and learn, explore. GS helps to figure out music		Indicate current satus (GS)	
3.07	{So you just, you were focusing on the timeline and then when you are out of idea, you, } Yeah, pull them from the graphical score.	Look at GS to pull idea from it.		Overcome fixation (offer idea) (GS)	
3.08	I think like, the second one (V3), since you have to interpret it a bit more. Like, it's a bit more abstract, not clear what, like it's trying to show you. So like, you can kind of like, interpret what the beats are trying to, like... hard to explain it.	V3 more abstract		More abstract (V3)	
3.09	And then the second one [V3] is likes different shapes or something, and then, I don't know, it's a bit more, like, not difficult, but like, you kind of have to like, see what you, how you identify it. Like it's not necessary like one way to identify that.	V3 is based on shapes, and sizes. More potential to interpret it. Not only one way to interpret the GS of V3		More potential for interpretation (V3)	
3.1	At the start I was looking at the score, and once I got into it a little bit, I was just on my own.	People begin to follow the GS. And then drop out after they are used to it.	GS support to start from scratch.	Connerstone for start (GS)	This could be a design guideline for supporting start.
3.11	If like, like in the question, like at a point I didn't know what to do now, and then like, I'll look at the score again and then like, see if I got a new idea based on that.	Look back when they run out of ideas and develop some new idea based on GS		Overcome fixation (GS)	
3.12	Not as frequent, like, not very frequent, to be honest. Like every once in a while, like I didn't really know what to do and then I go to graphical score.	Look at the GS when not knowing what to do		No rigious following (GS)	
3.13	Like, like the style, maybe the shapes or patterns. Like, looking at the graphical score, like, just looking at the colors of it, and maybe like, pulling an idea out of that.	Shapes, patterns, and color helps pulling an idea out of GS.		Shape, patterns and color	
3.14	There was like, one of the circle, like with multiple colors in it, and then, so like, for me it just gave me like an idea of like, starting with like, one beat and move to the second, like, introducing the second, introducing the third, and then like, pulling out the third, pulling out the second, and finishing it.	GS offer musical ideas.		Interpretation (V3)	
3.15	{Right. So do you think in terms of creativity, which one support you to be more creative?} I think definitely the second one (V3).	V3 is more creative		More creative (V3)	
3.16	{So which of them is the one you have, like the most inspiration from?} I think this one mainly [V3].	V3 support more inspiraton.		More Inspiration (V3)	
3.17	I guess like, since you have to interpret it on your own, like it's, like the interpretation is up to you, so... There isn't really like a one, like one thing that is trying to get across necessarily. So it's just, abstract. I don't know.	Being abstract and without any settled rules allow to interpret freely.		Abstract; No settled interpretation (V3)	
3.18	Like, I wouldn't know what this is trying to like request [pointing to No. 8 in V3], like I wouldn't know, if seeing that, like, I wouldn't even know what to do. But, like, I think, like, just the fact that there is different types of shapes or, like, and obviously like, different colors to match each type of beats. That's just, like, the idea is just like come and ...	Some of the symbols are difficult to interpret and player don't know what to do. But because it has different shapes, colors, the idea just come.		Difficult to interpret some symbols (V3)	
3.19	I did not know how to interpret the dots one.	The dots in V3 is difficult to interpret			
3.2	I mean, the, I think, like, the second one (V3) is more, like, cause a bit more, like if you're following it, I guess the second one gives you a bit more creative freedom. If you are not necessary following it, then like, I think, they are like. If you are not following it, then really doesn't matter.	V3 gives more creative freedom when following the graphical score.	The context of GS is important. Different GS serves different functions.	More creative freedom (V3); Support learning (V2)	
3.21	But the first one (V2) kind of shows you the way to do it. And then the second is a bit more optive.	V2 support learning			
3.22	Like the first one (V2) is, like, try to, you can kind of see what it's trying to show you.	V2 is easy to interpret		Easy to interpret (V2)	
3.23	So for example, there is the lines and might show like the loops playing, and then individual beats which were like the beats playing.	Interpretation of V2, which is close to the original design concept.		Interpretation (V2)	
3.24	these ones (V2) were fairly straight forward. I mean, so like, be pattern and certain like, beats and then repeat the loop and then the beat again.	V2 is straight forward.		Straight forward (V2)	

4.01	I believe something like that was interesting to me. As a person to create music, you know. So this timeline would be very useful.			Timeline is helpful
4.02	For me with more experience, like for me it's like examples, how to play chunk , you know what I mean?	GS offer examples on how to play chunk.		
4.03	Like it's important for people with no experience at all. How I see it, it's like examples of how I could put chunk of music, cause when you put music, it shows like, [drawing lines with fingers] stuffs like, you know what I mean?	GS is essential for non-musicians	GS serve as example for people to put chunk of music. And it also give direct visual feedback on interaction.	Offer example (GS)
4.04	So for my experience, it's much much easier to take examples and to understand the first graphical score, with the lines (V2). Because how the music write, it becomes lines and dots. So it's similar and it's easier for me to understand, and to learn from it.	Music is written in lines and dots in V2, it is similar to the timeline. So it's easier to understand and to learn from it.		Similar to timeline; easy to understand and learn. (V2)
4.05	So to interpret and to learn from, the first one was way better.	V2 is better for interpret and to learn from.		
4.06	Just the first one is easier for me to use.	V2 is easier to use.		Easier to use (V2)
4.07	No, definitely this will be easier for me to understand. And also I would like, I would feel more comfortable with the box, because ok, I produce sounds and understood what's going on. But this thing will give me example (V2).	V2 is easier to understand. Player feel more comfortable with it	Player feel more comfortable with it because two reasons: 1. understood what's going on. 2. Give example to follow.	Comfortable (V2)
4.08	And if I have a box like that, I would like it also to have options not just like the lights, that to recon the of these. That I can have examples of how I can create, to have my own ideas to create. Cause, I know that I didn't read it as you meant me to read.	Didn't follow exactly as designed. Did some own interpretation.		No rigours following (V2)
4.09	On the graphical line, I don't know how to call it. So here, let's say, each blue, or like each drum will have a bit difference, or the line of it will be, you know, different place,	Interpretation on V2: Map the symbol place to different drum keys		
4.1	{Ok, so if you have to choose, which one do you like?} The first one (V2).			Prefer V2.
4.11	But the second one was like, I don't know, I felt more like, free. Because it's the third time I play with the box, you understand what I mean?	V3 is more free.		Freedom (V3)
4.12	I did it only with this (V3), but again, it's just because it's the third time I played with the box, so I felt more comfortable, like.	Used plan ahead with only V3.		
4.13	I think here (V3) I was more creative but only because it's the second time I played.	Think with V3 was more creative but because it's the second time played.	Player feel V3 is more free, and felt more creative with V3.	More creative (V3)
4.14	But, because I had more experience in the second one, like I enjoyed it more.	Enjoy the playing of V3, but not sure why. Maybe because had more experience, or maybe because the design.		
4.15	It's more very, like for me personally, with my problems, with the music goes in lines and dots, these shapes really confuse me.	V3 with shapes, lines and dots, which confuse people with too much information.		Confusing as too much information (V3)
4.16	So I didn't know how to, like, for a person who doesn't know music, like I said, in the beginning it's inspiration, like ideas of how I can mix and stuff like that, what to use. But it was harder to understand.	V3 offer inspirations include how to mix, what to use, start or stop, etc.		Inspiration (V3)
4.17	Ok, this is very hard for me to interpret (V3).	V3 is hard to interpret.		Hard to interpret (V3)
4.18	{And when you saw these line shapes,} I want to put longer music.	Interpretation		
4.19	So let's say this (No. 1), or this (No. 12), like this kind of thing, or even No. 3, it's like for me it looks similar.	Some symbols looks similar.		Similar symbols
4.2	So how did I interpret it, so I have the red, it's outside, so I want to start with the red, I want to combine inside the white, and plug blues.	Interpretation on V3	Interpretation on V3 is closely connected with colors. Player mapped the color with the buttons. Depending on the color position to play the button sequence.	Interpretation (V3); Color
4.21	Here (No. 12), I want to start with a red, no stop, to put green and inside to combine yellow, like the white. Or, this I couldn't interpret. But this also, I want to start with white let's say, but to stop it quickly, with the blues blues then I get to the red, or depend which side it comes. This is my principle.	Interpretation		Interpretation (V3)
4.22	It's when I had the graphical score, I started looking at the examples of what I can combine. And I tried to experiment with the sounds, cause I don't remember which button makes what sound. So I tried to experiment and see if I can combine and fits. And if I saw something that doesn't sound good for me, so I tried to stop it. But not all of them stop at one time.	Process of exploring ideas of GS		Exploration process
4.23	And I didn't change to the piano at all, but, like, I didn't think it suit. The piano, with the type of the background suit that plays.	Didn't use piano because think the sound does not suit.		Piano sound does not suit
4.24	So it's like, guided me. … Both of them.	GS offer guidance.		Offer guidance (GS)
4.25	{Did you look at the graphical score frequently?} Yes . {So why did you look at it such frequently?} Because I don't know how to create music.	Look at GS frequently because don't know how to create music. GS give some idea.		Frequently look at; Give idea on creating music (GS)
4.26	And for the first, even when I started math, it doesn't matter, I follow an example, trying to understand the concept. Even if it takes me a day, a week, two months, when I understand I can start to do my own. But I need to see sequences, so because it's the first time I ever do it, I need sequence to guide you.	Need guidance in the beginning. GS serve as example for player to start playing.		Offer example and guidance
4.27	Just how to put a sequence, like how to combine the loops [pointing to red and white buttons on the box]. And where to plug in the drums [pointing to blue and green buttons on the box].	Example ideas get from GS.		Offer example
4.28	I think all of it. Like, it always. Like, it inspired me, I followed that. I really have no experience with music.	GS inspired non-musicians		Inspiration
4.29	Because, I don't know, maybe it's just me, because you put red, blue, like these colors [pointing to different sides of the box], so it's like 'ok, I can combine red and white, let's see what's going to happen. Let's put the green, cause we have a green, let's stop, chunk'.	Color gives indications		
4.3	Yes, for me it was the color.	Color offer most information.		Color give indications on music ideas
4.31	But I did use the colors. Let's say, it gave the ideas that I can combine, you know. Or here [No. 11 of V2], I can put a stop and between put drums.	Color offer musical ideas		
4.32	{So the dots give you like drums?} Yes. It's like a note. Like, one sound. You know, and the long lines, gave me the idea of the loops.	Interpretation of the GS.		Interpretation (V2)
4.33	Because of the graphical score. Ah, no, I also wanted to combine the sounds together. If it started with this, and it's like a bit low. So to increase it with a side beat.	Interpretation of GS: Map the sound with position.		Interpretation (Mapping) (GS)
4.34	{When you used this, did you go back?} I go forward.	Use plan ahead.		Plan ahead
4.35	{Go forward? To plan something?} Yes. Because of the graphical score. {Why?} I don't know. I just, I feel like I'm not in pace that I'm go forward to try to make it more accurate. {Right. So you look at something that's behind the timeline, that the graphical score is very long, is that something triggers you to do something in the future?} Yeah. Yeah. That's exactly what it made me want to do. Something in the future.	Use plan ahead to make more accurate and keep pace based on GS.		Plan ahead as a strategy for accuracy
4.36	Listen, it's amazing. If it's something smaller for kids, I would buy it. Like, it's really really nice. I enjoyed it.	Enjoyed playing.		Enjoyment
4.37	But the thing is only about experience. Like, if playing for a week, I would use it much more. It is important.	Need more time with the box.		More time
4.38	I can not really imagine music.	Can not imagine music.		Music imagination
5.01	You know the part of the shape is easy to understand which part of the button is. [You mean the?] Like, if you press, this is the red lines, and this one for yellow sign. The shapes and the color made it easier to identify which part it is.	Shape in V3 make it easier to understand which part of the button is.		Shape and color help on indentification.
5.02	So you know, you can just follow the recommendation on the top.	View GS as recommendation and follow it.		GS as recommendation to follow
5.03	I prefer the second one (V3).	Prefer V3		Prefer V3
5.04	But for prototype 2 (V3), make it much easier. They have burned by like different shapes and sizes. Make it easy to understand that, compared to that.	Shapes and sizes in V3 help the understanding better. V3 is easier to understand.		Shape and size helped understand
5.05	But for this one (V3), the colors are the same, yeah, I follow the color , but in terms of the shape, I know what button they recommend , so try to see like, if it generate like a good sound.	Color support playing. Match to each button based on the shape	This is due to on the timeline, there is a shape for each button. Some participants used this mapping to find more concrete thing to do. People developed different mapping strategies of V3 compared to V2, this could be a evidence for abstract graphics allows more freedom!!! Could also compare result of one question on the questionnaire.	Color and shape together give indication on button.
5.06	So it's like, the first by seeing what color it is. Then, I'm just like trying on different, so I'm focus on like maybe red, and see what is like, each button shape it is.	Color and shape give indications.		Color and shape give indications.
5.07	I prefer the second one [V3]. As you know, it takes faster to learning the order, like the term,	Prefer V3 as it's faster to learn		Faster to learn (V3)
5.08	I think it's much easier to understand this (V3). Because I understand, it tells what shape it is. Easy to see.	V3 easier to understand because the shape and it's easy to see.	It's easier to associate the shape to the buttons. And it's easier to see.	Associability; Visibility (V3)
5.09	The second one (V3), the understanding process is much faster. It's like, I can see what recommendation it gave us. And try it.	V3 is faster to understand because gave more direct recommendation linked to exact button. So it's easy to try out everything.		Faster understanding process and recommendation
5.1	And also after you understand it, and then you can try to create different types of music. And then just like, you can try this one and add maybe another yellow, triangle or yellow circle .	V3 shorter the learning process so leave space for own creation.		space for creativity
5.11	It's like when I run out of what to do, I kept repeating the same thing. Then I go to one of this and try what this gonna do [pointing to GS of V3].	Look for ideas in GS when running out of ideas. "Repeating the same thing" is an symbol for running out of ideas means .		Overcome fixation

5.12	And then it generates like, different (music), like what it's trying to say. But then you can add extra into it. It sounds nicer but I really want to make it sound much more creative .	GS in V3 offer different music. Allows add things to be creative. Want to be creative		Space for creativity	People have different styles for implementing GS. Some participants interpret GS in V3 as an anstract icon. For these people, V3 allow bigger space for creative output as the GS allows different interpretation, thereby different combinations; Some people link the shape in GS to the shape on the timeline, which make GS in V3 a direct link to buttons. For these people, V3 shorter the learning process so leave space for own creation.
5.13	But this one (V2) it just take longer time, as I said. But this one (V3) is a little bit faster to develop the understanding of it. I don't have to like keep looking to know what shape it is and what color.	Compared to V2, V3 is faster to develop the understand of it. Because V3 does not need to keep looking at the GS.	Maybe because of two reasons: 1. Sizes and shapes are easier to identify, so don't need to keep looking at it, so people feel more relax; 2. The abstract visual gives more freedom to develop their own interpretation, so it's less constrained	Slower to understand (V2). Open to own interpretation; Visibility (V3).	
5.14	But the first time when you look at it, it's kind of confusing .	First impression on V2 is confusing.		Confusing (V2)	
5.15	After you started playing with the box, it makes it much easier to understand the structure inside of the prototype 1 (V2).	Playing with the prototype helps to understand prototype.		Operation help understanding (hand help head)	
5.16	It's just portray[?] just like dots, it doesn't make any sense. It's harder to understand what all that means.	GS in V2 does not make sense. It is difficult to understand		Confusing (V2)	
5.17	Yeah. It takes longer to understand it.				
5.18	But this one [V2], it's take longer. And doesn't help me to understand what each one does. So I prefer the second one.	V2 does not help to understand what each button does what.		Slower to understand (V2).	
5.19	For this one (V2), I know that is, I know the color tell which side it is, but it's like, I don't know, for example which button it is in this one. So it's quite confusing.	In this sense, this is a more abstract concept, because it just indicates the color, instead of the exact button, which is confusing.		Limited freedom	The reason why this participant felt V2 is more confusing even though it seems leave more freedom for player to choose (as in V3 he interpret direct mapping to buttons), might be that the freedom offer by V2 GS is limited as the color indicate which side of buttons to press but not specific one. Or player just prefer more direct recommendation.
5.2	But this one V2, I don't know what is the recommendation they're trying to tell me to do. So it's a little bit confusing in this part.	V2 is more ambiguous for the sound.	For this participant, precise recommendation is more useful compare to more ambiguous ones. Because this participant take color as a priority element. V3 give precise indication because of the shape. But V2 only gave limited freedom, that the color is settled but not the button. The fact that participant need to make the decision on button make it confusing.		
5.21	So for example, this one (V2) is red, I don't know which red it is. So I have to like try and errors to see what sound it made.	With V2 it's not easy to link the visual directly to buttons.		Ambiguous; No precise recommendation. (V2)	
5.22	You know, in terms of the learning process, for the first one, it's not really fast. So it's getting used to all the buttons and sounds as well. So usually I used up my time. Most of the time, for the first one, I don't look at the graphical score at all because I don't know what's it trying to say. So I just try to see what button is doing. I mean when I looked at it, it's just like, I know what color it is, but I don't know what they are trying to say. So it's just like confusing.	V2 takes time to learn. When in the learning, people focus on the sound and buttons, they tend to ignore the GS. They tend to look at GS when they are more fluent with the prototype.	(there is opposite view in other feedback.)		
5.23	And then I compare to the bar, started to like, related to it.	Relate music to GS.			
5.24	Because there is like unfounsly[?], that you can map, as to like try different examples, like all of this, as much as, like.	Try different examples.		Try out examples	
5.25	First, I like, I tried like different buttons, then to see which one what sound it make.	Learn the sound.		Learning process	
5.26	Then I just like, then after I started to play. I started to copying, or, and then maybe add extra button to it, maybe green or blue, depend on what sound it sound nicer in my ear.	Follow GS by copying and add own stuff.	Patterns of using GS: 1. Some following/ copying it, and add own things; some create sound based on GS, and then develop own music idea based on what have learnt. 2. Some look back occasionally for inspirations 3. Some only look when running out of options	Creation strategy: Started by copying; then add extra own stuff into it.	
5.27	Follow it a little bit and then I add something extra into it	Add extra in based on GS	How GS affect playing. This is when creativity comes!!??		
5.28	Like, so usually I started with the loop, and I try to look what different button do and what the shape it is. Then I looked at the recommendation and try to copy that first, and see what it sounds like. Then maybe I add another tune or another loop into it to see what it gonna do, maybe something unique, something different than what they recommend.	Process of creation. First produce sound based on recommendation. Add things to it to make something different than what have been recommended.	Participants try to create based on recommendation.		
5.29	[Have you looked at it very frequently?] All the time.	Looked at GS all the time.			
5.3	[So do you think it helps you to learn, in terms of create. I mean..] Yeah. In terms of creating like different music, yes.	GS helped to create different music.		helpfulness	
5.31	But I think the more information in the box, I think it still limited. I like different sound, but it's only limited to two sounds. But then if I have maybe trumpet or violin, maybe it's much more fun to.	Choices of sound is limited. Expecting more sounds in the box.		Limitation	
5.32	Maybe when you press [red button], it changes to more. [Yeah, so you want more sounds?] Different sounds.	Expecting different sounds in the box			
5.33	I found the drum is really fun to play with, kept on going and going. But for the piano part, I think it is harder for me to make it into like, rhythm. But the drum is just like one sound, but for piano you have to mix one sound with another, but you have to be combined together really nice, but when I started doing it, it's hard to combine them.	Drum is fun to play with. Piano is more difficult to mix and combine together really nice.		Drum and piano	
5.34	I mean, for piano, if I want to combine the piano with the, you know the red one, and the white one, it's hard to do it. But instead drum is just like really easy to do it. That's why I used more often the drum, most of the time.	Combing piano with looping samples are more difficult. Use drums most of the time.			
5.35	Usually I got it like, usually I combine the drums with these loop thing [pointing to red buttons], and then I tried to just like, how you actually play the drum. It's like, I don't know what it's called. 'D-dd, d-dd [mock the sound]', something like that				
5.36	No, because I know what the sound is like, but also the graphical score helped me to make it easy to identify what it is, like in each button.	GS helped identify each button.		Indentification	GS helped identify the sound of each button.
5.37	I usually go to the future and then set the beat.	Plan ahead		Plan ahead	
5.38	Just change something. But I just wait until it go to that line and just execute				
5.39	Actually I just kept and let it continue. And then just gonna play what I set.	Play live		Play live	
5.4	Definitely is one with the graphical score	Prefer with GS.		Prefer with GS	
5.41	Also I look at the recommendation up on the front, and try to see which one is look like really creative.	Look for inspiration in GS. Choosing GS based on outlooks.		Offer inspiration	GS function
5.42	if you don't have the graphical, I don't know what each button do, I know what the sounds like. But it just, it's just a mixture of the sound. I don't know what it is. Em, it's like I don't really know, I know that this is like a drum, but this one is like looping, I can't remember which one it was. To determine the difference. So it's just like a four square box, so I don't know which one to create. I don't remember all the sound.	Need graphics to remind the sound	Can't remember the sound	Remind sound	GS function
5.43	But with the graphical score, you know some of it. it's like you get to understand what. So for example, a red triangle means one of the things, and one of the circle is one of the things.	GS helped to understand.		Help understand	GS function
5.44	It's the structure is like, yeah, put them together.	GS offer a structure to put the sound together.		Offer structure	GS function
5.45	And also you know the things that's here, you just, it's kind of help like, you can go outside of the box, and just like put something extra into it without (go wrong?), it's like creating your own music. So it's making it easier to do that	GS act as a base of the music, which make it easier to create your own music because you can go outside of the box.		Cornerstone for inspiration	GS function: GS as a cornerstone for creating music because of three reasons: base of the music so as for people to add onto it and create own music;
5.46	I find myself enjoy a lot.			Enjoyment	
6.01	Well. It's fun. Yeah, it's really fun.			Enjoyment	
6.02	The graphical score was interesting because it wasn't immediately obvious to me, like some of the colors correspond to, like, for example green being the long one, and the green is that kind of short	GS in V2 wasn't immediately obvious to understand.		Not immediately obvisous to understand (V2)	
6.03	but then it was like, it was definitely, you definitely could interpret it, in like, ways to	Interpretable			
6.04	And it was sort of, I noticed when I try to kind of follow the patterns, then more interesting things came out naturally, then sometimes just like randomly like playing around with stuff .	More interesting things came out naturally after following GS. Then randomly play around with stuff.		GS foster own ideas	GS function
6.05	But then at the same time, kind of, I spent a lot of time focusing on that framework, maybe more than I should have done.	Focus on GS framework		Focus on framework	

6.06	but I wasn't following it very well. I follow it quite badly.	Losely following GS			
6.07	Whereas with the previous one, I think it kind of inhibited me, because I was trying to follow it but I wasn't really following it very well.	V2 lead people to follow it but is difficult to follow		Imply to follow	
6.08	But then, there were, I don't know, it's difficult because then there were like, stronger structures that you could kind of make with the, I mean more clear structures.	V2 offer stronger structure to follow.		Structure (V2)	
6.09	The other thing that I found was, I had trouble mapping the square, like the square shape to the, to like the order of where it was. So I'd kind of be wanting to make this shape on the thing, than just be like [randomly pressing buttons].	Trouble to map the timeline order to the buttons on box.		Mapping problem	
6.1	With this I found more satisfied with, but to be honest, I think I did equally badly on both results.	More satisfied with V3; Not satisfied with both result.			
6.11	because in comparison to the other one, there seem a less direct mapping onto the timeline.	Less direct mapping onto timeline than V2		Less direct mapping onto timeline (V3)	
6.12	So I kind of feel like I had more freedom to experiment and interpret, in a more sort of fun and less rigours way, than like 'oh, that must be that', but then, you know I really wanted to make a really strong connection between the other one, whereas this was more like, it seems sort of less important, but then easier to like, play around with.	V3 can be interpreted in a more fun and less rigours way than V2; With V2 player tend to make strong connection. GS in V3 seems less important, easier to play around with.		Less rigours (V3); Direct mapping (V2); Less important (V3); Easier to play with (V3)	
6.13	I think it was, this No. 13. So you know, I kind of interpret that to mean like, you know, you have this kind of like main surrounding piece of music with like, tailing off bits. You know, sort of start a bit later and then tail off.	Develop own interpretation.			
6.14	And then, like it was actually when I was using that one, where I sort of started to experiment with stopping the long notes, because you can't, it's not like, it's not a direct, you know, where do you start one and the other, because they are kind of like, they are diagonal that don't really have [certain].	GS in V3 encourage experiment with long notes, because the abstract shape didn't give direct mapping. This allows freedom		Experimental (V3)	
6.15	But other than that, I didn't really pay too much attention to them. I just kind of like, thought they are all pretty and played around more.	Didn't pay much attention to GS in V3. V3 is pretty, which encourage playing.		Aesthetic encouraging playing. (V3)	
6.16	[So when you were playing it, did you look at the score frequently?] Em. Not as much as the previous one.	Look at GS in V2 more than V3.			
6.17	I looked at it a lot to start with.	Look at GS to start with.		Conerstone to start with	GS function
6.18	Whereas it got me more interested in trying to construct an interesting shape thing in like just a smaller area.	GS trigger interest for creating better shape in a small area.		Trigger interest to create	GS function
6.19	So I spent more time sort of going back and focusing on one section of time. And so I ended up looking at the picture less.	Playing strategy shift to composing with V3 from playing live with V2. And look at GS less because of this playing style.	Playing style might affect the use of GS. Playing live might need more looking at GS.	Playing style	
6.2	But I did so look at them, and kind of enjoyed them.	Enjoyed look at GS.			
6.21	Oh, if I was kind of stuck and I don't know what to do next. Or especially like at the beginning, when I, you know it was a blank canvas and I didn't really know what to do.	GS helped to overcome fixation, get inspiration and to start		Overcome fixation; Inspiration; Conerstone;	GS function
6.22	But then once you sort of getting into something, then I was more focusing on the thing.	Not looking at GS once getting into something.			
6.23	I mean, I think at the beginning, for experimentation, the graphical score was really cool. And then, when you kind of have an idea about what you want to do, it's less useful but it was still nice to have it there. So you could sort of, when you did get stuck, just have like, some nice ideas.	Positive to GS; In the beginning help experimentation and help overcome fixation later on.		Connerstone in beginning; Overcome fixation	
6.24	I don't really have a rigours mapping for like, how the symbols work.	No rigours mapping for V3		No rigours mapping (V3)	
6.25	The shape one. They were kind of, I was kind of trying to interpret them to do with, sort of like in time. So you know, you'd have some red, you might want to like have some kind of creshadow?? , and then you'd have some blue, although I'd probably replaced blue with another long extending ones. And then, although maybe not, maybe you just playing around with that.	Own interpretation			
6.26	Eh. I think shape more. Because, yeah, shape trumps color. Because like, for example, the blue ones are like percussion beats or you know, the distinct notes, I was still want this blue shape more than I would want the blue… well, I probably would want both.	Shape trumps color		Shape trumps color	
6.27	Yeah, somehow to combine that shape, that color of building up shape with the blue. But, I think, like, I didn't do this but I probably would have attempted that, failed, and then just gone, ok, I'll just use a white instead.	An experience of failure to recreate based on GS.		Failure to recreate	
6.28	This, I skipped really, [pointing to No. 8], I didn't know what to play.	Skipped because don't know what to play.			
6.29	Em, well I think for No. 13 [V3], I kind of did with, producing like, you know when you wanted like a big sound, then would have these ones coming off it.	Music idea inspired by GS of V3			
6.3	From [pointing to V2], because it did come from the score, just the idea that you could like, like here [pointing to No. 12 in V2], like stop all the things at once brokenly.	Music ideas inspired by GS in V2			
6.31	And also, I guess I did enjoy this one as well [V2]. Because like, it was fun to start, like this one was cool, [pointing to No. 11] and to start like, cause they were scrolling past on the screen, kind of layer up different combinations.	V2 helped to start		Connerstone to start (V2)	
6.32	I think this one gave me more structural straight forward ideas about particular things that I could try to do, that actually would sound interesting.	V2 gave more structure; and more straight forward ideas to follow		Structural (V2); Straight forward to follow.	
6.33	But then, actually, I don't know. Because the fact that there was more clear mapping, did mean that you had physical, like, you did have something that you could launch onto, and actually produce something, sort of more concrete.	V2 has a more clear mapping, which is more concrete, good to start with it.		Clearing mapping (V2);	The design suggestion: in the beginning the visual stimuli could be more concrete to help to learn and start, later on could be more abstract for triggering curiosity and imagination.
6.34	This one was more abstract. And so I think it did inspire me in a more, it made me sort of more relaxed, whereas this one a lot of the time I was making not very nice sounds because I was trying to copy it. And I wasn't copying it well.	V3 is more abstract and it's inspired because it's relax; V2 lead player follow it and is not easy to create satisfying result.		Abstract triggers relax;	
6.35	Whereas this I kind of felt more relax and more keen to completely just to experiment and, yeah, try out things.	With V3 player is more keen to experiment sound.		Encouraging (V3)	
6.36	I prefer this one [V3]. I think it has the potential to produce better ideas, but probably with more work. And also it has the potential to produce worse ideas. Just more experimental.	Prefer V3 because V3 has more potential, it takes more effort to create good result. V3 is more experimental		Experimental (V3)	
7.01	Firstly, you have to try to figure out which buttons do what. So you are like, when to stop.	Explore		Exploration	
7.02	And while it lights up, it gives indication of which ones are running on.	Light give visual indication			
7.03	And then, so I think the piano bit, because I'm not really good at music, so I didn't really know how to use like the notes. Cause there are like eight different notes. I didn't know how to use them. So I just stuck with the percussion instruments.	Piano and drum; Don't know how to use piano notes, stay with percussion.		Piano and drum	
7.04	{so how does the graphical score affect your playing?} It kind of like, tries to give you indications of like, which buttons to use.	GS give indications on which button to use		Give indication (GS)	
7.05	if you want to imitate the music scores, like sometimes you want to try and see what they sound like by themselves, without like the improvisations.	Imitate music score; a need for solo listen		Give example; Solo listen (GS)	
7.06	the score was moving as well, while the music was playing. So I was trying to like, I was thinking like, if you could give the score to a specific area. And then if you want to move, then that would be kind of good as well.	For better imitate score, limit it to a specific area			
7.07	Like, if you want to try to imitate, you knew what it sounded like. You did it step by step. Cause that way you can also improve it if you want to.	Listen to the what the GS sounded like. GS serve as an template, or example. Player imitate GS step by step, leave space for improvement.	This is player's strategy for ensuring creative space.		
7.08	There could be another like, option, where like the imitation plays as well, like the score. But then you also put like improvements aside it, like with it.	Improvement based on the score.			
7.09	yeah, they are more aesthetically pleasing than the dots and bars.	V3 is more aesthetically pleasing than V2		Aesthetically pleasing	
7.1	I think they are more inspiring.	V3 is more inspiring than V2		More inspiring (V3)	
7.11	Because I think the other one was, because it was just bars and dots. I think those were more for, if you want to have inspirations in patterns for music, I think those are good.	V2 give more concrete music patterns to follow		Concrete pattern (V2)	
7.12	But like, for this one, if you really can't think of anything, cause it's like, it looks more artistic, I think it gives more inspiration on like maybe if you don't know what to do, kind of.	V3 more artistic; give inspiration when don't know what to do		Artistic (V3); Help overcome fixation by offer inspiration (V3);	
7.13	Cause it's just like trying make it up as you go.	Player make it up as you go in real time	Player does not build a rigours mapping/understanding on GS V3. GS V3 offer an artistic feeling while playing in real time. V3 push player	Play live (V3 is good for play in real time)	
7.14	Whereas for this one, I didn't really understand what it meant, so I was just looking at it and I was like, "ok, so what can you fill when you look at the image?"	What can you fill when you look at the image?			
7.15	It's more of like a feeling,	V3 gives a feeling		Abstract; Give feeling (V3)	
7.16	And then the other one, cause it has like bars and dots, it kind of like give patterns, so it's good for, for example, if you want to have like repetitive patterns, you can be good for like, repetition.	V2 give patterns, good for repetition		Good for repeatition (V2)	
7.17	compared to the other one (V2), which is more like it gives you inspiration for patterns of music.	V2 give inspiration for patterns of music.		Give patterns (V2)	
7.18	{Can I understand it like this, that one gives you more examples to play?} Yeah, yeah, yeah.	V2 give more examples.		Give more examples (V2)	
7.19	For example, maybe like, if I saw like a couple of these, [from No. 1 to 3], maybe I want to have like, maybe more of the, it makes me think more of the red buttons. For example, the red sample. So I might think of use more of the red buttons. And then, maybe if it's like red and blue, some are reds and some are blue, I might choose all of them and grow around. This might be kind of good as like symbolism.			Symbolism (V3)	
7.2	whereas these doesn't really have a pattern, it's just like image.	V3 does not have a pattern, but like image.		Image (V3)	
7.21	{For this one, you just follow the pattern.} Yeah. So maybe like you choose like the different patterns there	Choose patterns to follow in V3		Choose to follow	
7.22	But for me I prefer this [point to V3]. {Because you feel more?} Inspirational.	Prefer V3 as it's inspirational		Prefer V3; Inspirational (V3)	
7.23	for playing around, this is really good [point to V3].	V3 is good for playing around		Playing around (V3)	
7.24	For this one doesn't really have a pattern because you can't really put that on the graphical score and stuff.				
7.25	But then, for this, [point to V2], I think it's good for like music structure. Like if you want to have structure in the music, so you have like, a base, and you have like, want to build it up, I think this is quite good.	V2 help to build up music structure		Build up music structure (V2)	
7.26	For these, [point to No. 8 in V2], it has like a pattern,	V2 give patterns,		Give patterns (V2)	
7.27	I think like, if it's a musician, they would want to have something like this [point to V2], because it's like they want to have structure and then, if they want to repeat like some of their structure, then that will be good.	V2 help musician to have structure for repeat structure.	As V2 help to build up music structure, therefore it's good for repeat previous structure, thus better for musician to perform; V3 is more inspirational, therefore it's good for composer to get inspiration.	Repeatition (V2)	V2 and V3 has different features, serves different purpose. Therefore according to different task, different GS should be adopted.

7.28	But if you're like someone like a composer, maybe, or like someone who needs inspiration, then they could have those [V3].	V3 is better for composer who needs inspiration			
7.29	I think like if I didn't know what to do, I look at the score.			Overcome fixation (GS)	
7.3	I think like for the first bit, I was thinking about the patterns. I try to see like which ones, how it works and stuff like do the dots. And like, if some of the dots didn't work, I delete it. And then just like try again.	Exploring V2		Exploration (V2)	
7.31	If you didn't know what to do, you can look at the score for this [point to V2], and then maybe try like different combinations of the dots and little bars.	Try out combinations		Try out combinations (V2)	
7.32	I followed it more.	Follow V2 more	V2 has this potential to let player to follow the score.	Follow (V2)	
7.33	Because it was more abstract and I didn't know how to apply it to the score. So I just made it up.			Abstract (V3)	
7.34	I think like, I go with the colors that they have. So like, this is a combination, I might go with like something here [point to white], and then green, and then maybe red.	Color indicate combination.		Color indicate combination (V3)	
7.35	I think, cause there were shapes as well in the thing that was playing. I thought I try to relate it to those. So there was like a circle I might add one of the beats that have a circle.	Relate shape to the timeline shape			
7.36	Oh, these one I just thought like the bars you know like about the shapes because it's like the lines. {So the lines are for?} The looping ones [point to red and white]. And then percussions here [point to green and blue] for dots.	Interpretation on V2. It's the same with design concept.			
7.37	I think it's enjoyable. I really like it.			Enjoyment	
7.38	{Did you go back or go to the future?} I went both ways.	Use both future and previous			
7.39	I added like beats to it. And play the blue thing [jumping button] to see what it sounded like.	Add onto previous record		Playing strategy	
7.4	Cause I did, if I want to have different combinations of buttons, you might go to the future, so that when you finish playing the other bits, the two combinations will come out.	Plan ahead		Plan ahead	
7.41	And then like, if you want to build up you just go back and then add more.	Play back to build up.		Playing strategy	
7.42	Because I don't know how to play the piano, so I thought like, I don't know like different chords and stuff, combinations that I could use	Don't know how to play piano (chords, combinations).	Piano notes are more difficult for non-musicians to find out the chords and combinations if they don't have such experience before.	Piano difficulty	Chords and combinations to play instead the single notes. Percussions are easier for non-musicians to handle as rhythm is easier to reproduce for non-musicians (?this part need reference)
7.43	When I was looking at this, the abstract ones, when I didn't know what to do, I will look at it, so like after maybe I've done a bit, and then like, don't know if it's sounds good or not, and then I'll look at the abstract, and maybe look at the colors and see what combinations I could use.	Look for ideas when don't know what to do; Color offer ideas on combinations		Offer music ideas; Color indicate combinations (V3)	
7.44	Sometimes you feel like you want to go out of the box, to explore. Because it's more interesting to look at, compared to like, dots and bars. You want to look at it more.	Player has the motivation to explore more on the box. So the abstract one fit their needs, compared to V2. That's why they find V3 is more interesting because they want to find more of the box.	Abstract GS triggers player's motivation for exploring more of the box.	Trigger motivation for explore more on the box. More interesting (V3).	
8.01	So after trying different interfaces, I have a very very small strategy in mind, just to get the ball rolling. So without being too crazy, I started with the basic beats, which are at the back. So it's kind of like, when the DJ would start the process of building thing, layer by layer. So essentially that was what I was doing, building from the bottom layer to the top layer.	Creation strategy, building from the bottom layer to the top layer.		Build up from buttom layer to the top layer (Creation strategy)	
8.02	Different riffs were also layer together. And then as the things got a little bit richer, I pepped these kind of things, small samples in, just to add some kind of decoration into it.	Decoration to music		Add decoration to music (Creation strategy)	
8.03	But after a few minutes, you kind of become very predictive.	Become predictive after few minutes			
8.04	So I wanted to changed it up a little bit, then I had to use some of these [point to functional buttons on top]. So these were a little bit more scary because they were more complicated to use. So that was the last interface in mind.	Functional buttons are a higher level of interaction		Second level challenge	
8.05	But I was kind of try to like keep up with the graphical score.	Try to keep up with GS		Follow GS (Creation strategy)	
8.06	So when there was a massive diamond, I felt I need to press something, almost like an explosion. So maybe the crash symbol. I kind of interpret it as some kind of loud explosion. And there were some smaller bits with arrows, triangles, and I kind of felt like that was more like a rewind button, so you can kind of use it to rewind back to the music.	Abstract symbol triggers more interpretation. Interpret shape meaning to like explosion, rewind.		Own interpretation	
8.07	But then after that I thought, maybe this is not the one. Maybe it's that I press different colors.	Take color into account.		Color give indications	
8.08	Cause I mean that's a fairly universal symbol for rewinding.	Previous experience.		Previous experience	Use abstract symbols need to take previous experience into account. could utilize or need to avoid ones that can be easily relate to previous design.
8.09	Because I play some keyboard music, but this is a very unconventional set up. So your mind is a little bit scrabbled, you know.	Unconventional set up of keys take time to learn for people who had some experience with traditional instruments.		Scrabbled mind	
8.1	Because you don't feel comfortable. If somebody give me a keyboard, it's very familiar. Or even a clarinet, you know with these keys. So half of the time, your brain is kind of trying to figure out what which notes these [point to buttons] are. And it actually took me at least half a minute to know what the notes are, for the piano. But it was interesting though, interesting process.	Exploring the box, try to figure out the mapping rule.		interesting process for exploring an unconventional setup	
8.11	So it was interesting to just to navigate it. But if there is some kind of indication whether which note belong to which. Then that might have helped a little bit.	Need some navigate to help exploring		Navigation	
8.12	And also if you could play chords, like... {Have you try to play chords?} Yeah, but, so these chords are not like western triad chords. So I was a little bit, not confused, but I try to figure out what's the best sounding harmony.	It takes some effort to play the chords		Play piano chords takes effort	
8.13	But the thing is, like, the music, you know, these graphical points, were very slow to reach, you know. It wasn't appearing like every beat. So you had to like some kind of anticipate it.	The pace of GS is very slow to reach. Have to anticipate the GS		Slow pace; Anticipate (GS)	
8.14	But sometimes you do miss it because you are too busy exploring these notes [point to blue & green buttons].	Sometimes miss the GS while focusing on exploring piano notes.		Miss GS	
8.15	Maybe, maybe if there were some kind of reminder, so when this is about to reach, maybe this count down. Maybe like four, three, two, one. And then this would actually like, enlarge a little bit, and then shrink. So almost like, so almost like a video game.	Count down reminder/indication for GS		Count down reminder (GS)	
8.16	It's almost like a queue. I think some DJ have this kind of thing I think. Or they have this ear piece, and the guy actually counts them in. Especially like the pop singers, when they about to sing, cause it's so loud, so they need someone to counts them in. It's almost like a graphical version of that.	GS as video game queue.			
8.17	But I was even more aware of the graphical scores.	More aware of the GS with V2	This is possibly due to the fact that this is the final prototype.		
8.18	Because they really resemble the, you know the Morse code. So it reminded me of the Morse code, which is very systematic and very organised.	V2 is very systematic and organised		Systematic; organised (V2)	
8.19	So I tried hard to really follow that, my interpretation of this graphical interface.	Tried hard to follow GS		Follow GS (Creation strategy)	
8.2	But it was also a little bit frustrating because, yeah. I mean the layout of the score was, it kind of indicate that I should press different buttons at the same time. But because some buttons are continuous and some buttons are not, I was a little bit confused how these would actually work out.	Frustration due to some confliction in GS			
8.21	If it was just scores for this part, like that would make even more sense to me. Not even any of these [point to white and red buttons], just this [point to blue and green]. Because you can play them and not play them.	GS make more sense to short beats compared to long samples as short samples are easier to manipulate.			
8.22	You try to follow it. Because if you are a trained person, it's all about following the score. Because I'm classically trained, so when I was playing, I always try to follow. And also, I was playing with the orchestra with all the people, you have to follow everything.	Participant who have clasical training experience wil tend to follow the GS.		Tend to follow rigorous (V2)	
8.23	because this was a little bit too much like, "this is the code and you have to follow this".	Participant felt obliged to follow with V2		Obliged to follow (V2)	
8.24	So for me, this would be very useful if you are playing with another person. So that you can synchronised together.	V2 is useful for collaboration for synchronisation purpose.		Good for collaboration for synchronisation purpose (V2)	
8.25	But that was more, I think for me that [V3] was much better	Prefer V3		Prefer V3	
8.26	But the picture, I really enjoyed the pictures [V3].	Enjoye the pictures of V3			
8.27	Yeah, this is great. This is almost like, it's very abstract, so this could be like an explosion. And for me, that's like a half explosion but with like a base line, playing underneath. So you can be so creative with this.	V3 is abstract and more creative		Abstract; More creative (V3)	
8.28	And this one [point to 8], this one could be this [point to scroll nob]. Or like a note modulation, which we don't have at the moment, but you know those kind of bending notes. That could be that. And this [point to No. 11] could be like stop, this one. Because that's red, and red means stop, like a traffic light.	Interpretation (V3)	Abstract symbols triggers imagination of player, that he develop his own unique understanding of the GS.	Interpretation (V3)	
8.29	But this is really great. I'm telling you, I really love this.			Enjoyment	
8.3	I mean, this is actually the opposite [V2]. Yeah, so this is more like decreasing the creativity, for me. It's very very like oppressive.	V2 is oppressive; V2 is decreasing the creativity		Oppressive; Decreasing the creativity (V2)	
8.31	this [V3], because you can improvise. It means anything to any people. No, it means different thing to different people	V3 is creative because it allows improvisation		Allow improvisation (V3)	Support creative engagement need to support improvisation. Abstract visual could be one option.
8.32	{and then you look at the graphical score occasionally for inspiration.} Exactly. Yeah. Especially the big parts [point to No. 12, 13].	Look at GS occasionally for inspiration. Focus especially big symbols in V3.		Look occasionally for inspriation;	
8.33	So I would tend to ignore these [point to No.4-8, dots], because you are too focus on what you are doing at the moment	Tend to ignore the dots symbols in V3	Focus especially big symbols in V3 and end to ignore the dots symbols in V3. Probably because dots are too small and easy to ignore.	Shape symbols prior than dots ones	Designing better recognised symbols
8.34	But these would be like key points, key sound butts.	Big shapes indicates key sound points/butts		Indicate key sound points (V3)	
8.35	I guess it's more visually more appealing.			visually more appealing	
8.36	But these [NO. 4- No 10] are very very small...I mean these could be very small sounds.	Map size of symbols to the sound volume		Map size to volume (Own interpretation) V3	
8.37	But I think if you play longer, you get used to the things, and then you would focus on these.	Get used to GS			

8.38	{So I guess if you got to choose, you will definitely choose the abstract ones? } For sure. But with a group, this one [V2]. If I'm playing to someone. It doesn't have to be another person with the same machine, but maybe a drum or a keyboard player. I will actually follow this [V2]. But we have to agree what it is first.		V2 and V3 suit different senarios: V3 for solo playing and V2 for group.	Solo vs. Group (Scenarios)	According to different senarios, choose different GS.
8.39	I think if you're practicing, then I don't need the score.	Practice no need the score			
8.4	But then if I'm performing, so that's a big difference. You are performing to an audience. So you wanna be even more inspired. So I think this will be very very helpful. But you know what it is, even the big rock bands, they practicing in the small room like this. And then when they go to the concerts, they always have this kind of visual thing. I mean, it's at the back of the thing. But it's obviously to help them. So this could be like the version of the thing	When performing to audience, V3 will help to be inspired.		Performing to audience need to be inspired (Senarios)	
8.41	{BTW, did you use the timeline to go to previous or to go to the future?} Yeah, I tried. But it was a bit too much for me. Because I'm not a DJ, if I have some DJ experience then maybe			Plan ahead is more advanced technique	
8.42	{Did you try to queue things up in the future?} I did. But again, it was a bit too much… But in general, if it was a little bit too complicated, I try to shy away from it.			Plan ahead is a bit too much	
8.43	{So you mainly played at the current time?} Yeah			Play live mainly	
8.44	Maybe because I felt I need to create something that's quite good, rather than experimental completely.	Player has requirement on the quality of the music.			
8.45	Because the notes are very very restrictive. I mean if you ask any musician, they would say, this is too restrictive.			Piano notes are restrictive	
8.46	But with the drum beats, you know, you can experiment with different rhythms.			Drum allow more freedom to experiment rhythms	
8.47	But when I was, I had half minute to figure out which notes these were. And you know, this is really confusing, cause it goes like, 1, 2, 3, 4. So it's not like this way.			Take effort to figure out piano notes	
8.48	But if you are creating something that sounds nice to your ears. This would be a bit of problems. Cause of course, I can follow this exactly. But with the sounds, I didn't really like it.	Felt disappointed on the result following the GS.		Disatisfied on the result from GS	
8.49	But with this [V3], because it guides you but it's not really asking you to do it. This [V2] is like, asking you, "so you have to do this now".	V3 provide guide but not instruction; V2 give instruction		Offer guidance (V3); Give instruction (V2);	Player felt different on the
8.5	I enjoyed more with V3.				
8.51	Yeah, so, for me it was a little bit too many options. I mean it's wonderful, but it's too many option. But for me, I'm just used to only one thing. But if you give me this, I can be very creative with one of this [point to one button]. {One of that? You mean only one button?} Yeah. So one of this [blue], one of this [red], one of this [green], and one of this [white].	Constraints triggers more creativity		Contraints trigger creativity	
8.52	Because creativity for me it doesn't have to be impressive. Like I don't have an audience, so I can be like very very silly and stupid. But it's creative for me, as long as I'm happy, that's alright. But if there is a performance, like DJ, Raph came, I'll be very nervous.	Creativity doesn't need to be impressive; Creativity can be experimenting things. But in terms of a performance, creativity need to be accepted by other audiences.		Creativity definition; Senario for creativity	
8.53	But, this is great. And you've got so much potential. I see like a DJ bar with your stuff and experimenting with it.			Potential for experiment	
8.54	And like, take this to schools. Because that's where they learn music. So everyone at school always starts with this [keyboard]. So in their mind, they are always stuck. This is a huge problem for creativity. But if they just give you this, then there can be whatever they like.	This could help young kids creativity		Potential to trigger creativity	
9.01	I'm really struggling composing something cause I'm not a musician.	I'm not a musician		Lack of confidence	
9.02	Because usually when I do someone's study I felt like "oh, music supposed to be something that supposed structured, not very improvised". But now at some point I was like, "oh, I can just improvise. It would be fine.".	Thought making music need to be structured composed, realised with this box he can just improvise.		Shift concept of music playing	
9.03	Yeah, so in the beginning, I tried to look at the graphical score. But then I found it difficult to. So I, at some point I think I didn't look at the graphical score any more.	Try to follow but find difficult		Find difficulty to follow GS	
9.04	I think the timeline stress me up because I tried to find out what the graphical score means. And at the same time try to do something that correlates to it. And then the time was too quick for me to actually slowly think about it.	Timeline stress player up while trying to find out what GS means		Overwelming information; Multitask	Too much information, too fast, or multitask always challenge non-musician's abilty, which easily lead to frustration, and thus draw back their exploration.
9.05	Sometimes when I went back in the timeline, I felt like, that, and then when I went back in the timeline, I realised that sometime what I did did correlate to the graphical score. So maybe that's something like unconscious adapting of the shapes and so.	Look at GS occasionally			
9.06	But I found it interesting to think about what the graphical symbols mean, like what the difference between like the bubbles, and the size of the bubbles and stuff like this. And that I found interesting. And also the lines between the dots also. I found it interesting to think about what it could mean, how it could be translated.	The process of making sense of the GS is interesting; Enjoy the process		Intrigue, Making sense of GS; Enjoyment	
9.07	But then, I think because I'm inexperienced in like making music, or so, I was a bit rush with the timeline, and then you know I still would kind of need more time to be able to reproduce something that's in the graphical score, with like going back on the time, kind of torching around.	Inexperienced in making music; Scroll function need more practice		Lack of confidence	
9.08	I mean in the beginning, when I was trying to interpret and create, yes, so I was, I think, I mean the things I went for, looking for interpretation were I think first the colors, and then second the shape, and such, and the size of the shape. And then the last bit was the lines between the dots for example, I was thinking like "oh, what does this mean, how could I like interpret that."	Interpretation on GS V3; The 1st is color, 2nd shape, 3rd size, 4th relationship between graphics; Abstract symbols trigger reflection on interpretation.		Priority of graphic element	The design need to take into account the process when people interpreting a symbol, the priority of graphic element.
9.09	Then when I went back to maybe add something later, then I looked at the graphical score, and thought like, "Yeah, that's when I realised sometimes I would like unconsciously maybe correct what I did with how I would interpret the graphical score."	Unconsciously correct music based on GS.		Use GS to correct previous	
9.1	And then, but I don't really know if it affected me in like what I added afterwards, you know like after went back in time if I then added something.	Add onto previous creation		Add onto previous (Create strategy)	
9.11	I didn't do it in a systematic way. It was more of like improvise that kind of thing.	Improvisely adding to previous		Insystematic way/ Imrpovise (Create strategy)	
9.12	So ok, with this graphical score, in the beginning, I thought it would be more easy to interpret. But then when I tried to interpret it, I found it actually more difficult than the first one.	V2 looks more easy but actually more difficult	Reason? Might be because when participant felt more obliged to follow, they felt less relax and more difficult to follow.		
9.13	Because here it gives you suggestions of the length of things. So it worked for the loops, but not for the other bits that much. I mean there are dots as well, so it kind of works. But then I felt there are more lines compared to the dots, so sometime when I tried to interpret the lines as duration of time, and the different colors as different melodies, I found it confusing, like I wasn't pleased with the audio result.	Length of duration work for loops but not for the other short samples; Not satisfied with the audio result by following the score.		Dissatisfied with result from GS.	
9.14	And more the, I think in general, I focus more on the graphical, on the visual outcome of what I've produced.	Focus on visual outcome produced on timeline.		Visual outcome	Visual outcome could also be a source for inspiration.
9.15	{After the first initial part, did you go back to look at the records?} I think less than the first one. Because at some point I got really into playing, and then I didn't care about the graphical score any more, and then, at this time I didn't go back in time. For the first prototype I did.	Go previous more with V3, less with V2; Engaged in playing lively, ignored GS and other options.		Engaging in playing live	
9.16	And then I also found it easier to look back at the graphical score. But maybe because this is very linear as well. So it's like a very linear understand kind of, it implies a very linear understand of the music more than with the shapes.	Linear design implies a very linear understand of the music more than with the shapes.	This "linear understanding" seems an important achievement of V2 as it sort of help player to develop understanding, and the structure of music kind of thing.	Linear (V2); Develop a liear understanding of music	
9.17	{So for the previous one you went back is just to double check what you've done, or} Oh no, I added something.	Add onto previous		Add onto previous	
9.18	For both I think. That in the very beginning, before I figured out what I wanted to do, I kind of went back and delete it and kind of started all over again. So, but I think just in the beginning.	Use delete in the beginning			
9.19	I always went to the past and added things, other than future. Cause sometimes I took the loop as a base, and then I added the beats to it in the past.	Always scroll to the past and add onto previous			
9.2	What I find aesthetically more appealing is the first one [V3]. And I also find it gives more space for interpretation. So it's kind of nice that you can make your own idea of what the things mean because it's multi-dimensional.	V3 is multi-dimensional, allows more space for interpretation, and is more aesthetically appealing		Multi-dimensional, more space for interpretation, more aesthetically appealing (V3)	
9.21	So I think if I would have to recreate something according to what graphical theme, I would find this more interesting, the first one [V3]. Because it gives space for also discussion what the size and shape means, and it's just a bit more to kind of interpret from I feel	More interesting for recreation based on GS theme as give space for discussion on interpretation.		More interesting for recreation based on GS, allows more freedom (V3)	
9.22	Whereas the second one [V2], in the beginning as I said, I thought it would be easier to interpret it, and try to recreate it musically. But then I found it more difficult, and kind of more linear and strict.	V2 more difficult, linear and strict		More difficult, linear and strict (V2)	
9.23	Serious the duration [point to V2] for me it was like the length of the line is like the time duration, and then the color according to the different things.	Interpretation on V2, lines as duration of time		Interpretation (V2)	
9.24	And here it's the duration, the color, but also indicates, like you know, these different loops have also different shapes, so it could give actually more explicit explanations of maybe, which shape to.	V3 has more factors		More factors (V3)	
9.25	In the beginning when I was playing with the second one [V2], I did feel more obliged to follow it on there. Cause I thought it would be easier to actually follow. But at some point I figured out that for me it wasn't easier to follow.	Obliged to follow V2; Not easy to follow V2;		Obliged to follow; Not easy to follow (V2)	
9.26	But from like, if I imagine to follow it, like also I tried in the beginning I found the first one more interesting. Because it does kind of give you some kind of ideas about like shapes, and then the shapes correlate with actually the individual buttons maybe. Cause on the buttons, you know the loops and the beats they have different buttons as well. They are like circles, and triangles, and rectangles, which you could maybe correlate to that.	V3 more interesting; Interpretation: correlate the shape to sound shapes on timeline		More interesting; Interpretation: correlate the shape to sound shapes on timeline (V3)	
9.27	{So in terms of the inspirations of musical ideas, which one do you think gives you more inspirations to play?} I think also the first one [V3].	V3 more creative		More creative (V3)	
9.28	Because it leaves also more space to interpret, so I would feel more creative in trying to translate these symbols into musical piece.	Player feel more creative when GS allow more space to interpret.		More space to interpret cultivate creative engagement. (V3)	
9.29	Whereas here, [point to V2], as I said, it looks quite linear, so I felt like dot and line, that's kind of like clearly distinguish in terms of what I can do with this. And then the durations are still quite short, so it didn't sound very pleasing to me when I tried to recreate this and interpret the lines as durations. So it felt a bit more strict.	Feel more strict with V2 as it clearly distinguish what people can do with it; Not pleasing with the sound from V2;		Not pleasing with the result; Feel more strict (V2)	

9.3	So the first one I used when I went back in time, and I kind of accidently discovered that even though I wasn't following the graphical score that much, but I did something that was still relate to it. So I thought "Maybe I did it unconsciously. Maybe I followed it without knowing. "	Affected by GS unconsciously, followed it without knowing		Unconsciously affected by GS	
9.31	I think like, this. [Point to No.12] Yeah, like I can't really remember, but this is an interesting shape, or like this. Because I tried to correlate with the color to shape, and find 0 quite interesting, and 12.	Interesting shape			
9.32	Because it gives me freedom and also kind of make a systematic sense of things. So a lot of time in composition I feel like I understand.	Give freedom and also a systematic sense of things. Player felt he understand and his interpretation make sense.	" I feel like I understand. "	Give freedom and a systematic sense	Balance of freedom and systematic rules, allow multiple way of understanding
9.33	So I maybe used it like when I went to the past and added some elements in to what I've previously created.			Refer to GS when adding onto previous	
9.34	So I think the easiest thing to adapt it is the points, because then I can, you know, it's the easiest to click. To go back in time or something, like you know, it's just clicking.	The dots/short sampes are the easiest one to adapt to			
9.35	Whereas this is more complex to interpret [point No. 0], but it's more interesting. So I found it more creative.	In V3, shape based symbols are more complex to interpret but more interesting and creative.	More complex symbols but more interesting and creative.		
9.36	Whereas this if you have something very strict for learning, to really really produce, yeah No. 4 and 5, or like 8 and 9 they also look like easier to read for beginner, but less creative.	Dots symbols are strict for learning,dots one are easier to read for beginner, good to learn but less creative	Simple symbols are easy for learning, but strict for interpretation, less creative	Graphic complexity and learnability	Balance the complexity so as to balance the learnability and space for creativity.
9.37	Maybe without. Because in the end I felt I didn't follow the graphical score a lot. And I found like, again, the first graphical score is a nice visual addition. But it helped me very margin, very little in creating music.	V3 is a nice visual addition; Prefer without GS as GS does not help much.		Nice visual addition (V3); Prefer without GS	
9.38	So I found it interesting to go along, to maybe if I run out of ideas to reflect back to it. So I wouldn't mind if the first graphical score is there.			Overcome fixation (V3)	
9.39	But for the second one, I felt like "oh no I need to ignore it", because otherwise it will stress me.	Need to ignore V2 as it will stress people		Stress people (V2)	
9.4	I thought in the beginning with the first graphical score would help me to learn. But then I felt stress about it. Because I didn't like the result of trying to recreate it, so I kind of skip it.	Dissatisfied with result, fell stress about it		Stress people when get bad result (V3)	
9.41	I think the first graphical score could help to explore and create. But less to learn. Unless you are an expert maybe and really know what it means. And also because you know it's quite short and the time was like proceeding.	V3 help to explore and create but not to learn	Reason: Abstract to know what it means, time proceeding	Help to explore and create, less to learn (V3)	
9.42	And the graphical score if you go back in time, because in the beginning I also tried to like, go back, and reproduce the graphical score with the first one. But the graphical score didn't go back in time. So I was like, "Oh, I can't."	Can not control GS		Controllabilty	
9.43	And then I wanted to go back and realize I can't go back for the graphical score. That's also I think part of the reason why I didn't follow it anymore.	Stop follow score because can't control		Quit following GS	
9.44	Because I tried to but I wasn't fast enough to recreate it or something.	Player feel he is not fast enough to recreate the sound from GS.		Not fast enough	
9.45	I mean it can be like very free just like give you some inspirations if you're out of ideas. It pops up you know.	Pop up inspirations to overcome fixation			
9.46	at some point when I accept it that I'm not strictly following it, then it's kind of more free and then I can just refer to it when I'm out of ideas and feel like "oh, how could I make this? How could I turn these symbols into a sound now? "	Not strictly follow GS, more free		Not strictly follow	
9.47	Because as a non-musician and someone who doesn't, I don't know even play an instrument. I always felt like "ok, right, I need to produce a piece of music and it needs to systematic organized. And it needs to make a lot of sense in terms of the composition."	Non-musician has this concept that they need to make a structured and coherent piece of music.			
9.48	So I tried to also visually like maybe mathematically to see it's coherent.	Player try to use visual and math to help create a systematic organized piece of sound	Visual and math do help creating music in a sense;	Visually & mathematically coherent (Create strategy)	
9.49	But at some point I was like, "No, actually I can improvise." I can still make a pattern where I can include some regularity of it. Because I visually saw like the distance between the sounds and source so I could match it.			Shift concept that they can improvise	
9.5	But I was still more free in improvising. So I found it's nice to improvise and still have some level of control of like making a coherent melody. Yeah, it's like a jazz box.	Enjoy improvise with a guarantee of music quality; It's like a Jazz box		Play live with guarantee	Gurantee music quality is an ensential step to encourage improvising. From other feedback, frustration or disatisfaction on result always lead to some sort of quiting.
10	It was interesting. Yeah, it was fun.			Enjoyment	
10	But like, you know when you are playing an instrument, you kind of like press it really frequently and you wanna hear it. So that was the only problem because if I was even pressing it frequently as you said it would come with the beat, with the correct beat. And the sound of pressing the keys was louder than the actual sound.			Direct and instant sound feedback	
10	So, yeah, but it was interesting like, I forgot everything else for the moment.			Engagement	
10	I was, what I was trying to see was like what it even means. So yeah, like it's difficult to interpret.			Difficult to interprete (V3)	
10.1	But when it's there you kind of like make your own meaning of that.			Develop own interpretation	
10.1	And then just like, you follow it for a while, and then you're just like, you give up, you don't understand.	Start with follow but give up because don't understand		Quit follow as not understand	
10.1	Because like, I was trying to like interpret it, but it wasn't working really well. It didn't make any sense.			Difficult to interpret (V3)	
10.1	I was looking at it like frequently as to see if there are only two green or two blues, I would play it. But if there are so many like mix, I wouldn't know what they mean.	Follow the easy shapes but ignore the complex ones.			
10.1	This one was even more difficult to interpret than the first one for me.			More difficult to interpret (V2)	
10.1	Because over there it at least have triangles and stuff, and when you play certain keys and it gives you triangle or a square.	Match the shape with the timeline shape			
10.1	But this one are just lines, you don't know what they actually mean. Sometimes they are in this position but sometimes they are on top of each other.	V2 is more difficult to interpret than V3			
10.1	So the difference, what I feel was like in the first there were a few shapes, that you could at least try to follow.	The design of shapes make V3 easier to follow			
10.1	So like, there is a pattern so you get to read for instance the blue and then the yellow, and some of them actually have the triangle shape. So you feel like you are understanding it more.		"You feel like you are understanding more."	Shape help understanding	
10.1	And then, whereas here it's just like lines [V2], and you don't know which line should you play first. So like, in this one, it's like easier you playing red and then you play a blue, and then you play yellow. And then you think "what does this mean? Isn't this the same as that?". So it was difficult. And especially this one [point to No.7], because like you don't know "Should it be synchronize in that way or something?". But this one [Point to No. 9] was a bit easier, so it was just like you play a blue, and then just let it drop a bit, and then you go on to yellow bit. That's what I took out of it.				
10.2	But I don't know if I'm right or wrong since I don't know any music.	Lack of confidence			
10.2	I wouldn't say easier, but like you can just create something in your mind from that. But like, if you tried to, you can just come up with something, trying to follow it.	V3 allows different interpretation, it's easy to come up with something			
10.2	Yeah, I would say the first was better [V3].			Prefer V3	
10.2	In the beginning I was just like trying to follow it till I guess the six note. And then I was like "Let's not follow it". And then this one appear, because the dots were difficult to follow, whereas this would still be like you play the reds.				
10.2	So for the first one [No. 0], when I just started, I just put like the first red, the second blue, and the third yellow. Yeah, so it's just like number of them in your brain. And then, yeah.				
10.2	Yeah, and it's like visually it doesn't, it's visually pleasing. And you just look at it and you are like "ok, I might follow it." Yeah, it just get a bit like, when you come to this one [point to No. 3], you are just like "ok, what does this mean?".		It's interesting to see that a lot of participants say this when they look at GS in V3.	Visually pleasing; trigger the motivation for creation. (V3)	
10.2	I would look at it occasionally. I'm being very honest. The same was here when I was doing from 4 to 11, I was following it occasionally. Because from 2 to 11 they are a bit not making sense.	Look at GS in V2 occasionally as the dots symbols are not making sense		Dots symbols not making sense	When designing GS, shape is easier to understand than dots symbols. Need to take this into account
10.2	Whereas these triangles [V3] still make sense.			Shapes making more sense than dots symbols	
10.2	I just to like look at it and trying to follow it again. Because you were unable to follow it in the first place. So you just like occasionally you go there, there is a note which is easier you try to follow, interpret it.				
10.2	It did helped to like, have a look at the colors of different keys, but I wouldn't say that what specifically what it focused on	The GS gives some ideas but not specific ideas			
10.3	If you mix them both, that will be a perfect inspiration.	Mix V2 and V3 is a perfect idea.		Combine V2 & V3	
10.3	Like you mix both of them. Because some of the notes here are not easy to interpret, some over these are not easy to interpret				
10.3	Because dots here do not make any sense [V3], dots here make sense [V2]. Whereas the bars do not make sense [V2] there but the shapes still make sense [V3].	Reason to combine V2 and V3			
10.3	But when I was looking at it, as I said, I was trying to follow, so it would create something new.	Gs gives some new idea.		Offer new ideas.	
10.3	Even if it's there, it would just like, because you would look at it, even if you don't want to, you would look at it cause it's there. And you would like, naturally in your mind, try to follow.			Unconsciously affected by GS	
10.3	But with this it's just like it kept me going.			Keep playing going (Overcome fixation, motivation)	
11	Well, so I went to try out some of the things on the score.	Start with exploration			
11	But I found it quite hard with the timeline. That the timeline just moves, and things doesn't...	Paticipant indicate the timeline moves too fast, and they don't have enough readiness time to keep up with the timeline.		Difficult to follow (timeline)	
11	And it's graphic, so it's sort of encouraging this sort of graphic interaction with the music.	The GS encourage graphic interaction with the music	Graphic interaction with music is an interesting phrase.	Encourage graphic interaction (GS)	
11	Because it's all like visual, right? You're presenting the music visually in a timeline. And then you're suggest, you have a list of suggestions, like visual.	Timeline is a way to present music visually. GS is a list of visual suggestions.		Presenting music visually on timeline; Visual suggestions (GS)	
11.1	And then what I create does not correspond with the visual. And then it's just for me I found it's very confusing.	When participant can't recreate the music correspond to the visual, they feel confused.		Relate music to visual; Frustration	
11.1	I was trying to like, experiment what was presented to me. But it didn't, the two things didn't work very well together.	Experiment with the visual; Do not satisfied with the result from GS.		Disatisfation on result (V2)	

11.1	{Did you stop following it?} Yeah. But then, that's how I started.	Start with following the score and experiment the visual suggestions, but then stopped after a while.	They stopped follow the score when they feel frustrations.	Quit follow GS (V2)	
11.1	But then you have no like feedback, I still don't know what I was doing is good or not.	Don't know what I was doing is good or not	Lack feedback for whether the interaction is good or not. When participant felt they are obliged to follow the score, maybe because they take it as a gamelike thing, need the system to give a judgement on their outcome. Or maybe because they lack the confidence to judge their music work.	Feedback on quality	Provide feedback to help player judge the quality of the result or interaction. However, for non-musicians it's difficult for them to play in real-time and judge due to their abilities.
11.1	So you could either work with it as just like a painting, I guess like graphics, and then play back and listen, "ok, this is good, this is not good.". or if you are doing it in time with the music, so you hear the music.	Work on music like painting. Play back or play in real-time to judge the result quality.		Work on music visually; Play back to judge music quality.	
11.1	It was very hard to sort of stop and start.	The visual which suggest stop and start in short time, which is not easy to achieve, and not good musically.		Difficult to do in real-time	
11.1	{You mean in real time, it's difficult for you to manage everything?} Yeah. That is like, I don't know whether if it was looping back on itself, like if it was a restricted time piece brings it here. Because then you can, second time it loops back you can add another element, then you can add another, I mean then it will be a loop rather than a composition.	Auto-looping	Participant suggest another way of doing the creation, with the help of the auto-looping so as to go back again and again.	Composition mode	
11.1	I don't understand what the different buttons, like different sounds it does.	Trouble to remember the buttons and its sound		Remember	
11.1	I found this [point to V2] definitely more helpful in terms of visualisation. Whereas this one [point to V3], the abstractness of this. Because they are giving the same information. Yeah, for me this [V2] is a lot easier to read than this [V3]. This [V3] needs a lot more interpretation.	V2 more helpful in visualisation, easier to read. V3 need more interpretation.		Helpful in visualisation, easier to read (V2); Abstractness, more interpretation (V3)	
11.1	But I think because this [V2] is like saying exactly what the timeline. Whereas this is like abstraction, so..	V3 abstraction	The GS of V2 correspond to the timeline, which make it easier to understand.	Abstraction (V3); Close to timeline (V2)	
11.2	Like if I knew exactly what buttons, and like if I knew how to play an instrument, I think it would be more useful, this [V2].	V2 will be more useful after people get confident with the instrument.	Participant has been underlining that she is not yet confident with the prototype yet, mainly because she have no music experience before, and she can't remember all the sounds, or match the sound with the button.		
11.2	But I didn't feel like I could really explore like the composition, because I was still exploring the instrument and the sounds.	Not enough time for exploring the composition, still explore the instrument and sounds.			
11.2	{Do you think the graphical score helped you to play?} Yeah, possibly once you know what you are doing. if I knew this sort of scale, or that it was like in the keyboard style, I don't know, so that I would knew where I was. Whereas I feel like with this that I'm just groping in the dark.	Paticipant cant match the sound with the button. So she is groping in the dark	Participant is suggesting a mapping of the sound so as to help to remember the sound, like the scale.		
11.2	Because like I was just push the button it wouldn't necessary be the right sound that I wanted.	Randomly push button	Because participant can't match the sound with the button. This randomless cause a problem.	Memory	
11.2	And then there was no undo or like, … You can't edit. Yeah, you can't go back and edit and say actually I don't want this part of the line, because you will then just get rid of everything [behind].	Edit		Edit necessary	
11.2	{So for V3, the second one you were playing, are you still following the same strategy that you are trying to follow the graphical score?} Not, sort of. But also just like, trying, exploring.	Player adopt different strategy for playing, V2 for more following, V3 more randomly exploring.		Play strategy	
11.2	Less frequently with this [V3]. Also because I don't quite understand how to do this on the timeline [No. 4, 5 of V3]. Or like these things [point to final ones of V3], I don't understand how they. Like I can understand how to do these things [point to No.3 to 9 in V2]. But I don't understand V3. Like I can see that there is a similarity, but this is like,	Look at GS of V3 less frequent because she don't understand some of the symbols.		Occasionally look (V3)	Abstract symbols has this potential to free palyer's attention to focus on music perse, rather than visual.
11.2	I mean, it looks nice.	V3 is visually nice.	Even though people find V3 too abstract, they still think it's visually nice.	Looks nice (V3);	
11.2	Oh, visually, probably this one [V3].				
11.2	But this one [V2] says what it need so much quicker.		V2 is better in terms of the efficiency of communicating the information.	Efficiency (V2)	
11.3	So there is more like, you don't need to interpret what the symbols means, it's just like, yeah, I guess this. You could have given me this [V2] without explaining what it does, and I would have understand it.	V2 is direct, no need explanation		Direct, easy to understand (V2)	
11.3	Whereas this one [V3] I would definitely need an explanation. And I'm still not sure if I understand.		Even though after explanation, participant still not sure she get it correctly.	Need expanation (V3)	
11.3	I would have no idea how does this means [V3]. I mean this one [V2] I would have been like, "yeah, I get it".				
11.3	it sort of make sense to me, but at the same time, like I don't know.	Abstract symbols has this uncertainty, which gives the potential for free interpretation.		Uncertainty	
11.3	That it's like, there has to be a relationship of what are the sounds combine together.				
11.3	because the first time when I was playing with it on my own, without anything, that was the most fun I had.	Playing witout any GS offers most fun		Most fun without GS	
11.3	Well, so I'm not really a musician. But it's like, so I can't say whether what I want to achieve is like I want to make this pattern exactly, and that's what I'm upset that I can't make this pattern exactly.	Upset that can't make the pattern exactly.	While following the GS, participant tent to try to reproduce the pattern that the GS suggests, but there is this potential that it will easily frustrate player when she can't really make it.	I'm not really a musician. Upset for reproduce.	
11.3	...that it is like, "this is very distracting.". Like I keep trying to make this happen, and it doesn't happen, and it's sort of conquer me. Whereas when I was just given no instructions, that was kind of.	Distracting, player try to make it happen but it doesn't happen, which discourage them	So basically this thing gave player some kind of compulsory, that player kind of feel obliged to follow it. And it also kind of distract player to focus on the music itself. Need to notice that this is the first p that was told about all the design concept before she played. This telling thing might influent p's experience, making them feel obliged to follow and recreate the score.	Discouraged, frustration	Need to be careful about this, reducing the potential for making player frustrated.
11.3	{So you were trying to recreate the patterns of the graphical score. Is that kind of stop you from building a whole piece, like a structural piece?} Yeah.	Following GS is not good.			
11.3	When I do my creative work, not making music, you sort of have to let go in the beginning, and just like explore and try things. And maybe this is good to sort of try things in the beginning and say "ok", so just like play around with these things. But then have a break, and then just like create things, and then maybe come back and like, "ok, I kind of like this.", but maybe if I look at it, it's kind of like this pattern, "maybe if I try to make it more like that, it would sound better or." That it's like, it's a long messy process.	Creation process is a long messy process		Messy exploration process	
11.4	Or maybe there could be like a toggle thing, of like, yeah, I want to, like I feel a bit stuck now, I want it to give me some inspirations, and then you can turn it back off again. And then you can just free style for a bit then.	Visual score has the potential to give offer inspirations.		Offer Inspiration (GS); Control GS	
11.4	{So in terms of these two, I guess you will definitely prefer the V2. } Yeah.	Prefer V2.		Prefer V2.	
12	I felt like I have an expectation of the outcome, but it doesn't.			Expectation on outcome	
12	I think, all the changes I made came out of exploring, mostly exploring the keys around, more than following the screen.	Exploration		Exploration	
12	So I think I felt like all the things that kind of made me to make any difference, was mostly based on the keys on there, on the instrument, more than following the screen.	The sound affect more rather than the GS		Based on sound than GS	
12	Because there were too many things. I knew that there was something going on at the top, but it wasn't that easy to follow for me.	Exploring keys around. Too many things going on, which is difficult for people to follow.		Difficult to follow (GS); Information overwelming;	
12.1	Because I knew that there was something going on there. But, first I didn't feel so familiar, and I saw that there was a pattern but I didn't know how to catch up with that.	Not familiar, can't catch up with the score			
12.1	So that was, I think I could have done maybe, how to say, even more [adding], but I think I want to hear kind of harmony easily	Could have done more; Focus on sound		Could have done more; Focus on sound	
12.1	So once I found something that was matching, I stopped following the screen.	Follow the score in the beginning. Depend on listen.		Quit follow GS	
12.1	but then it wasn't easy at all, to look at that, to try to understand, but at the same time to do something. So, if I just watch it, that's fine. But at the same time I couldn't do anything	It's difficult to do different things together;		Multitask	
12.1	So I just started to touch the keys and try to get a nice music out of it			Focus on playing	
12.1	Yeah, I think there were a couple of times that I checked. Like when I was just doing one note at the time, I checked once or saw, just three small dots, "ok, probably that's in line". But apart from that I didn't really follow. Because I felt like it was too much to…	Check GS occasionally to make sure everything is in line		Look at GS occasionally to make sure quality	
12.1	It was actually, because I wanted to keep one of the notes in the loop and I didn't know how to do it. And I don't know if it's possible to do at all.	Look at GS for solutions		Give support for solutions (GS)	
12.1	Because I wanted to do many of the keys here [point to blue and green buttons], in this right and left bits. So I moved it a bit forward in the future, so I did that and I came back and I was listening to it and I did that.	Reason and process to go to future		Plan ahead	

12.1	So that it was, I mean I could have done it at the same time, but I think I can't focus on two different things at the same time. So I was like, "let's do it in the future" so that I can come back and […] in the future.	Can't doing two different things at the same time		Plan ahead	
12.1	I mean, I think it does. Because, it's, I guess it's clear that there is a structure that's happening there. Even though, yeah, usually, there were differences between two or three patterns	GS offers a clear structure of music		Offer structure (GS)	
12.2	But I think I need more understanding of it to be able to follow.	Need more understanding to follow	The participant kept saying that she need more practice to develop more understanding, which is the same as P11. This is maybe due to the fact that they were told about the design of the graphical score, and they felt they havn't grasp all the meaning of it. So that it gives a kind of pressure.		
12.2	Yeah, I lost the track of it eventually. It was just in the beginning that I could focus very briefly.	Lost track eventually			
12.2	No, I didn't feel obliged at all.	Do not feel obliged to follow at all			
12.2	I think that's why I made maybe a choice in the very beginning. Because I can follow it, and then it can be just random, not nice outcome. Or I try to make something nice based on whatever I discovered here. But it was really hard to focus on both at the same time.	Follow and explore are hard to do at the same time. Dissatisfied with result from following GS.		DIfficult to follow (GS); Multitask; Dissatisfaction on result.	
12.2	So for prototype 2 [V3], I was focus more on the score, which was more chaotic this time.	Follow V3	Different strategy for the graphical score.	Follow V3	
12.2	Because I don't know, it was hard to interpret, but I want to stick to it. And, but it was just noise then, I didn't feel like music. Hard to interpret.	V3 is hard to interpret, and the music outcome is satisfying.		Hard to interpret	
12.2	it wasn't more abstract, I think the first one [V2] was more abstract. Because this one has more like clear shapes, but the other has lines.	V2 is more abstract because V3 has more clear shapes		More abstract (V2); Clear shapes (V3)	
12.2	In the previous one I was less looking at the score, and this one I was looking more.	Look less at GS in V2, more in V3.	It's quite interesting that for now, the group who know the design beforehand don't like V3.		
12.2	I didn't feel like it helped me much.	GS in V3 didn't help much		Not helping (V3)	
12.2	Because it was the interpretation first, it took me a while	Interpretation is difficult even though was told before hand what does they mean		Difficult to interpret (V3)	
12.3	And then I don't know if I cope with that, I just felt like noise.	Not satisfied with the outcome		Dissatisfaction on outcome	
12.3	Yeah, I was trying to follow.			Try to follow (V3)	
12.3	Try to remember what they stand for, and what kind of changes I should make. Em, but then it's also the score that made me do things, I don't think I added anything myself.	following the score instead of creating your own music	Follow the score hinder the creativity	Follow score	Follow score is not good
12.3	I think if I was more professional maybe that will be the way to create in this way. Because I really don't have any experience.			Lack confidence	
12.3	I just felt like "Oh, I follow something", and then da-da-da, where is the music? But not the music I make. I didn't feel like I was contributing.		Follow the score is not contributing to music	Not contributing	
12.3	{So you didn't feel like you are creating music?} No, not at all.				
12.3					
12.3	I prefer this one [V2]. But I don't know if it's because it was more expressing, or is it because I didn't follow it as much as I follow this one [V3]. So yeah, this one [V2], because I felt more free to do what I want to do.	Prefer V2. V2 is more free to do what I want to do	Participant prefer the playing mode when she is not following the score so mcuh, which allows more freedom to do what he want to do.	Prefer V2; Playing mode;	
12.3	I felt more control, let's say in the first one [V2]. And in the second one [V3] I felt more restricted	V2 allows more control. V3 is restricted.	Need to note that here the preference is based on the strategy of dealing with the score. She prefer V2 because she didn't follow it, but with V3 she try to keep following and felt frustrated with the music, because she can't do the follow, listen and create at the same time.	More control (V2); Restricted (V3).	
12.3	Maybe because they are bold, I don't know. {R: You mean the shapes are bold, you felt more obliged to follow?} Yeah. But these [point to V2] are like smaller, or I don't know, softer in a way. Let's say this [V3] was more aggressive in a way because, I don't know. Although it's, em, I mean they are presenting the same thing, but this is like, it's kind shouts at you to follow it. So, I don't know.	V2 is smaller, softer. V3 is bold, aggressive, which shouts at people to follow.	Visual style actually play a role to influent people's strategy decision, whether to follow or not.	Smaller, softer (V2); Aggressive (V3)	Need to consider how graphic style affect people's feeling. Because it will affect player to adopt different working style.
12.4	But I don't know, if I was following in the other order, I don't know if I would, anyway.	Not sure if it's the palying style that's making the difference, or the graphical score.			
12.4	I think it just lets me free, so I try to understand what all the keys are stand for. But I don't know if it gives me an idea. I didn't consciously follow it to give me some inspirations.				
12.4	I did. Yeah, yeah. I looked at it sometimes.				
12.4	Because I think I don't know what to do, or was getting like a repetition of what I was doing, like "oh, where am I, where am I in the timeline? Ok.".	Look at GS when don't know what to do or get a repetition.		Overcome fixation (don't know what to do, repeatition)	
12.4	And I remember it was, I think No. 5 or 6, something like that, so I just started to press them in an order after that. So in that case, I think it inspired me to, just a couple of notes.	Music idea offered by GS		Give inspirations	
12.4	I will choose without.				
12.4	Because I think it's distractive in a way, probably that's all the informative part about music. But because I don't know how to play an instrument. That was distractive.	Prefer without GS because think GS is distractive		Distractive (GS)	
12.4	I think it helps to learn. Because it is very well structured. And once you do, you hear the result, the output result of music.	GS helped to learn the music, gives a structured way to learn.		Help learn (GS)	
12.4	But I'm not sure with the create, cause I think I need to learn it first to be able to create.	Not sure whether it help to create.			
12.4	Learn what they stand for, maybe more like going one by one, like 0, the example of 0 is this, the example of 1 is this, so like repeating all the patterns.			Learn symbols	
12.5	{do you think it helps you to explore more music ideas?} If I stick to it, I mean, I don't think so.			Following Gs does not help creativity	
12.5	I think it's a necessity to be able to create a good piece of music. But I can't see how inspiring it can be.	Necessary for make sure good quality music. Don't think GS is inspiring.		Make good quality music (GS)	
12.5	Maybe throughout the timeline, they were there. So I don't know, maybe there will be less obligation. I don't know how it works in music at all. Like if half frequent they were in every two second, or... I mean you have No. 0, 10 seconds later you have No. 5. Also visually because it was so slow it looks like they all following each other. But if there are more blank in between, maybe it will be more like,	Suggestion on GS to be less obligation to follow		Less obligation to follow	GS need to be less obliged to follow
12.5	I don't know if... I think it would give if a few if you have more effort, I'd say, but to me they were like, yeah, quite abstract.	It has the potential to be inspiring, but only when you have more effort.		Potential to inspire	
13	So basically I started with the similar tunes that were here [point to red buttons]. So then I thought of adding the drum. This one, yeah, the ding- ding- ding- ding one, that one. After I stopped, here [red buttons] if I stop one or two tunes, I will start then from here [white buttons]. So like, basically, I'll just add these two, I'll press these two and add these tunes like the drum on the [planball] or whatever it is. And I'll keep these tunes on, both these [point to white and red] I'll just keep them on. But I'll just try to like, interact like you see d-d-d-d-d-d, so I was trying to make that tune.	Creation strategy			
13	{So, is this graphical score affect your playing?} No. {Not at all?} No.				
13	So I thought that the graphical score that I thought that they were the drum buttons. But I couldn't figure it out. So I just continuing playing it.	Can't figure the GS out.		Difficult to interpret (V3)	
13	So I just, I basically wanted to do different things with the drums. The drums and the piano. So these two sides.	Focus on playing with the percussions and piano notes			
13.1	So when I was in my school, I have taken piano. So I just dealt with these two sides.				
13.1	So basically when I look at the, so this most [point to No. 2]. I mean, when I look at all of them, so I thought they were kind of take the keys. So basically when I wanted to create a frequent tune, so I kind of was this [point to No. 2]. So basically when I wanted to continue playing the same tune, I will press it. So I thought that it was building this kind of things. But when I, suppose I play a drum, the drum with a regular interval, so I thought that was like this, dot and a gap, dot and a gap.	Interpretation of GS in V2			
13.1	{So you saw this, from No.3 to 9, when you see the dots happening, you play the drums.} No. So, not the drums, but the… when I see these dots, I play that instrument at a regular interval, like not to play it continuously.			Offer ideas on rhythm pattern (V2)	
13.1	So if I see this one [No. 2], then I, so I suppose if I press this one [point to red], then there is a continuous sound going on.	Interpretation of V2 GS is the same as design concept. GS do affect playing.			
13.1	{So this one kind of affect your playing more, compared to the first one?} Yeah. So this one helped.	V2 affect playing more, compared to V3			
13.1	{Which one do you think gives you more musical creation ideas?} The second one [V2].	V2 gives more musical creation ideas			
13.1	In the first one I wasn't try to make what the symbols were.				
13.1	Yeah, according to me I understood this one, I didn't understand the first one.			More difficult to understand (V3)	
13.1	{Which one do you think is better, with or without the graphical score?} Without one I think.			Prefer without GS	
13.1	So if the graphical score on the screen, I thought what is this showing up on the screen. Like even if I play, I will have my focus on, thinking, I'll have my mind thinking that what are those graphical scores. So like, even if I want to make a good thing, my mind will be staying focus on the graphical score, so like, I wouldn't be able to make up something that's right.	Graphical score is distracting people from making the music		Distracting (GS)	
13.2	If I don't understand the graphical score, it's a bit distracting				
13.2	{So you are constantly trying to figure out what does this mean?} Yeah.				
13.2	So I used to play, I used to look at it, I used to play, I used to look.	look at the GS alternatively.		Occasionally look (V2)	
13.2	Yeah, to get some ideas.			Offer ideas (V2)	
13.2	Musically I thought that these symbols, these graphical score, they show what I played previously. So I used to look at them, I used to try to manipulate the same thing in the after playing of music.	Player think the GS is generated based on what've been previous played.		Smart GS (Corresponding to previous music/interaction)	
13.2	So, in this [V2], basically I played, I look at the graphical score. So I thought that the one which I played the most, the key which I played the most, it [graphical score] showed which I used the most.	Player think GS is corresponding to what you've already played			
13.2	So like when I was playing, I was lost in my own world.			Engagement	

13.2	{the music you created, you have the previous one and this one, which one do you think is better?} the second one.	Prefer the quality of second piece.			
13.2	So in the first try, I just, adapted to the keys, like, these keys make the sound of drums, and these keys these tunes.	In the first try, adapt to the keys.			
13.2	So in the demo and the first one, combining this try so the second one was pretty easy to figure out which key make which sound.	In the second try is more confident and comfortable			
13.3	Yeah, confident and comfortable to like which key make which sound.		After a few trial, player started feel comfortable with prototype.		
13.3	{Or does that helped you to sort of create, in some sense? Or do you think it helps you to learn?} Learn. Also exploration.			Help learn and exploration (GS)	
13.3	{So compare the two graphical score, you think this one [V2] is easier to understand.} Yeah.				
13.3	{And when you look at the graphical score, are you look for inspirations, or examples, or just for randomly things. } Random things.			Random things in GS	
14	I try to make my own sort of music. So that was where I was relying on the beats themselves. I was able to make my own music.	Rely on listen; Motivation for creation		Rely on listen; Motivation for creation	
14	The graphical score is just, basically I looked at the space of them. And I sort of, that helped me sort of know when to begin places. I didn't really use them as numbers or as inspiration, I more use them as a placement.	Use symbols as placement		GS offer idea on music structure	
14	{So you more look at the space between them instead of the shapes. } Instead of what they actually mean.				
14	But I'm not really like that, I'm not as abstractness as other people.	Not a visual person			
14.1	Yeah, I mean that's something that I could interpret from that. So for example if I wanted a bit of music to sort of, you know, sharply crack. I probably look for part ways of No. 8.	Possible inspiration from V3 GS, sharply crack music		Offer ideas for music strucutre (sharp crack) (V3)	
14.1	Sure, I mean they're colourful sort of, and they are to like, you know, give you inspiration in a sense that, you know, this could represent a breaking of music and this could represent something that interlinks, you know, it's about how people interpret it.	Possible inspirations from V3 GS		Various possible interpretation (V3)	
14.1	As in like, maybe you want one of the loops to just stop, or you want to maybe, maybe you want all of the loops to break and then just the beats. Because sometimes people like music when it just suddenly stop and then it's quiet, and then the loops come back, sort of unexpected.	Possible inspiration from V3 GS; Use previous experience for music creation		Various possible interpretation (V3)	
14.1	No. 1 I didn't really do. But I thought, personally for me, this interpretation I'm giving you, they are not actually the things that I did. But they're things that can be interpreted. So for example, when I looked at that, I interpret that as a loop within a loop within a loop.	Interpretation of V3 GS		Various possible interpretation (V3)	
14.1	So maybe every time you see No.1 you started another loop. Here for these two [No.4, 5] you could think, at this point break it and start a new loop and at this point break the loop and start the same loop again, cause it's the same color.	Interpretation of GS in V3		Color helps interpretation (V3)	
14.1	These are all really good symbols.	Like GS of V3		Enjoyment	
14.1	When I was playing, again I wasn't really focusing on them as the thing.	Not focusing on GS		Not focusing on GS	
14.1	But if you had like, perhaps maybe these more clearly , and, because… If maybe the user was allowed to place these at certain points, that would help.	The current symbols could be more clear		Not clear (V3)	
14.1	Cause all of the symbols were in a row, and it's just keep going. So it means that if the user does interpret that as a certain point, he is limited to where that exists in the screen.	The symbols are moving		Limiting	
14.1	So if the user was to make music and then thought, "ok, now I want to break this loop and start a new loop. I'll put No. 4 symbol there."	User to create GS as a comment		Smart GS (Allow user modification as a comment)	
14.2	Sort of like a comment, if you would, like you know, "oh, at this point, the reason why I've done this is because I wanted this to happen.".	Suggest to allow player to put comment			
14.2	Otherwise to be honest, especially they are all going past, it's very difficult when the screen is going, for you to, and the spacing as well, was slightly inconsistent, so it's very difficult for you to plan around these.	Difficult to follow GS and plan around according to GS		Multitask difficulty	
14.2	The only way you could really use it in that instance in which I was playing, was for inspiration and personally I didn't.	Has the potential to offer inspirations (GS)		Potential to offer inspirations (GS)	
14.2	{Did you look at it occasionally?} Yeah, I did. Definitely, I did.			Occasionally (V3)	
14.2	I used a couple of them to sort of, because even the space was inconsistent, it sort of gives you like an idea of when you should start a new loop. So when I was, when I first did the first loop and then did the music, I went back. And as I was playing it, waited for 8 loops to go, and then matched it up with the symbol, and then pressed it, that's when the second loop started. And I think I had 4 loops in the end. I think they all matched up with the symbols. I tried my best to do, so.	GS offer indication of timing.		Offer indication of timing (V3)	
14.2	So what I personally think would be more appropriate, was instead of the symbols, the different symbols, you had one consistent, maybe circle, at intervals to show, like a beat. And then at those circles, you can put these symbols. That way, you know, what do you want to do.	Suggest combine more simple symbols with the abstract ones.		Combine V2 and V3	
14.2	The problem for me is that the graphical score interface makes very little difference to me.			Make little difference (V2 &V3)	
14.2	In fact, the only thing that I really can say about the graphical interface is that the second one was worse. Because the second one was to me, it made less sense. Or was less consistent with the spacing, less easy to understand because they were bunched up together. The symbols were also more specific in the sense that if you want to interpret them, the lines were very linear.			Worse, make less sense, less consistent with spacing. More linear, specific. (V2)	
14.2	Whereas the first graphical one had a mixture of symbols combined together with different sizes and different colors, to like, that you could interpret it when certain things have different voices, when they should coming and stuff like that.			More possibles to interpret (V3)	
14.2	So V3 is more easy to interpret.			Easier to interpret (V3)	
14.3	Yeah, because when I look at this [V2], I can't, they are much more specific in a sense that, these dots here, [point to No. 6], they can't really represent much to me, in a sense that, "Ok, a beat goes here, then two beats go here, then three beats go here."	V2 is very specific, can't represent much to player		Too specific (V2)	
14.3	Whereas when I look at that [V3], I think this as a break. And a break can be applied to a loop, can be applied to a loop and maybe a consistent lead I'm doing and stuff like that.	Symbols of V3 can be applied to different things, which allows more freedom.		More freedom (V3)	
14.3	These [V2] are much more linear, whereas these are much more , I can interpret these better.	V2 is linear, V3 is more abstract. Can interpret V3 better		Linear (V2); Abstract, better interpret (V3)	
14.3	If I wanted to make music that was much more specific, I think I could use this [V2].	If just reproduce music, V2 is good to use. For improvising, V3 is more suitable.		Serve different purpose (GS)	V2 and V3 can serve different purpose due to their specific feature.
14.3	I actually think a combination of some of these [V2] and some of these [V3] would go very well. Using abstract ideas to help you understand what these points represent. And then also if you want to make a note of pattern of beats for example , so if you want to alternate, let's say for No. 8 you want alternate between these two, then if you put that at a point, then you could just keep alternating between them on to, maybe. Let's say you put 8 here and 8 here, and then you have a beat here and a beat here, you keep alternating until you get to that second 8. And that way you can sort of, you know.	Suggest a combination of two GS. Adopt the abstract idea of V3, and keep dots of V2 as comment.		Combine V2 and V3	
14.3	I think the problem with V3 though, is that, if you give, if I did some music and use the basic interpretation, and you give it to somebody else, they may interpret it differently	Abstract symbols is not easy for consistent interpretation between people.		Difficult consistant interpretation between people (V3)	No good for collaboration
14.3	And even though when they listen to the music, when you look at this, and you start to try to interpret yourself, it does make like a subconscious impact on how you interpret the music	Visual graphics make a subconscious impact on how people interpret music		Subconscious impact (GS)	
14.3	I actually, during the questionnaire I said that I was more creative and more expressive during V2, having said that I felt that had nothing to do with it. I felt that just because I had more experience with it and I was getting more used to it. And mainly because I actually started going back and started putting things in, making sure, because I was still struggling with the interface during the first phase.	Although in questionnaire said with V2 is more creative and expressive, but it's not because of the V2, but because player had more time with the prorotype.			
14.3	{So playing with V2, did you try to follow the score or did you look at it occasionally?} I began to, and then I gave up.			Quit following GS (V2)	
14.3	Eventually I just found that listen to the music itself and knowing when for it to stop, because each loop is a different size, is better.				
14.4	So instead of using, once I get to this point, I'll stop it. I just think it makes the sound up go down, that's one loop. Up down, two, up down, three, up down, four. Then I stop it, then I start, just you know how I feel was appropriate. But again music is all subjective and, you know when you feel it's right to stop, somebody else might not, you know.	Create music depend on own decision. Subjective experience.		Rely on own decision	
14.4	If I had to choose, I would have to choose V3. Just because I felt that, with a bit more work, it could be applied better. Like you could start, if you could pop these things in certain places, it would help the user more than it would for this one [V2].	Prefer V3 than V2. Could be improved.		More potential to help user, could be improved (V3)	
14.4	But that's me because I prefer to make music a bit more creatively than, I prefer to use this for creativity reasons than metrical reasons like spacing.	GS is for creativity reasons than metrical reasons		Prefer to use GS for creative reasons than recreation reasons	
14.4	I prefer to do the spacing in my head. And the number of times, something loops, based on my own opinion. I don't want these to determine when I should start, when I should stop.	Player prefer to do the creative decisions by themselves.			GS should not determine what should be done to the music. When designing GS, need to minimize the potential that player feel determine by GS.
14.4	I feel like, these ones, the graphical representation shouldn't be used for that. Just my personal opinion, I felt like they should be used to give you an idea of what you want it to be, rather than what they should be.	GS should be used to give an idea of what you want the music to be, rather than an indication of what the music should be.			
14.4	Like, for here [No.2 in V2], here it would say, this comes, and this comes, and this comes. No. 2 here [V3], that you can't interpret this meaning from this. It's much more difficult to understand what that means. Whereas it means you can make your own meaning of it. And what meaning you attach to that means you could apply whatever you want.	V2 gives explicit and specific ideas of what you should do; V3 allow more freedom to make own interpretation, allow a variety of interpretation.		Determine (V2); Own interpretation (V3)	
14.4	I think the first time I played without the graphical score is probably the one I preferred the most.			Prefer without GS	
14.4	Mainly because I hadn't understood this [point to V3] at that time. And they are more of a hinder than, they are more of control over what you want to do.	When player do not understand the GS, it becomes a hinder of creativity and control over what player want to do.		Hinder, limit freedom (GS)	
14.4	Again I would much to prefer this to be something of what you can put in yourself. If they were, I'd love this [V3].			Smart GS (control)	
14.4	But the fact that they are just keep coming, and keep coming means that they are sort of a bit confusing. { They are too much?} Yeah, it's just a bit unorganised and things.			Confusing, unorganised (GS)	

14.5	Actually I do think it does provide some ideas to how you can play it. I mean, for example, let's say you draw a blank on what you want to do, No. 10 [V2] or even in here [V3], it gives you ideas about what you can do.	GS offers idea of how you can play, what you can do.		Help learn (GS)	
14.5	But again, music is a bit more from a creative side, so it's more explore what you want to do. So for example, when I was doing it, I will do a loop. And then I did this loop [point to white buttons], and then while I did this, I took this loop off and I tried to alternate between these two. I started comparing them, in my head which one I like better. And then I delete one of them, I think I delete the alternating, that seems more creative to me	Create music need to explore. Exploration process involves comparing two alternating samples.		Exploring by comparing alternating samples.	
14.5	I also think that if you do follow this rules, it does have an impact on the music you create. Sort of makes you music a bit more. Ur, maybe not, maybe not, but I feel that it makes the music just a bit more still in a sense that you are following the rules, that your music can only be generated from these [symbols of GS]. Whereas you could, this probably a million combinations you could make. But you are only following these 14, sort of limits what you can do. But that's for somebody who follow the rules to the bone, doesn't use their own creativity.	GS might limit creation if it's too strictly followed while playing.		May limit creation (GS)	
14.5	I more went to the previous.			Add onto previous	
14.5	Because I didn't feel comfortable going into the future playing something. I didn't feel I had the musical experience to know how that's gonna sound.	Use more the previous. Not comfortable and confident with the results to go to future.		Not confident in plan ahead	
14.5	I always did something, went back, and then did it again, and make sure it sounded nice.			Ensure music quality	
14.5	Add onto it and then just, so because I'm quite slow. When I did the loops, I was taking the loops off, I wasn't able to alternate these [point to blue buttons] at the same time. I'd have to put those alternations inside afterwards. So whenever I see like a huge gap, when nothing is being played, I'll probably fill it in with these beats here, or maybe another loop for a bit.			Slow; Multitask; Ability	
14.5	I think the future aspect of it probably has more application, but I'm just not very good at it.	Not good at the future, but it do has a potential.		Plan ahead has potential	
15	Um, mainly I actually didn't look at it [point to graphical score] very much, the score thing.	Did not look at GS much			
15	At first I tried to, but it's like, slightly confusing.			Quit following, confusing (GS)	
15	{In what way do you think it's confusing?} Probably how it presents.				
15	Cause at first, I tried to look at it like, yeah, maybe it's a way to find inspirations, probably. Like, get some ideas to try to match it. And probably the outcome would help me to make a piece of music.	Look at GS for inspirations, and to build up a piece of music.		Look at GS for inspirations	
15.1	{Do you think it's helpful to your creation? } Yes, to a certain degree.				
15.1	Like, for this one, [No.12], you playing one first, and then another, and then another, and then playing together, yeah.				
15.1	This one [V3] I think it's even more confusing than the first one [V2].			More confusing (V3)	
15.1	Basically, the symbols. Like to me, after you explained this one [V2], I can kind of get how you're going with it. Like this [No. 4], what does it mean. Like No. 5, it's like three dots, like three notes consecutively. But then on V3 which appears on the screen, I just don't really know what's happening.	V2 is easy to learn once explained; Don't know what's happening with V3		Easy to learn (V2)	
15.1	I tried to understand it by looking at it. But I just couldn't, so I basically stopped looking at it.	V3 is difficult to interpret.			
15.1	I'm the person who likes instructions. So I think that's better than just nothing tell me.			Prefer to play with GS	
15.1	Yes. It helps, cause again like I said before, from start, for me I kind of follow like how I can make something.				
15.1	I prefer V2. Cause it seems easier to me.			Prefer V2, V2 is easier.	
15.1	However, I do like the looks of V3.			Like the looks of V3	
15.1	Kind of like, I actually don't know. I just start pressing buttons.				
15.2	At first, yes, but then I just didn't use it afterwards. Like during V3, I used it a little bit.	Used scroll in the V1, but less in V2 and V3			
15.2	Like the whole process. Like during V3, I used it less.				
15.2	{So you just focus on the current time. } Yeah			Play live	
15.2	Yes, it gives inspiration to people, I think.			GS gives inspirations	
15.2	I will choose with the graphical score.			Choose to play with GS	
15.2	Yeah. Cause it's, I could have something to follow with, and I could choose not to. I have more options. Like, if it's just V1, I might not know what to do.	With GS player can choose to follow or not to. Without GS, one don't know what to do.		More options. Overcome fixation (GS)	
16	But, I don't know, I just experiment with the sounds. And then I thought what sound good together. And then, yeah, a lot of experimentation with the sides, because I thought it's a bit difficult to create music with the sides of the box, than with the premiere loops.	Experiment with the sounds; Difficult to create with the beats than loops.			
16	The graphical scores I used a little bit, but not too much.	Used a little bit GS			
16	It's just as an inspiration	Use GS as an inspiration		Offer inspiration (GS)	
16	but, like, if I try to follow it, and I feel like it's a little bit too small or too fast to trying to follow. And then cause the buttons on the sides aren't very responsive, you couldn't do that patterns and things.	GS is too small and too fast to follow. Buttons aren't very responsive		Too small and fast to follow (GS)	
16.1	It's like, it's there, when you push them, they don't always register. Or like straight away, there is a bit of delay.	Delay of drums		Responsive	
16.1	But then when you start following it as well, generally you start here at certain things, and you wanna change it anyway a little bit. So you start following it, and then you focus on your own thing.	Start follow but always go away	It's an interesting phenomena that people try to start to follow and then shift away. It shows that the GS do has this potential to guide people to start with the sound.	Quit follow	
16.1	It did give me some inspirations.	GS gave inspiration.		Offer inspiration (GS)	
16.1	Like, when it said, so all of them at the same time, I started to put all the sounds on.	Example of an inspiration			
16.1	And when there were the dots that were in the, like a, you know it looked like a rhythm of dots, I was trying to do that a little bit as well. So, No. 1, and No. 8.	Try to make the drum pattern		Recreate from GS	
16.1	Yeah, to recreate.				
16.1	I think it would be really cool if you could like, record, the things you did on this side [point to blue and green], and those as well.	Suggest to record the drums and reuse the ideas.		Reuse ideas	
16.1	Reuse it as well, as samples.				
16.1	it was very similar, I found the graphical just a bit confusing.	V3 is confusing.		Confusing (V3)	
16.1	Like I didn't know what, I guess that one [V2] is a bit more intuitive.	V2 is more intuitive		Intuitive (V2)	
16.2	Especially, you know like I play a lot of games, and when you play music games, generally they are similar to the first one, where you have a whole first amount of time, and stop and.	V2 similar to previous experience of games			
16.2	So I was using the graphical score I guess a little bit less.	Use GS less in V3 than V2			
16.2	I tried to, but then there was sometimes as well, where like they didn't really match. So you had, I think, so you had something like this, [point to No.1 of V2], where everything is playing at the same time. And then like No. 11 comes up, where you suppose, you feel specific add more . {So it's difficult to put things together?} To like match it.	Difficult to match GS symbols with what is playing currently		Difficult match GS with currently music	
16.2	And then I guess maybe, I guess the graph is like a little bit small.	GS is small.		Small (V3)	
16.2	So you know when you start a beat you have that delay, so I'll push a button, I will try to gradually do it in. But I do it too fast and it comes in at once.	Button delay (auto-synchronisation) cause some problems			
16.2	It's a bit difficult to follow.				
16.2	{In terms of the inspiration, did it gave you some musical ideas?} I think the other one did, the first one.	V2 gives more ideas.		Give more idea (V2)	
16.2	{Visually, which one do you think is better?} The first one as well. It's just clearer.			Clearer (V2)	
16.2	It gives you, yeah, different ideas.	V3 gives different ideas	Two version of GS give different ideas.		
16.2	So like, there is more you can interpret. Like, it's more your own ideas. Because like, if you look at No. 5, or 7, or 8, I guess to different people they mean different things. So to me like, No. 7 is playing rhythm with all 4, with 4 of the beats.	V3 give more space for interpreting own ideas.		Allow own interpretation (V3)	
16.3	And like, No. 5, I guess it supposed to be rhythms, but you could maybe have them be rhythms with a beat, or rhythms with a loop. So there is a little bit more interpretation.	V3 is more free. allows more interpretation.			
16.3	I think it will let the music be more individual.	V3 allow the music be more indivisual.		Allow music be more individual (V3)	
16.3	I think this will give me more inspiration, but then I feel like it's just not very intuitive.			Not intuitive but give more inspiration (V3)	
16.3	I will choose without. I just feel like it gives you a little bit, while the graphical score doesn't take away freedom. So I just feel like it will be a bit more free to create what you want to create.			Choose without GS.	
16.3	Whereas with the graphical score, it feels like it's a game kind of thing. You have to try and match the score.	With GS imply to follow		Distracting (GS imply to follow)	
16.3	{Do you think it has more potential to explore, create, or to learn? } I think to learn.			Help learn	
16.3	Just because then you see how the music can be created using the box.	GS showed the potential of the box		Help learn how music can be created	
16.3	Like when you showed me the first graphs, I didn't think about doing a rhythm. I push the same button multiple times and then mixing it, so that I guess give a little bit more inspiration in that sense.	Example of an music inspiration.		Give ideas on rhythm (V3)	
16.3	I think what will be quite cool is, if you have like an animation on the screen, It's a bit weird to say, you know, do you remember windows media, windows media player, when you put music on, and you would have, you know those bars, and different animations and things on the screen that change with the music. I thought that will be quite a cool way to explore with the box, like creating different visuals with the music.	Suggest a generated animation based on music		Smart GS (Generated visuals according to music)	
16.3	{So you prefer the more concrete ones than the abstract ones? } Yeah.			Prefer V2	
16.3	I think then I definitely prefer the first one [V2]. Because then I would have no clue of what's happening with the abstract one.	Without being told the GS, it would be more difficult to play V3.		Intuitive (v2)	
16.4	But then I think, if I was using the box, I don't want to go back.	Don't need to listen back.			
16.4	Then I don't think they'd really go back and listen. Maybe listen to the recordings afterwards, but I don't know, I get the feeling that, if you are making music, like as a first time, you make what sounds good and then listen back to it, and then maybe afterwards change it.	Enjoy real-time playing		Enjoy playing live	
16.4	I did use the future. Because like if you have long periods, with silence or with two beats playing for example, then you can like skip a little bit and work with it faster.			Plan ahead for efficiency	
16.4	But then like, I don't feel like if I had this [box] at home, I would really use the back a lot on it. {You mean you wouldn't use the future thing as well?} I just play around with it.			Enjoy playing live	
17	Mostly I was listening. Like the visual part, I wasn't very engage with it.	Focus on listen. Not engaging with visual.			
17	So I was more engaged in the sounds.			Engaged with sound	
17	Also the visuals, like not the dots, that were being registered as I was playing, but the animations that were like blinking, that ones were really kind of, were playful, and entertaining, and engaging, that I kind of was like being, well maybe inspired by the movement of them.	Animation on timeline is playful, engaging, entertaining, and inspiring.			The moving animation is inspiring.
17	But regarding the timeline and points that were being record, I didn't took a lot of attention to them.	Didn't pay attention to timeline			

17.1	And also I find like it's a little bit, for the samples, it's very good, it's like this, that you can, and since you have like an automate synchronising, it helps a lot.	Automate synchronisation helps.			
17.1	but regarding the individual notes, it's like you planned to sound it here, but it doesn't sound. So it's more, so it's like a little difficult to keyword note for a single sound.	Auto syn of percussions cause delay, result in difficulty			
17.1	For a single sound, I find it a little bit difficult. For starting the loops, I think it's great.		Difficult for a single sound		
17.1	Because actually the lights help a lot, because you're aware of which ones are playing.	The button lights help			
17.1	{Then do you think the graphical score helps you to create?} I think, not. Because I wanted to create something, and these were kind of, as you mention, this is what I understood from you, that I would see the score, but it's just like something that's gonna be there, that I could use to be inspired, or somehow.				
17.1	But on the other hand, I didn't want to follow the score. I wanted to be creative.	Think follow GS is not creative	Participant try to ignore GS as he has the motivation to create something by himself and don't want to play music predesigned by other. He is afraid the GS will hinder his creativity. Player has the	Follow GS is not creative	
17.1	But at the beginning, I was kind of, "Ok, just, I'm gonna ignore it.", because I want to be creative by myself .	Want to be creative by himself.		Motivation for creating	
17.1	I didn't try to follow it because I don't want to play something predesigned by somebody.			Do not want recreate	
17.1	Sometimes I looked at it. And, but no, it wasn't. I didn't even start to think about it, like, "Ok, so should I try to mimic it to? Should I do it the same way?"				
17.1	But after thinking about it, it could really be something that help you to get inspired, to kind of mimic or repeat the score and try to do it.			Have the potential to help inspiration	
17.2	It's very fun to play.	Fun to play		Enjoyment	
17.2	Well obviously, I don't know if it's obvious, but in my case, the second prototype [V3] has a certain advantage. Not because its design or whatever, but just because the fact that it's the second.	The second prototype is better because player getting more used, comfortable with playing with it.			
17.2	Try playing with the other, like the idea of playing simultaneously, it came after experimenting with the previous one.	The idea of start something together came after a few trial with V2		Offer idea (V2)	
17.2	Ok, in this one I was more interested in the graphical interface in the score.	Put more focus on GS		Play strategy	
17.2	So I tried to follow some patterns.	Try to follow			
17.2	And in this one I just accidently tried to press simultaneously to the piano, and I discovered that I could do it. So I played a lot of kind of solos, with combining piano, I was enjoying that. Because it sounded like more pleasant, and like very, I enjoyed that process that I was playing a lot with the piano, doing the same, like using two or even three, and at the end even four together.			Enjoying playing with piano; Senrendepy	
17.2	But I think the fact that I internalised in my brain the idea of being something that could help me be more creative, then I was more interested to it.	The idea of telling affect how people treat GS.			
17.2	The fact of knowing it was an inspiration tool, that changed my perception about it. So I was more willing to experiment it due to the fact that I knew what was the main purpose of it.				
17.2	{Do you think it helps you to create?} I think yes. Yes, I think it's an interesting tool.			Interesting tool (GS)	
17.2	But on the other hand, like for example the pattern, start one, two, three, I kind of followed it.	Examples of musical ideas offered by GS			
17.3	But then, I was, I like more the way that I was doing it, which was more like just listening, and then "ok", at the same time activating and deactivating. Looks was more like feeling it, like listening to it.	Enjoy more creating based on listening			
17.3	So in the second prototype [V3], I followed some patterns at the beginning.				
17.3	So at the beginning of the second prototype, I tried to follow some patterns of activating and deactivating the loops.	Try to follow in the beginning			
17.3	And I was open to listen how it sounds.			Open GS ideas	
17.3	But then unconsciously I went back to the way I liked, which is just like activating and deactivating at the same time, waiting, and then "Ok, it's time to change, so I'm going to do like this [pressing loops buttons at the same time]." I suppose to like, following something visually.	Started by following GS, and unconsciously shifted to own decision.		Follow GS loosly	
17.3	So at the beginning I was open to explore it. But at the end, I just follow my instincts, without looking at it.	Own instinct		Follow own instinct	
17.3	Yeah, a lot. In the second prototype I look at it a lot.			Play strategy	
17.3	Because I was open to maybe experiment it again, another pattern.	Look back at GS to experiment more patterns		Offer ideas to experiment (GS)	
17.3	It gives ideas.				
17.3	And maybe if, and I wasn't sure when I imitate it, when I follow it, I really did it well.	No feedback of sound quality			
17.3	So just my idea like, maybe if you kind of like blow it, or do something about it when you actually make it sound as it showed.	Suggestions on feedback when followed the score exactly.		Sound feedback	When player has the idea of following the score, they need the system give feedback on whether they are following it right.
17.4	And that could give me some certainty of what I did, it was exactly as the score suggested me. So that meant, that, "oh, ok, I got it", this is something that score is suggesting	Offer certainty of what player did based on score.			
17.4	Feedback from the score itself. Maybe this is an idea for future implementation or whatever, but you know, when you are playing these games of [], or whatever, that you when you hit something, so you feel like "hey, I'm doing it right."			Feedback on	
17.4	Like when you want to follow it, you follow.			Choice	
17.4	And then if you do exactly as the, who knows, maybe if I'm, because at the beginning I told you I didn't follow it in the first prototype because I didn't want to feel like directed or something.			Follow GS is directed	
17.4	But maybe when you're creating you mind changes. You're willing to use it. Maybe it's part of the creative process to sometimes let you to be directed from someone, something. And sometimes I'm by myself, sometimes I go back.			Playing strategy may shift while playing.	
17.4	I like more the second one [V3].			Prefer V3	
17.4	Maybe the graphics are bigger. It's like more distinguishable, it's more clear, maybe. Because it's bigger.	V3 is bigger, more distinguishable, more clear.		Distinguishable, more clear, bigger (V3)	
17.4	Because in the end both are like abstract representation, you are not like kind of analysing them as it fits like some...			Abstract (GS)	
17.4	So it's more like an aid, and something intuitive.			Aid, intuitive (GS)	
17.4	Because the screen is also small. So the other symbols were smaller. If I remember, they were just dots and bars, right? That was the first prototype.			Small (V2)	
17.5	And this one has like a triangle, round ball, I don't know how you call it. Diamond. Yeah. Diamond. Yeah. That one for me is more representative, more interesting.			Shape is more representative, more interesting (V3)	
17.5	I changed my mind set in the second one. In the first one I was not, not drawn to that part because I didn't want to follow anything.	Change mind set about GS		Playing strategy / Mind set on GS	
17.5	I enjoyed more when I changed my mind set, and everything.			Enjoyed more when use GS	
17.5	{So you enjoyed playing at the current time?} Yeah				
17.5	Well, depending. Maybe if I am willing to do something, I don't know, electronic, or something for movies score, or something cuba, or something Mexican, and then there are patterns, that can help you to follow, to create something in that direction. I would be willing to use it.	GS has the potential to offer inspiration on certain direction, for example the music style.		Offer inspiration in certain direction	
17.5	I think it would be useful if you want to get some kind of help, or inspiration in a certain direction. I think it would be very useful.				
17.5	But if I use it to play, and then I wouldn't use it. if I use it just to experiment totally, then I wouldn't use it.		GS serve different purpose and scenario.		
17.5	Maybe more learn and explore. Because creation, from my point of view is more intuitive, and more without thinking, without, yeah, just performing and moving, feeling. And I didn't like, waited it as part of my creative experience as if it were, as the sounds themselves were like, taking me to the next note to be played.	GS helped more on learn and explore. The sound helped to create rather than GS.		Help learn and explore (GS); Creation came from listening.	
17.5	Just that the sign is very appealing comparing that it's very good way of having six places to play with. As opposed to the traditional table, like it's just like this. It doesn't creating that inspirtional interface, that volume my trick.			Enjoy tangible interface	
17.5	It's three dimensional. And also like, it's kind of, in economical it's like well designed because you can grab like this, and it's like, I feel it like nice.				
17.6	yes, for the loops, I kind of experiment it like, like, for example, [point to No.12, 13 of V3], I was trying to start like, one, two, three. And then stop, three, two and then one. {So that one gave you some ideas?} Yeah, this one for the most. The ones that I was more attracted to or the ones that I was experimented with, were those ones.			Offer ideas (GS)	
18	I found it a bit confusing to remember what the symbols of the musical score meant.	Confusing to remember GS symbols.		Can not to remember symbol meaning	
18	So initially I was trying to focus on following what you told me about the meaning of the symbols. But then I lost that, so I just, I looked at the symbols trying to interpret them somehow, following my own rhythm.	Try to follow in the beginning; Develop own interpretation because it's difficult to remember what has been told.		Develop own interpretation	
18	But then I actually, I looked at it because it was a pleasant, visually pleasant.			Visually pleasant	
18	But I didn't create music on the base of what the musical score was telling me. Because I couldn't remember what the symbols meant.			Create based on own interpretation	
18.1	I realized that I couldn't really remember, and it was getting more on the way of how I would have compose the piece in the sense.			Quit following GS	
18.1	It's that I didn't understand the correlation between the musical score and what was happening actually.	Confuse about GS and timeline.			
18.1	And I didn't understand if the symbols, whenever the bars, the sequencer was passing under symbol, if that would have affect the samples. Or if it was me that I needed to actually press one per time, or, you know. I wasn't sure if I had to press one sample at a time, beat sample in here or, if I would have press it once, and then it would have automatically done the other two notes. I was confused, then I realized it wasn't doing that.	Thought GS would affect music	Seems that telling participants what does the GS symbols mean cause a lot of problems. For example, players were trying to remember but not success, causing frustrations.		
18.1	And I actually wanted to understand if actually, because at the point I pressed one single beat sample, and it did it twice, it played twice, but I haven't realized if it's me that pressed twice, one after another without realizing it, or it was because of the score				
18.1	Because then I realized that no other sounds were affected by the score.				
18.1	But because I didn't remember the symbols and what should I have done. I just, yeah, I didn't follow the score anymore afterwards. I just improvise by hearing what I liked.	Cant remember the GS. Improvise based on listening		Can not to remember symbol meaning; Quit following.	
18.1	It's confusing.			Confusing (GS)	
18.1	It can be a bit confusing, because I'm not musical trained person.			Not a musician	
18.1	I mean that there are 13 symbols. There are 13 symbols of the score that you need to remember. And then all the buttons functions that you need to remember. So it's a bit tricky.	Difficult to remember symbols and button functions.		Information overwelming	
18.1	Probably if you will leave a picture of the symbols with what they are supposed to mean, visually in front of the participants. So the one can actually think around that they can use it in a more useful way.				

18.2	Because after all I gave up using it, I was looking at it because it was nice. They are nice symbols, and it's colourful.	Although didn't follow, they look at V3 GS because it's nice.	Participant might develop less own interpretation because of being told the meaning of the symbols.	Visually pleasing	
18.2	It gives you proposal, so you just try to actually do something in relation to what the symbols actually want you to do.			Give proposal (GS)	
18.2	But then it's tricky to remember what you should have done.	Difficult to remember previous interaction		Difficulty to remember	
18.2	Yeah. It could be, if I would have remember it, I would have probably follow the score just to see what would have come out. But because I didn't remember what the symbols meant, I just tried initially and then I	Would like to try follow GS.		Quit following	
18.2	I mean that at the beginning, I felt a bit stupid because I couldn't remember the symbols.	Felt stupid because couldn't remember.	The telling thing seems gave a little bit pressure to participants. Which make participants felt obliged to remember and to follow GS.		
18.2	But then you told me there is no right or wrong way to do it. So I was actually ok with what I was trying to do.			No right or wrong	
18.2	It seems that it's boots on time, it's very straight forward because you don't have to think about the timing, the beat, I mean I played as a DJ, so finding the right BPM, that goes with one track to another, it's quite tricky. Yeah, you actually doing it automatic, so that's quite pleasant. And it gives you the impression that you almost know how to compose a piece of music in a certain way.	Auto synchronisation is pleasant. Participant felt almost knowing how to compose a piece of music.		Confidence	
18.2	For instance, I don't know, I was seeing the symbols, [point to No.1 of V3], and I did remember that in my head that was one sample each of these ones, the full ones.			Offer idea	
18.2	So rhythmically I was interesting to see what it was suggesting me to do.			Curious about GS result	
18.2	so that intrigue me in a sense that I was curious to understand what it was suggesting me to do for the creative side of it.	GS intrigue player to understand GS		Intrigue player to try (GS)	
18.3	But then, yeah, I mean I haven't really follow it. So I haven't really			No rigorous follow	
18.3	For instance, this symbol, [point to No.6 of V3], the No. 0 and 6, I don't know. They make me just follow the three things, so you just go with three sounds.	Examples offered by GS			
18.3	I would do them separately. Because they are different colors.	Color affect decision			
18.3	Then actually comes naturally.			Ideas come naturally (GS trigger creativity)	
18.3	But for the nested beat, that was a bit unsure.			Unsure about some symbols	
18.3	I'm inspired.			Inspired (V3)	
18.3	And also the NO. 12 and 13. But maybe because, yeah, I don't know. It reminds that they were meant to something, so yes, I was suppose to.	GS symbols remind player that they mean something. Abstract symbols intrige player to think about doing something.		Trigger interpretation	
18.3	I paid more attention to the score in this one.			Swift play strategy	
18.3	So I was trying to improvise, following the symbols.	Try to follow symbols.		improvise with GS	
18.3	But I fell more restricted as well. Because I was trying to following the symbols, instead of just doing it as I would have.	Following GS cause the feeling of restriction.		Restricted when following	
18.3	Although it's interesting, it was an unknown outcome, so it was still an interesting thing to get to know what the computer want you to compose, or whatever.			Curious to see GS outcome.	
18.4	I found that the interpretation, I liked more the first symbols [V3].			Like V3	
18.4	But the interpretation probably, was more facilitated by the second one [V2]. Because they were just bars, and they are the length, or they were dots. So you were following the dots for the shortest notes, and the longest bar.			Easier to interpret (V2)	
18.4	It's easier to follow.			Easier to follow (V2)	
18.4	Because the score is there just as a support and not as a given that I need to follow.	GS is a support rather than instructions that something need to follow			
18.4	Probably the first one [V3], cause it's more appealing. The symbols are more appealing			Visually appealing (V3)	
18.4	So one could actually infer the meanings to the symbols without having pre-set ideas.			Infer meaning without pre-set idea (Free interpretation) (V3)	
18.4	While the bars obviously give you the time length and it's very much correlated to music thing.	V2 is straight forward, correlated to music thing.		Straight forward (V2)	
18.4	I don't know, somehow it made me being more creative , because being more abstract in fact you were…	Being more creative with V3		More creative as being abstract (V3)	
18.4	And then this thing that I haven't really paid, because I didn't remember the meaning of the symbols in the first one, I just gave up at some point.	Can't remember the meaning of the symbols in V3		Cant remember, frustration, quit following GS (V3)	
18.4	While at the second one, I was more concentrated on and focused on following the score.			Focus on following score (V2)	
18.5	Just because I went along by myself, I did more things by my imagination.	Not following the V3 GS because it's difficult, which make participant feel more creative because they are doing more things by themselves.			
18.5	I mean the visual cube weren't affecting any actions on me, while the bars were giving me a certain length, were giving me more detail of which note to play, and which sample to play.			More creative when not follow	
18.5	I don't think I created good music with any of the two				
18.5	In terms of creativity, it's a bit tricky because there is a limited amount of samples that you can use. So you don't really, I mean I haven't really found that I could have been as creative as I would have wanted if I have a range samples to choose from.	Suggest more samples.			
18.5	In terms of the expressivity and creativity, then lots of things that comes in to play, that I really didn't enjoy the outcome of both of them. I mean, it's facilitated.	The music is facilitated.			
18.5	I mean, if you have the samples of the music of your liking, if I have extreme samples, electronic music a bit more experimental, I would love it.				
18.5	Although it would have been a very experimental music composition, there were some samples that I really liked there. Put together, probably I would satisfy more in that sense.				
18.5	But I felt that the fact that I was putting the samples on time, it's facilitating loads of the production of the music. Because the music just get on tune on time straight away, so that was nice.			Auto-synchronisation facilitate music production	
18.5	That's a nice thing that actually make you believe that you are doing a good job. Although you might not like it, but it's something there.			Give confidence	
18.5	I probably wanting to do in what I wouldn't have done instinctively. So I tried to do more something that I probably wouldn't have done instinctively, just because I was trying to follow the score.			Follow GS trigger more potential	
18.6	So it was more following the instruction thing than.			Follow instruction	
18.6	You get to be less lost, just because there is always something to follow, that you want to keep up with the timing, and things.	Be less loss because always something to follow		Get less lost (GS)	
18.6	As a non-musical person, maybe the first one. But just then because you didn't, I felt a bit more, I felt that I had a bit more freedom. Just because I wasn't following it that much. Or at least not as you described.			Non-musician; Prefer V3, V3 more freedom as not following much.	
18.6	Because I wanted to listen again what I did before.			Re-listen to previous creation	
18.6	And because I saw that there were drumming, in the piece where I started, it was nice because I stopped with drumming, so I wanted to stop the one from sort of looping I had done.			Reuse	
18.6	Add as well. Yeah, if it was too empty, probably I would have added something.			Add onto previous	
18.6	{Have you tried to do something in the future?} No, in fact not at all. Now that I'm thinking about it, not at all.	Never used future timeline.			
18.6	Probably the color code is a bit confusing. Because you expect these color to correspond to the samples. And I realized it wasn't correlated. So I got it tricky in that sense because there is the musical score that would suggest you what to do, and so you would think it telling you which sound to play exactly. But probably that's the freedom that you leave to the player.		Color might not be the right thing to leave freedom to player. Because it's very instinctive and intuitive. Player think of the mapping of color instinctively.		
18.6	It felt a bit restricted.			Felt restricted when follow	
18.6	But it depends really what's the purpose. Because if you want to teach, to give a guidance, to the person, to the player, probably the score will help, either, than without. Just because you want to guide somehow. While if you just want to give them a creative tool for them to be creative, then probably I would say no graphical score.	GS serve specific purpose, GS teach and guide player.		Teach and guide (GS); Scenario	
18.7	More, yeah, and be guided, and not necessarily duplicate what's in the score, but yeah, sort of learning experience, guiding experience.			Help learn, give duidance (V2)	
19	I was confused because in the beginning I thought I had to follow strictly the pattern.	Thought had to follow GS and confused			
19	And then I was like, "Em, this is not working for me. I don't like. What am I getting?"	Not satisfied with the result of following the GS.		Not satisfied with result from GS	
19	And then I realize I also maybe need kind of more time, not to understand how it works, but to memorize what kind of sounds. So that I can choose the one that I like, and then think "Oh, maybe next one might sound good with it."	Need more time to remember the sounds.			
19	So at some point I just started pressing buttons, like kind of experimenting, but I don't feel like I was creating the piece.			Experimenting	
19.1	Yeah, the first part I was more like I follow this and then I feel like this is not giving a good rhythm, so I was like "Ok, I'm gonna forget a little bit about this."			Quit follow as not satisfied with result	
19.1	And every now and then I return, like "oh, it says I can do this, Oh, OK." Maybe I'll try	Refer back to GS and pick something to try		Offer idea (GS)	
19.1	but like if I wasn't the one I do right now, I would ignore it.			Pick symbols to try	
19.1	Yeah, I didn't look at it that closely. Like I always looked at it a little bit and then like, say "oh, maybe this might work right now." But I wasn't following completely anymore.			Look occasionally	
19.1	Yeah, I think the hardest part is also that I want to always leave a sample playing. And when it says stop the sample, I was like "but?", I feel like the piece was finished. And then I was like "em." I feel like I was starting again every time I played another sample.	Not satisfied with the sound followed by the GS		Conflict between GS and own ideas.	
19.1	{You're reluctant to follow the sample which indicate you to do something?} Yeah, a little bit.			Reluctant to follow the score.	
19.1	To get some inspirations, I guess.	Look at GS occasionally for inspirations.		Offer inspiration (V3)	
19.1	Well, I liked to choose a sample as I mentioned earlier. And then based on that I had like a continuous sound. And then add like piano or drums to it. And then maybe add another sample towards it.	Still experimenting the sound with third prototype.			
19.1	So sometimes I was pressing and maybe sometimes I press the wrong one, and I was like "Ok, that sounds ok." or "No, I don't like that", so I repeat and try to get the one I wanted. So yes I was basically still kind of experimenting with the sounds.	Try and error to find the right sound. Indicating player have problem to remember the sound.		Try and error	
19.1	Yeah, I think it helped to get inspiration. So it's not something that I'm gonna follow by heart.	GS helped to get inspirations; Don't like to follow			
19.2	But sometimes I looked at it, because the colors are very bright.			Color attract	Bright color helped to attract player to look at GS.

19.2	So you can have a look at it, and then you might say "Oh, that might work, I will try that later."	GS give some ideas to create		Offer idea (GS)	
19.2	For instance, I really like the pattern ones for instance, like follow the altogether one and [Point to No.3 4 5] especially when you came to the piano on the drums, yes, those are the ones that I like better.	Like the pattern symbols			
19.2	Maybe sometimes starting them one by one and finishing them together or the opposite.	Idea offered by GS.		Offer idea (V2)	
19.2	I think that was more like, it wasn't thinking it's going to sound ok, at some point I was like, I want experiment more with the piano, or I think I have enough now, I want to experiment back.			Piano	
19.2	And at some point I want to kind of switch back and forth quickly. But I feel like my fingers were not too fast, to play a piano, change to drum and then back to piano, and then mess it up with the timing.			Can't achieve what wanted to do	
19.2	{So which of these two do you think is better for you to get inspirations?} The number 2 [V2].			Get more inspirations from V2	
19.2	Yes, I think the first one is very aesthetically pleasing.			Aesthetically pleasing (V3)	
19.2	But this one [V2] is more simple, and then because you already thinking in how to create the piece or how improvise, I feel like you can just quickly look at this and understand it much easier.			Simpler, easier to understand (V2)	
19.2	I think for two reasons, one because it was easier to follow, the pattern suggested. But also because I had played it once. So I had more ideas on what I want to do on the second one. And a little bit more knowledge about the instrument.	V2 is easier to follow; More ideas come out and knowledge with the instrument in the second creative process.		Easier to follow (V2)	
19.3	No. I think almost at the end I realized I could have played with it. But I felt like it was a like second level of, like a second challenge.	Didn't use scroll bar, think it's a second level and challenge.		Second level challenge	
19.3	And I was still too new, so I wasn't like very happy with what I was doing with my music, so I thought like that might make it harder.	Not confident to use scroll timeline.			
19.3	I think I developed some. And maybe sometimes I was even looking quickly and I thought "oh, it means this", and then I realize it didn't mean that but I used it in that way.				
19.3	Yeah, so for instance at the beginning, I exchanged the dots, I thought they were the samples instead of the piano. And eventually I realized "Oh, no."	Develop own interpretation because didn't remember the original meaning.		Develop own interpretation	
19.3	And then I started using for instance this one, [No. 8 and No. 10 of V3] I think that they were very creative. So it let me kind of imagine what could I do with when it has a six beat shape.	Abstract symbols encourage people to develop their own interpretation.		Abstract symbol encourage own interpretation	
19.3	when you are already maybe more familiar to the instrument, I think this [V3] would be better. Because then, it kind of gives you inspiration, but gives you freedom at the same time, to create your own piece.	The open symbols offers more creative possibilities.		Inspiration and freedom (V3)	
19.3	Yeah, I think it helps to explore, and learn.			Helps to explore and learn (GS)	
19.3	Because when you are getting introduced, sometimes you might be like with a blank head, like "I don't know what to do."	Start with a blank head without knowing what to do		Start with a blank head	
19.3	And then if you see these, you got an idea, and you started exploring those ideas.	GS offer idea for exploration when started		Help to start (GS)	
19.3	Maybe eventually you won't need the score, cause you are kind of familiarise with even start developing more personal style.	Might not need score after getting familiar.			
19.3	But I think at the beginning, and maybe at some point, even you have your personal style, it's still helpful to go back to it.	It's still good to have GS.		Good to have GS	
19.4	Like exploring, and thinking, oh, if I do these three together, I get this sound.	Learning the sound			
19.4	And also, like learning about the instrument, for instance, I realized that some buttons still have a little bit of delay. Or that if I don't press hard enough, it comes a little bit later. So it also helped me to learn how to use the instrument.	Learn the instrument		Learn sound and instrument	
19.4	I think I will prefer right now without.			Prefer playing without GS	
19.4	Because when I started exploring it before going to the improvisation part, I already had some ideas that I wanted to play, but then when I got the visual score and I was given a specific instruction I felt more constrained.	Got some own idea to play but with GS felt constrained with as it gives a specific instruction.		Hinder own creativity (GS)	Although player said earlier that it's good to have GS to help exploration and learn, but he also mentioned that it will hinder own creativity as it give instruction. This is due to the fact player felt they need to follow or response to the GS. This issue need to be handle to minimize the influence.
19.4	But to me, I think it will help me. I think abstract is always good with creativity, but that's just my point of view.			Abstract is good to creativity	
19.4	I liked it a lot.			Enjoyment	
19.4	Like, I've seen instruments, like box instruments, but do other things, but don't attract me to play with them. But this one, I really like that it has a screen. That was the first thing I saw and I really like it, because you have a visual feedback as well. And then like all the buttons playing different things, I really like samples, cause it give you a different option to create your piece. And I think the best part is like the scrolling option, cause you can come back and sort of edit, or add some things.	This box attract player to play with visual feedback, various samples and different options, and scrolling option for edit and add.			
19.4	I think for a more pro person, I still feel like I'm basic in this,	Still need more time with prototype			
19.4	but it might give many options to delete and add all the things, even if you didn't do it at the time.			Improvement on functions	
20	Ok, so one thing is that at the beginning I tried to be more, I tried to be influenced by the graphics, the symbols. But I realized that I wasn't getting much of it.	Tried to follow in the beginning. Didn't get much from GS.		Quit follow GS	
20	I prefer just to play on the sound. How it sounded good, as, yeah.	Prefer to play based on the sound.			
20	And there is also one thing difficult for me is that, when you play sometimes, there is the delay you explained to me. Try to match to the right timing. But this delay was sometimes very unhappy to have it. Because I sometimes want to hit a lot of notes, like have many many many, and didn't.	The 8th auto-synchronisation is not good to have because player want to have more control over it.		Expressiveness	
20	So this influenced I think the improvisation in the sense that I would hit less. I tend to be just like, yeah, just produce less notes in general.	The delay influence the improvisation as player will tent to produce less notes.			
20.1	And sometimes, the graphical score would influence the sequences. Like if I hit this one, this button here, and this button here, and this button here, so like da-da-dak, this was like inspired by the graphics, the triangles and things like that.	Idea inspired by GS		Influence sequence (GS)	
20.1	For instance, this one [point to No.0]. Sometimes this one [point to No.12]. Yeah, these ones were harder [point to No.3 to 9]. Maybe this [point to No. 6]. Yeah, kind of sometimes were inspired by these ones.	The dots one are harder to interpret.		Offer ideas (GS); Dots symbols are harder to interpret	
20.1	And when I liked it, then I would play it, do it again. And do it a few times.	Use the GS to find some nice musical ideas		Pick symbols to explore	Whether the symbols look good is important, as player are choosing based on the appearance.
20.1	And it was hard to do it again because of this delay, so that was really affecting my way of really being able to do it again, like repeating, repeating the same pattern.			Delay hinder play and create (repeat pattern)	
20.1	at the beginning I was mostly playing these ones [point to blue and green]. The drum beats and the piano without the loopings. Yeah, try to get from that, and then introduce the loops.			Piano	
20.1	I mean, I can say that I got inspired by the graphics sometimes.			Get inspiration (GS)	
20.1	But most of the time, I was just, it was more tactile, more like, "Yes, I will play this, and then this, and then this." I don't know why, but I will do this, you know.			Based on tacttile and listen	
20.1	Well, it was very similar. I found it was very similar, so the process was a little bit, yeah, close to the other one.	Similar process			
20.1	But I can say for myself I was trying to pay more attention to the graphical interface.	With V2 focus more on GS.		Play strategy;	
20.1	But at some point I found frustrating. I tried to match, and like if I make it as a game, but I wasn't getting the sonic feedback I like. So I would just try to match it, but I didn't like the sound so much. So I stop doing that.	Try to match GS in the beginning but do not like the sound result, cause frustration.		Quit follow; Dissatisfied with result, frustration	
20.2	Yeah, yeah I kind of decided I'm not gonna pay attention. Maybe I'm just gonna play for it.	So stop follow the score			
20.2	I mean it's not a problem because you can very easily ignore it. But that's pretty much what I did. So I basically stop seeing it and just focus.	GS is not problem because it can be easily ignored.		Easily ignore	
20.2	I mean if you're having too much input, and I suppose if you're not a musician, then having to pay attention on what you're seeing, and what you're touching, and what you're listening is too much. I think it's too much material, too much information. So better focus on how you're touching, and the sound.	It's difficult to pay attention to different things.		Information overwelming	
20.2	{So after you stop following it, did you look at the graphical score occasionally?} Occasionally.			Look at GS occasionally	
20.2	Yeah, I think sometimes, there are some patterns in it. I think they can be translated to sound sequences.	GS has some patterns		Offer idea (pattern that could be translated to sound sequences)	
20.2	But then also I found that not having the control of the instrument, or at least not knowing how to play the instrument, because it's the first time I play it. then it's hard to come and take the graphical pattern and translate it into sequences.	Without being confident with the box itself, it's difficult to deal with the GS.		Need time to learn more about the instrument	
20.2	Yeah, I think it's very biased if I say the first [V3]. Because I was enjoyed more, maybe. Maybe because it was the first one. Maybe because the way I was playing was, I don't know, for some reason I was focusing less on the visual. So I was like having more fun than the second. Maybe in the second I was tired. So I can not really say I prefer this or this.		The playing style that didn't pay much attention on the score might make player feel more relax and more fun.	Play strategy; Enjoyed the fact that focus less on visual.	
20.2	For instance this, [point to No. 13 V2] this was interesting. So I was kind of playing, just hitting three buttons at the same time. And at some points stop hitting one, staying with two, and then just hitting one, and then stop	Idea from V2			
20.2	Well, I find this one is a bit more beautiful than this for me, I think. But I mean, aesthetically.			Visually appealing (V3)	
20.2	I mean, I cannot really choose, I cannot really tell you oh, this is better for my creative process than this, or the other way around.	Cannot really choose which one helped more on the creative process.			
20.3	Interesting. I think I will still prefer having the graphical score.	Prefer having the graphical score.		Choose play with GS	
20.3	Why? This is aesthetically. {Because it's more beautiful?} Yeah. And I suppose if I was to play with this for a long time, at some point you don't have any ideas any more. It could be helpful.	Prefer to have GS because it's beautiful; GS could be helpful after playing for a long time and out of ideas.		Beautiful, overcome fixation (GS)	
20.3	At the beginning a little bit, but no, not really.	Not really used the scroll bar			
20.3	Yeah, maybe learn.			Help learn	
20.3	But I like for instance seeing the dots when I played. When I played at the button you have the dots and you have the timing. It's very small so it's very hard to really see how the patterns.	Records on timeline too small		Visibility	
20.3	{In terms of the two graphical scores, which one do you think is more inspiring?} Maybe this [point to V3].			V3 is more inspiring	
20.3	Em I liked it more, I don't know. Yeah, the symbols are more complex. This is just dots and lines [V2]. This is triangles, and then you have dots, and you also have lines, different thickness.	V3 is more inspiring because it's more complex, with shapes, dots, and lines, and thickness change.		More inspiring as more being complex, with more elements (V3)	
20.3	Yes, it was fun.			Enjoyment	

20.3	Yeah, I think, I had a different approach in the second and the first. Like in the first I was being less related to this graphical scores. And in the second I just started trying to just match. I don't know why I did that, maybe just it seems interesting to explore.	Different strategies adopted for V3 and V2. Followed more V2 than V3.		Adpot different strategy because find interesting to explore.
20.3	Yeah, it's just because they were hard to predict for me. Because I didn't know everything, and I don't know very much on how to use them. Because at the beginning I was playing. But it's kind of you have too much at the same time happening, and you have one loop, and you have another loop, and you have things you are playing, and they kind of not match. Then it's just more noisy than, so I just prefer not to.	Reason for avoiding loop samples. Because It's hard to predict. Too many things happening at the same time is noisy.		Avoid looping samples to control quality.
20.3	Yeah, it will be nice to be able to change the loops. { Change to other sounds?} Yeah, other sounds. I mean you could be there and play for hours.			
21	I think at the beginning I was trying out the patterns. But then I was like they don't make a lot of sense.			Dissatisfied with the result
21	So I started like a background thing. Then on top of that I was sometimes trying those kind of additions, to the loop. And that was much better. And then I was trying things I guess. I don't know, like…	Experimenting process, try out the scores.		
21	Like sometimes I was combining, I was mainly, yeah, I was using the concept behind it, like "Maybe you should start briefing the time, or maybe you should try this type of thing."	Using the concept behind GS to create.		Offer ideas (concept behind GS)
21	And some I like, some I didn't like.			Pick symbol
21.1	Some I like and from that idea I developed something else, based on the sound it makes, more than the visual thing. Cause like I go from the visual to the sound, and then from the sound to another sound.	Develop further ideas based on ideas offered by GS.		Help develop own idea (GS)
21.1	No, I wasn't trying to follow because the first thing I notice was that the thing was moving, and then I couldn't go back, and like filling the gaps. So I thought, "Ok, I'm not gonna follow this."	Decide not to follow the GS because it's moving		Quit follow as can not control over GS
21.1	But at the beginning I was trying to perform the thing, like "Can I actually do it?" Like, my fingers are fast enough and stuff like that. But then that was a bit dry so I added the background thing.	Try to work out the patterns		Trigger thinking
21.1	No, I think because I see it and then I try it. And then even if I didn't see it, I remember I've used it before. And then I can do it again.			Give concept of playing
21.1	But I don't know if I was really remembering them, or it's like unconsciously they were kind of passing, so I don't know.			
21.1	No, I think for me, they also worked like a horizontal structure.			
21.1	But using this [point to No.3 to 9 V2], I found it's more useful for either applying it into this, like vertical, or for shorts.	Some short ideas, some short transitions, it's better to use No.1, No. 3 to 9 and No. 12 and 13, it makes more sense to you to kind of do something. And then in the long term, you might do something, No.0 and2, like big transitions, but that's foundation of a piece, it's not developed from the graphical score.	GS is good to support developing short ideas, or short transitions. But for long transitions, or structures, the score doesn't offer much help.	
21.1	Maybe if you look at my data you will find something like this, or something like this. But I didn't do it on purpose, because that was kind of the bones of the piece. And I wasn't getting ideas from this, it's just like, this is how the thing developed.			
21.1	But for like short term goals, like short term sentences, then these were nice, and this.			
21.1	And then from trying, for example these [No.3, 4], and these [No.6, 8]. I was listening and the sound was nice, so from that I was doing more like percussions stuff.	When the result is nice, it encourages people to do things.		Encourage play (GS)
21.2	The question about the satisfaction and the creativity, I think I'm giving a higher score because after using it 3 times, I feel just more confident.	Get more confident in the final play.		Confidence
21.2	I think I was more inspired and helped by the previous interface [V2]. Because I couldn't really make a sense of the symbols.	V2 gave more inspiration and help. V3 is difficult to make sense.	Even though being told about the design, participant feel difficult to make sense of it.	Make no sense (V3)
21.2	So at the beginning I think I was using the ideas from the previous one.			
21.2	And then at some point I was like, wait, maybe I should take care of the structure of the music as well, not just what I'm doing right now, that I'm trying this combination, but like more about this. {More about the general structure?} Yeah. And then in that sense those images were not like inspiration but like a reminder, like the music should have a shape, and should have a volume, and should have a, I don't know how to explain. Like remember the whole picture of more like the structure. like you shouldn't keep the loop, the same one for the whole time. I don't know why, but those images were kind of like reminders, of like take care of that as well.	The abstract symbols act like a reminder for taking care of the whole thing of the music, for example the general structure, the volume, the combinations.	This is an interesting and new interpretation. It seems that the abstract has the potential to remind the structure as well.	Reminder of general structure (V3)
21.2	And then, but at some point I was a bit tired of playing, so I started to use the back, the timeline, which I didn't use at all before.	Get tired of playing		Tired, play back
21.2	Like before it's only like going forward, going forward, and trying different things, and trying different things.	Playing in real-time with V2	It's a good idea to compare the times of using the scroll in V2 and V3, to see if this make any difference.	Play live (V2)
21.2	And now I came back to this idea that it should be a piece, it should has a start, and so maybe I would maybe listening it again, and like trying to ended it in a nice way, making sure it was not like a crazy thing, yeah.	In the second piece, the strategy is different.		Play strategy (compose, take care of the whole piece with V3, improvisly play live with V2)
21.2	Yeah, like what to press, kind of things. Like it was more like instructions.	V2 offer more specific ideas on what to press. V2 serves more like instructions.		Specific idea, instruction (V2)
21.2	And this one was more like abstract thinking, but I'm not able to relate that to the correctness of the music. It's more spiritual, I don't know.			Abstract thinking and spiritual (V3)
21.2	More like I used it as a reminder of taking care of the piece.	Use V3 as a reminder to taking care of the piece.		Reminder of general structure (V3)
21.3	I think it's a combination because they serve different purpose.	Prefer to combine two as they serve different purpose.		Different purpose/ senario; combination
21.3	So the first one would be great to learn, and to kind of get ideas and things like that, but once you master that, I don't think you need it all the time there, you can skip that part.	V2 is good to help to learn. And is not necessary after you master that.		Learn (V2), no need after fluency
21.3	Yeah, it's mostly not like an idea of specific thing. It's like, imagine that was a sentence, that it goes over and over and it's always the same sentence, like "Lucia, keeping in mind this thing."			Reminder of general structure (V3)
21.3	Oh, yeah, I think it's like a reminder of like being creative as well. It's like, because that doesn't make a lot of sense , I was like "I can as well do random stuff and see what comes out of it." Cause it's like really open and like it doesn't bound me to being right or wrong in how I clicking buttons and stuff. It's more like interpret it as you want, so I'm like, ok, I keep it as a reminder of do what you want, kind of things.			Reminder of being creative, abstract, open and not specific, no right or wrong (V3)
21.3	It's more like a global, the whole thing is one concept, it's like being open, like try different things, be expressive or things like that.	Concept developed from GS V3, as a reminder to be open, try different things, be expressive, take care the structure, be creative, etc.		
21.3	I think because they are not so easy to understand, just like.	V3 is not easy to understand.		Not easy to understand (V3)
21.3	I wasn't look at specific ones. It was, in my eyes it was one thing, I don't know.	Take the GS as a whole V3.		
21.3	Sometimes it happens. Like sometimes I remember I was getting this, and this, and this I think, [point to No.7, 8, 9] is like oh, this indicates a circular of music. This [No.8 V3] indicates going up and down, and like alternate things. This indicates, I don't know, going from I don't know this one. But it wasn't like, "you should press this and this and this". It was more like "oh, remember that there is the concept of circular thing", I don't know, like one two three four, or I don't know, something like that [No.7]. And this [No.8] is like, I don't know what I did after this. Or this [No.5] I interpret it as more like harmony between two things. And this for contrast between sounds.	Develop own interpretation. Examples of interpretation on the V3 GS.		Interpretation: harmony or contrast between sound, alternate or circulat things.
21.3	Because I don't think I have, I imagine myself to use it more at my free time. Just to enjoy myself.			
21.3	And it's more fun having this, because I don't have in my mind the goal of composing, or like, so this is really a creative input. Like, I wouldn't know how to do otherwise, I think. I mean I noticed that this time playing this, it was much more fun than the first try we did today.	With GS is more fun, and it helped to set a goal for music output. GS is a creative input.		Help set a goal for music output, creative input, more fun (GS)
21.3	I think this was to learn [point to V2], the first version was helpful to learn and to get inspiration. And this one [V3] was more to be creative, I don't know, maybe to explore beyond what's written here. So more freedom maybe. I mean the first one give you freedom after you learn, then from that you can develop. And this one ask you to abstract directly. But this [V2] kind of give you a help, and stuff.	V2 is good to learn, and explore, and it give help at first place and then you can be create based on that. V3 is free, and abstract, ask player to be creative directly.		Different function; Learn, explore, develop own idea from V2; Free, abstract, creative
21.4	Oh, that, with this one sometimes [V2], when the first one tells you to make this shape [No.7 V2], I'm not sure whether I press this and then this, this will be above or below. So I can't really recreate exactly the same shape, because I don't know the map between this and the graphics.	With V2 not sure about the mapping between buttons and position on timeline, which make recreate pattern difficult.		Reproduce same pattern (V2)
21.4	And in this one [V3] I was not bothered with that			
21.4	And then I think I appreciated more on the physical appearance of the thing, because I kind of used it at some point as a percussion thing, like I was using it to like as a drum thing, with rhythm and stuff, so that was nice. Except this face [white buttons] is really hard to achieve. But these were cool.			Enjoy tangible interface
21.4	I'd say the first one [V2], but just because I'm sure that I didn't have this [V2], playing with this one [V3] would be really hard. Like I enjoyed playing with this [V3] much more, but I think it's because I used it [V2] the first time. I used the first before. So I think this is more inspiring, the first one [V2].	Enjoyed playing with V3 much more. Think V2 is more inspiring, and playing directly with V3 would be really hard.		
22	So I try to use the loops, have a combination of the loops. And then I'll go back to try to fill some of the single touch ones. And if maybe, sometimes the loop was more melodic, it seems to match more with the piano single ones. And then the percussion ones, it seems to fit more with the percussive.			Explore how sampes fit each other
22	Yeah, it was normally do a little and go back listen and trying to add something.			Add onto previous
22	So one of the good thing was the scrolling, so you can easily go back and start where you need to go.	Being able to go back is really helpful.		Play back is helpful
22	The maybe, one issue is that, if you say, if I had a looped pattern, and I was doing one on that loop pattern, to add in, fill notes. If I made a mistake, I couldn't just delete that fill, I'd have to delete everything. Because it deletes from that point on wards.	Delete onwards is might potentially be an issue.		
22.1	But I think it's fine, it depends how you view it. If you being a bit more creative, then maybe that's not such an issue, but if you a bit more that have an idea for you want to do, then that's maybe an issue, potentially.			
22.1	So it did in the sense that, [point to No. 0, 1] so maybe this one, and these two, I found quite useful. For making the loop patterns. Because yeah, it helped to give an idea of how I could, yeah, create those loop patterns.	GS helped to create loop patterns.		
22.1	I probably looked at it occasionally. I did start by trying to follow it. but it was a bit quick for me, like when it was moving across.	Look at the symbol occasionally. Try to follow in the beginning, but then stopped because it's too quick.		Quit follow (move too quick)
22.1	So I was more looking at the symbols, for inspiration ,			
22.1	I probably didn't do it as much, but [point to No.13], this potential would be the one to use for the end. So sort of fade out, but I didn't do that. But maybe in the future if I do it again. And then this [No.11] sort of maybe give you an idea you can have the loops and then interjecting the single.	Interpretation on GS V3 is based on the introduction.		Give inspiration (GS)
22.1	So I probably, I was probably trying to follow the score more with this one. Perhaps because it seems it was simple to understand. The, so I was trying to follow each of the symbol as they came about.	Follow more on V2 because it's simple to understand		Play strategy (follow more on V2)

22.1	It was quite an interesting thing to do, but I think I might have been a little bit more creative with the first one [V3]. Because I think maybe, but maybe more because I was either trying to interpret what I was seeing, and then I was trying to make my own ideas a bit more.			More creative when try to interpret symbols, and make own ideas more (V3)
22.1	Whereas with the second one I was probably trying to follow what I saw, if that make sense?			Follow without create (V2)
22.1	Also, maybe partly that also I think because when I went back, when I was going back and playing it again, sometimes it was clear which of the symbols I looked at, but the symbols sort of different, cause the symbols didn't stay. It was more difficult to remember which the symbol I was trying to follow.	Symbol do not stay, difficult to remember the symbol before		Symbol do not stay
22.1	But potentially what I could have done is listen to it, and then modify it as I want to, maybe using the symbols as an initial framework, and then.	Use GS as an initial framework and modify on it.		Be more creative with GS as initial framework and modify on it
22.2	Yeah, I could have potentially been a bit more creative if I approached it in that way. But it didn't occur to me while I was doing it. Maybe afterwards I'll do.			
22.2	I think the first piece was probably nicer than this			
22.2	I think it's probably it's linked with the creativity I was being, I think I was being more creative in the first time than the second time.	More creative with V3		
22.2	Yeah, I think I probably did enjoy it a bit more the first time.			
22.2	I think it's I enjoyed more when I wasn't following it. I think these symbols [point to V2] are clearer, so. But I, because of my approach, I think I enjoyed the first time than the second time.	Enjoyed more when not following GS. The approach make a difference on the experience.		V2 is clearer. Play strategy (enjoy more when not follow GS)
22.2	I think I probably started that way, but I probably kept missing them. It was difficult to trying keep track of all that was. So, it may be a bit more when I remember to look up and try again, a new one that I could see coming along, it may not be the next one, but it will be one that sort of on the screen that come along.	Did not follow the score strictly because it's difficult.		No rigorous follow
22.2	I think I just, is more of a, I saw a symbol and thought "where could I put it?" [V3]. Whereas with this one [V2], I saw a symbol coming up and trying to put it in next.	The approach is different for V2. Player try to do the symbol instruction immediately, but with V3 player is deciding where to put those symbol suggestions, instead of doing it immediately.		Play strategy/approach different
22.2	So I probably prefer this one [point to V2]. But I think there is the approach, I enjoyed the first time.	Like the approach with V3 but prefer V2 because it's logical.		prefer V2
22.2	I think this one [point to V3] is more creative			V3 is more creative.
22.2	this one is more logical [point to V2]. So from a, because I'm an engineer, I like very logical.			Logical (V2)
22.3	But for someone who is creative, maybe they would prefer this [V3]. So I mean it depends what is this meant, the target audience for this. Maybe if the target audience is younger, like a child, or a young person, they prefer something a bit more visually creative. But for me, this makes more sense [V2].	V2 is more logical and make more sense.		Target audience
22.3	Only in the end. Yeah, I did go play what I've done to it again. And I was trying to put some more, put some other things in it, but I found that more difficult because I couldn't remember which pattern I was trying to follow.	Used scroll to previous a little bit to listen what has been done. Can't remember what symbols were follow when go to previous records.		
22.3	It does in a sense that it gives you, it depends on your interpretation, but it gives you an idea of how you may begin and end. Maybe these ones [No. 12 and 13 of both], give. I think, both of them, cause they give you an idea of how you may begin and end a piece. Maybe it's more difficult in the middle of a piece. But they are, I guess ones like this [No.1 V2] could be, you try to think of a loop that you want to put in between, that you can add onto.			Give music idea
22.3	I think in some ways it needs to, it's more useful if people don't try to follow it. The symbols are good for inspiration, but I don't think, for me I don't find it helpful to try to follow it. But the symbols themselves can give you good idea.			Follow GS hinder creativity.
23	Effectively, I, when you show stuff, I took notice some of the sounds I really like this, I really like to listen to. And then thought to myself, "Well, how can I do this, and make it sound nice?" I think the nicest sounding sound was the stuff to do with the piano, so I started with that.	Start with sound that's nice.		
23	Start to introduce a bit of drum beat in there. Don't know if it worked or not.	Not sure about whether the sound worked or not.		Sense of music
23	The only thing is I can't vocher how good the music actually sounds.	Can not make sure the quality is good.		
23	I found it helpful when I was stuck for what to do next. Had a quick glance and thought, "Em, I can do that. It's not so bad."	GS helped when stuck for what to do next.		Overcome fixation
23.1	Look at it occasionally.			
23.1	Not really interpretations, more so just the way I understood what it was. It's not really interpretation, it's more like I use my own ideas to say what it's actually is, if that make sense. So I guess you could say I have. What I really did was, with regards to the several triangles, I figured, you've only explained what it meant, I probably would have assumed it something like, I'm going backgwards and implementing something when I go back.	Developed own interpretations		
23.1	That actually sounds like good. [Laugh] I'm just surprised that I'm actually make it sound half way piece. I'm not criticizing the music but I'm just terrible at music as I always have been. And so to make something this good, yeah, I think it test how good the product is.	Surprised by the quality of the result.		Confidence; satisfaction
23.1	The only thing I would say is whenever trying to rewind, I always seem to hit the reset button. Because the way you have to twist it, you occasionally just stuck.			
23.1	With the second one [V2], I basically just thought to myself, "What would sound good?" Looked to the top, "Ah, that's probably a good compose." Start with those, kept glancing back and forth.	GS helped to start compose by offering possible ideas.		Give ideas, help start
23.1	I did a lot more glancing with the second one than did with the first. Really helped my ideas for what to make it.	Look at V2 more than V3		Approach/play strategy
23.1	Especially like the fact that you could stick a loop on and press a bunch of single beats, turn the loop off, press another couple of buttons, press another loop on, turn several on.	Example idea got from GS V2.		
23.1	It made more sense as well with the graphical interface at the top. Because it's literally just dots, and dots, and dots. It makes more sense to me.	V2 make more sense.		Make more sense, simple (V2)
23.1	The second one. I find it far easy to follow, and gives me more ideas.	Prefer V2, as it's far easy to follow and gives more ideas.		Easier to follow, give more ideas (V2)
23.1	Create and explore, the second one is good, I really think it helps on that. Learning, it helps you to learn the combinations of sounds, but the sounds themselves are fairly easy without them.	GS helped on create and explore, also learn combinations of sounds, but the sound is easy to learn without it.		Help learn and explore, and learn combination of sound
23.2	Listen to it and maybe add a bit in it if I think it need stuff.	Go back to relisten		Play back and add onto
23.2	{So which one do you think is more inspiring?} Second one [V2].			More inspiring (V2)
23.2	Because it gives me more ideas, allows me to come up with more ideas on my own. Once you start coming up with ideas, you come up with more automatically, so.	V2 gives more ideas and allow to develop more ideas based on it.		Develop own idea based on GS ideas; Come up with more idea automatically
23.2	NO. 6 was quite useful, thinking like "Ok, one beat, second one two beats and three beats." That's quite good.	Example idea from GS.		
23.2	Yes, I thought to myself "Well, maybe I can blend something like this" [point to No.4]. So if I blend with No.6, so for example if I do, say, red. One beat of red, second time I'm gonna do two beats with red, and then one beat of blue, and just keep going like that.	Example idea developed from the symbol.		Developing own idea: blend with different symbols;
23.2	It's just make less sense to me. Because this looks like a rewind button [No.0].			
23.2	I like having the graphical score. So I choose to keep it. It, as I said, it helped inspire me and gives me ideas. But more than that, it actually makes it more fun. For example, because you could probably make a little game out of it, like "Ok, I've got to play exactly like this, or like that." Because it's randomized every time, you probably gonna get, and there is 14 of the symbols, you probably gonna get 14 factories of possibilities.	Prefer with GS, because it inspire player and give ideas, and make the process more fun, and give more possibilities with the music.		Fun, inspire, give dieas, various possibilities (GS)
24	I enjoyed doing it.			Enjoyment
24	So once I figured out them all, you said the looping on this one. So I was basically trying to put a little bit of sounds with drums on this side, and sounded good. So I was just like checking which of those went well with the loops, that different. I don't know how to speak different musical times, different beats, and temples as well.			
24	And, it was, pretty much, I trying to, the entire time I was playing, I was looking at the screen, looking at which shapes are coming up, and then at the same time figuring out if this color belongs to this color.	Look at GS very frequently, trying to follow.		Color helps inspirations.
24	And went to change from percussions to piano. Also noticing the color change and then figuring out that ok, this one sounds this way when I use this button and that button. So it helped to remember what each of them was, in a way.	GS helped to remember what of each of the button was in a way.		Help learn sound, help remember what each button does (V3)
24.1	The color helps to visualise, to remember, that this were always the red, the big ones in a way.			Color help visualise and remember
24.1	And then, the drums, was the big blue circle, so every time I did that, 'ok, that's the drums', so when I change it to the percussions, it was the tinier ones. So every time, did I just mixed it up? But basically I remember that's what I'm doing. So it helped.			
24.1	{So you get some, like, en,} Guidance from the color to choose which one to play			Color offer guidance to choose which to play
24.1	In the beginning, yes, I was looking at the screen. But at the same time, I was like, trying to figure out first what the buttons were getting. Once I got used to that, and then look at the screen, I was pretty much looking at the screen the entire time.			
24.1	It helps to distinguish which sounds, like which button belongs to which sound.	GS Shape helps to distinguish sound of buttons.		Help to distinguish sound (GS)
24.1	Cause you can see, I can see which one with the line and stuff, so if I was going back a step to a previous one, I know how to put a drum for example, I will know, 'ok, this line belongs to the drum', so I can like, I put it in there, in that sense yes it helped.			Give idea on which sound to choose
24.1	But as the thing was going forward, I was looking, the line going forward, I was looking at the ones that are just before the line, I was thinking in advance what will come next as well			Think in advance
24.1	Also I mean, even though yes, the colors, [pointing to No.3] No.3 for example, it was like 'ok, I remember this is red, this is blue button'. I couldn't get every single one of them.	Can't follow all although can remember them.		Not fast enough
24.1	'ok, I just did that', I just keep playing. At the same time, it was like, because I can see the color go with this one as it goes across the screen. Sometimes I try to see if I can match it. Almost all the time, it was just like, going with the flow of the music.			Going with the flow of the music
24.1	Sometimes I try to like, make it continue.			Play live
24.2	Sometimes I was mixing that with pianos. Cause it won't going well, so I just went back to the drum.	Piano is less well compared to drum.	This might be because of the auto-synchronisation. Need to check the data the difference between auto-synched and not-synched sound.	
24.2	The […] representation was slight, just slightly easier to follow.	V2 is easier to follow		Easier to follow

24.2	But because it was like, with the other one, it was like all these shapes, so it was, I don't know, more visual, like visualise the buttons and everything better, compared to this one.			
24.2	Even though I can tell, like, with the length of the lines you can start and stop, stop and start, that was easier to do, and the dots also. But it goes to the point where when […] there are many many dots, so it was like 'no, I'll just do my own thing.' B	Too much graphical information		Information overwhelming (V2)
24.2	But sometimes I remember 'ok, let me follow the representation a little bit'. But then after sometime it was more of like just go with what sounded, and playing with the sounds and seeing how it sounded. I did like the second one better because it tells you start and stop, stop and start.	Relying on listen, look at GS occasionally; V2 help play better music as it indicate when to start and stop.		
24.2	But the other one has its own benefit the shapes, going with like, I think it was NO. 10, 12 and 13. These ones are like, I like these two. And then this one as well, No.0 and No.1. [pointing to GS on v3]	Own benefit		
24.2	For guidance, the second one [V2]. For remembering, which of the buttons are, the first one [V3]. The second for guidance, when to stop and when to start, which buttons to go with. Yeah.	Serves different functions		Guidance (V2); Remember buttons (V3)
24.2	{In terms of creativity, which one do you think is better? For like, helping you to create?} I will say this one. [Pointing to the v2.]			
24.2	But only like, after you get used to the colors, what the buttons do, what the colors are.			
24.2	Because I didn't really follow the first one as much as I follow this one. All this one helped me was to remember how this look, how it was like. Yeah. But with this one I can see start-stop, start-stop, start-stop, start, start, start, start do this and do this, and then, d, d, d, d, d…	Follow V2 more than V3.		Approaching GS differently, give instruction (V2)
24.3	{In terms of the result of the music, the two piece you've created, which one do you prefer?} The first one I think. So with the first one, it was because I lost track of this, so I was just making my own thing.	Satisfied on the result with V3 although she think V2 is easier and more creative.	This participant's explanation is interesting because her choice on the prototype and the result seems conflicting. Player made this choice probably because of the style of playing, the way that she didn't follow it and had more time creating own thing, which make she feel better.	
24.3	The second one, I was following this, but then, it wasn't all sounding too well together at the beginning. And then let's say go for a bit and did my own thing and it started to be ok again.			Dissatisfied with result from following GS
24.3	This one, I kind of feel like I got back into it, till it was the end. But then, I don't know. It's difficult.			
24.3	The first one only because I lost track, it was easy. I like that one.			Not follow GS is easy and good result
24.3	Yeah, because of the shapes I could still remember what they were. The shapes helped to remember that, so I just get going on with the…			Shape help remember
24.3	The second one (V2), because it was like start and stop, start and stop. I didn't really want to stop, so it was like, let me just continue. But it was like, go with this, so I will stop it if I didn't want to.	V2 people felt obliged to follow the score even when they don't felt like to		GS conflict with own idea, choose to follow (V2); Determine
24.3	If I see this, even though sometimes I'm not looking here, I'm just like pressing, pressing, but I know because I can see the shape. And compare with these ones, it kind of like make sense a little bit more.			Shape help to see even when not looking at GS (Visibility)
24.3	So like, with these ones, [pointing to red buttons on the box] the way you've done, the representation, is that, some are like, the bigger ones. So with that, I'm like able to say, I'm able to remember, like going with this [pointing to GS No.12 on V3]. And the smaller dots, to me, I interpret them as smaller ones [pointing to GS No.8 on V3]. And the bigger ones with the looping ones. So with that I kind of remember.			Shape helps to remember
24.3	For this one [V3], I went to the future. With this one [V2], I went back and delete it.		!!!! Do the versions affect interaction? Maybe it's good idea to check whether the times or time of spending on future/previous timeline is significant across versions.	V3 future, V2 previous
24.3	{you went to the future to plan something in the future?} Not plan per se. But just like, do stuff there			
24.3	It was to reduce, to remove something. And then, so I went back, to play it back, but I made a mistake by pressing one of the buttons while pressing another button. So it sounded good, but then it just went like crazy. So I went back a little bit, delete it, played it again, and then it was fine up until this point where I close it. So I left it there.	Made a mistake. Go back to remove things		
24.4	I'd say, for the second one [V2], it helps to create. But limitedly, with limitations. Because if I was like too keen, like following each of them, I wouldn't pay attention onto like how it sounding. I will be following this.	People tend to follow the graphical score on V2	Limitations - Following graphical things would distract people from concentrate on music per se.	Help create with limitation; Obliged to follow, not pay attention to create.
24.4	But this one [V3], I know it's slightly more complicated, but it will let me, it helped me to visualise what I was doing. And then, in terms of creativity, apart from when I wasn't following it. Because of the way it looked like, I lost track of this and I was just do my own. But sometimes I'd go back to it, and say 'ok let me see, if I can get the next one coming up'. But most of the time, I was like, after the first few seconds, just like understanding the colors and getting them together. I was just doing my own thing.	Because V3 is difficult to interpret, people stopped following it. But player go back and look at it occasionally.		Allow more freedom to choose to follow or not (V3)
24.4	This one [pointing to v2] helps me to focus properly on like, try to do d-d-d, like stay with it.			Help focus properly on sound (V2)
24.4	It has its usefulness.	GS has its usefulness.		
24.4	But with this one [pointing to V3 GS] my whole concentration would be, give it was like match each of this [pointing to V3 GS], my whole concentration would be like, 'oh, no it's not this. It's that one, it's that one.' So I wouldn't like let go. Because one of the questions was did you lose yourself in it? If I was rolling this to the tea, yes, my concentration would be on the screen. But it wouldn't be on the music that I'm creating, it would be more of like trying to launch each of those.	GS will distract player from concentrating on music, but focus on launch each of the GS.	How task affect participants. This participant take the improvisation task as to 'match each of this'. They take it as a thing to follow, which cause pressure. This is something needed to be avoided.	Distract people from concentrating on music
24.4	En, without, I can explore, properly. And like understand how it works. And say 'ok, if I do this for a few seconds, and went previous and it makes more sense'.	Without GS can explore properly.		
24.4	Without it, it would be me trying to learn, and listen. Like remember. Learn and remember, and then do.			
24.4	So I would say, doing it first helped a little bit to be able to do this [pointing to V3 GS]. So if you give me this (V3), if I just sat down, instead, follow this and try to make sound, I'll be completely lost. It will be like, so it's good that you give me that to play around first.	This participant's talking correspond our design.	In the pilot study, we found participants getting lost without properly learn the box. Given the graphical score in the beginning will affect their learning on the box. That's why we introduce V1 in the beginning of the study.	
24.4	If you give these two [pointing to V2 and V3], because, yes, even though I saw the shapes and all the other stuff, I didn't really think about it properly until I saw this [pointing to V3 GS]. So this helps to follow on from that.			
24.4	But if it was like, give me this and then say, create music, it will be not good. It will not be like, a structured sound, until like after a few try and understand the sounds.	Learn the sound is necessary for creating a structured piece.		
24.5	{In terms of the creativity, you think the second one (V2) gave you more?} it gives more structure. Yeah.			Give more structure (V2)
24.5	I mean, as I said, it doesn't leave room for like, expressing yourself a lot. Because you're trying to like, go with every start and stop, like, yeah, it just gives structure	V2 limit creative freedom because people trying to follow the score,		Limit freedom/expressiveness (V2)
24.5	Yeah. Unless you do it a few times and you understand like how it works. Then you could do like, 'ok, create something real.' But like, for the first few, I'd say half an hour, it was still take some time, to like, say 'leave this for this long, and then do this, and then this', then it would be much better.	Create after exploration		Exploration
24.5	With this one (V2), it was more of trying to, get it to continuously flow well together. Because with this type [pointing to No.1 in V2 GS], this was start and stop. So it was like, I start a long loop, and then I stop and start. So there is a breakage in between. So for that, it wasn't like, it wasn't very helpful to like create a music that went smoothly. Because it's start stop, start stop. So in the beginning, it was like, very, all of it out of place.	Music flow disrupted by V2 GS as it's start and stop all the time.		
24.5	When I lost track of what I was doing, then the music I've created was more of like, slightly goes flow. In terms of the type of music, I don't know. I was, my one aim was to let the it be continuous as much as I could.			
24.5	Yeah, the sounds were relaxing. I felt like going to bed. It was like lullaby .	Sound is relaxing, like lullaby,		Enjoyment
24.5	Definitely, like with this dot, [pointing to V2], the small ones, No. 3 from then No. 8, it was easier to interpret. I mean, this (V2) is very easy to interpret, compared to this (V3), generally.	Dot patterns of V2 is easier to interpret.		Easier to interpret
24.5	{So you preferred the second one (V2)?} Definitely. Yeah. As a beginner.	Good for beginner (V2)		Good for beginner (V2)
24.5	Yeah, with this one (V2) it's just simple lines and dots.			Simple (V2)
24.5	If this was like, Morse code or something, someone's like, 'interpret this'. I would probably trying to do with this (V2) first. It makes it easier to understand for sure.	V2 is easier to understand		Easier to interpret (V2)
24.6	If I would go for complex music, then I'm like, 'ok, I'm gonna challenge this (V3)'.		V3 offers more challenge, and has the potential to help create complex music. V3 is more inspiring, and offer slash material, and is more motivating. Give player more challenges. V3 helps to create complex structure	Good for complex music, challenge (V3)
24.6	With this one (V3), as a person, if I see this, I'd like 'oh, ok, let me try to create the music.' I'll think this is complex, like complex musical structure. Compared to listen to this. That's what I'll think.			Help build comple structure (V3)
24.6	If give it was like a challenge, to create something, then this one (V3) would be…more inspiring, slash material.			More inspiring with slash material (V3)
24.6	Motivating. But you know how people, that was like, easy to do. That was easy, give me more challenges and things.			Motivating (V3)