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Applying User-experience Design to support Johannesburg high school educators teaching Design Thinking.

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To Christo Mynhardt, thank you for all you support and always willing to "fix" my grammar. Your support was unwavering even though all the difficult times. I love you.

Thank you to my Faculty in general for always being there and supporting me through this process.

Abstract

This research paper describes and reflects on the effectiveness of integrating Research through Design as both a methodology and Design Thinking in order to co-design a digital product with and for high school educators. In reference to this concern, the aim of this study is to explore how digital technology can be designed by applying User-experience Design (UXD) to support the teaching activities of educators teaching DT, so that they may become more confident and knowledgeable facilitators. The end result of this process was for an interactive digital platform aimed at introducing DT to SA teachers of art, design and technology.

A Research through Design methodology is applied in this study within the specific contexts of a co-design project involving high school teachers in Johannesburg, South Africa. The study undertakes a human-centred design philosophy whereby users' problems and experiences are seen as contextual and complex, therefore requiring that the researcher to have consideration and understanding before these problems can be resolved. The design process applied in this study therefore focused on gaining an understanding of the teachers' experiences in order to design effective and empathetic technological solutions that will be meaningful and useful to the teachers.

The study concludes that this integration of Design Thinking and Research through Design is effective, in particular through its enablement of user participation in contributing meaningfully to the co-design process.

Keywords: Design Thinking (DT), creative thinking, private education, public education, Interpretivism, Heuristics, Activity Theory (AT), Human–computer interaction (HCI), User-experience Design (UXD) Experience Design (ExD), Research through Design (RtD).

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CHAPTER 1. INTRODUCTION TO THE RESEARCH

1.1. Introduction

Design Thinking (DT) has proven to be successful in applying creative thinking to resolve complex problems in the ever-demanding global environment. The DT phenomenon has also been recognised to be successful in the tertiary educational system in parts of Asia, Europe, and the United States of America (USA) as well as in a variety of primary and high schools mostly in the USA (DT for Educators, [sa]:1-5). However, through research done in the researcher's Honours Degree, it became apparent that DT has not been integrated effectively in teaching practices related to art and design in the South African school systems. This research seeks to address the current perceived effectiveness and impact that DT has on stimulating creative thinking and innovation in the art, design and technological environments in the public and private high school education sector in Johannesburg, South Africa. Furthermore, this study will explore the process of a user experience (UX) project centred on user experience design (UX design) and using DT as a tool to illustrate this. In reference to this concern, the aim of this study is to explore how digital technology can be designed by applying User-experience Design (UXD) to support the teaching activities of educators teaching DT, so that they may become more confident and knowledgeable facilitators in terms of more innovative and creative teaching with the use of DT concepts, tools and techniques. The design solution for this project will be in the form of an interactive software interface to facilitate and guide teachers to use the DT process to create an environment for more creative and innovative thinking

This paper will start by exploring several definitions, concepts and processes offered by various theorists and academics within the DT paradigm. The discussion then presents a range of the opinions and theories around DT in education and examines a range of positions by scholars who advocate DT within the educational system. It is worth pointing out for the sake of clarity that in this study, DT is considered in two distinct ways. Firstly, DT is the learning content, which the envisioned final product delivers to teachers. Secondly, DT is also applied as the broad pragmatic approach to problem framing and creative solutioning applied in the practical design component of the study. In this sense, the discussion of DT framed in the Literature Review supports both aspects.

The introductory framing of DT is followed by brief discussions on digital convergence and how education can be improved by employing a new teaching approach, in this case DT, within a blended learning educational environment. The paper will continue with the proposed methods for formulating the research essay by exploring the nature of DT and the application of this mode of enquiry specifically within a high school education context.

1.2. Context of the study

1.2.1. Purpose of the study

The purpose of this research study is to gain a detailed understanding of DT and creative thinking within an educational context, and how the insights gained are synthesised and embodied in a digital product and related design deliverables that meet the relevant needs of the user community.

The teaching product may inform class teaching or teaching support. The final strategical concept of the product is dependent on the needs of the teachers that will emerge through the design research process. Through a co-design process, a digital product has been identified as a possible solution to aid teachers in teaching DT and challenge learners to think more creatively and become more innovative in their design strategies.

This pragmatic study will apply a Research through Design (RtD) methodology. Pragmatic research evaluates theories and concepts according to the success of their practical application. A pragmatic study is a process of firstly identifying a problem which is followed by research inquiry, which seeks to better understand and solve the problem and provides the foundation for understanding and exploring the role of aesthetics in the broader context of scientific inquiry (Zimmerman et al's 2007). Design as a form of inquiry allows for exploring designers' aesthetic skills in DT, paying particular attention to embodied interactions with sketches and prototypes as well as visualisation practices (Rylander 2012:38).

RtD is a form of practice-led research in which a design project is the central object of the research study. Practice-led research, typically includes practice as an essential

part of its method and that the results of practice-led research may be fully described in textual form with indirect reference to creative work (Candy, 2006, p. 1) (Muratovski, 2016, p. 192).To ensure criticality Zimmerman *et al* four criteria for "evaluating interaction design research within HCI (Process, Invention, Relevance and Extensibility)" will be applied to reflect on the contribution the design process, methods and associated concept may bring to the practice of UX in South Africa, generally, and the design of digital teaching aids for DT, specifically (2007:499).

The Process aspect of a RtD study typically describes the design process. As such, while RtD is the encompassing methodology of the study, as part of the design process other research activities are included. Thus, within the RtD method, the design research strategy is largely interpretivist and focuses on how people manage aspects of their everyday lives and to "gain a better understanding of the world of lived experience from the viewpoint of those who live it" (Bertram & Christiansen, 2014; du Plooy-Cilliers, 2014). Mutual understanding and the sharing of meaning counts more than empirical observation when seeking knowledge (du Plooy-Cilliers, 2014). In this sense, the purpose of the design research is to understand teachers' experiences and perceptions of their everyday life within the school system and curriculum.

The study done during the researcher's Honours Degree found that introducing DT as an approach to stimulate creative thinking and innovation could benefit the students. Teachers have shown a need for competence, autonomy, influence and meaningfulness. By providing knowledge, advocating creative thinking and sharing experiences teachers' needs could be met. Put differently, the researcher's study supported the notion that creative thinking and innovation takes place when DT principles are applied during the design process.

1.2.2. *Background of the study*

This study is fundamentally based upon three factors, firstly, there is a need for training high school art and design students and teacher candidates for a variety of thinking skills as there seems to be a lack in abilities to solve complex problems creatively. Secondly, educators, for a number of reasons, feel unconfident about teaching DT, and thirdly, digital technology is well known for abilities to communicate and distribute knowledge.

The reality is that life in our 21st century global economy will demand of these students an astute and integrated application of their imaginative and innovative talents in tandem with their ability to act practically and show entrepreneurial understanding (Ingalls Vanada 2014:1).

In South Africa, research has shown that many students' educational experiences are still being reinforced by linear, logic-driven, and compartmentalised outcomes, primarily intended for gaining higher test scores. Many art classrooms continue to use traditional teaching methods, at the expense of preparing students to think more creatively, analytical, and to become problem solvers who can communicate and collaborate well with others (Ingalls Vanada 2014:21-22). During previous research done with art and design teachers, it became apparent that not much has changed in the way creative subjects are taught as in traditional teaching methods are still being use on a large scale. "In 2011, only 36 percent of college students demonstrated significant gains in critical thinking, analytic reasoning or written communication [after] four years of college, as measured by the Collegiate Learning Assessment" (Ingalls Vanada 2014:1-2).

While some of these views originate in the USA, they also resonate with many of the responses from South African educators interviewed for the researcher's Bachelor of Arts Honours study.

Tony Wagner refers to a "Global Achievement Gap" which, according to him, is a gap between what schools are teaching versus the actual skills all students would need for careers, colleges and citizenship in the 21st century (cited by Scheer, Noweski & Meinel 2012:10).

DT has been positioned as a powerful method and set of concepts that can help enable creative thinking strategies that can be applied in the resolution of complex problems. For teachers, DT may serve as a problem-solving tool for the design challenges, from curricular planning and assessment.

"[DT] serves as a creative and reflective tool for approaching teaching as both artist and designer of thinking in the classroom, for collaboration, and as a model for designing learning experiences" (Ingalls Vanada, 2014). Art and design education

teacher training programs that include a DT approach may answer this challenge, using empathic problem-solving techniques (Ingalls Vanada, 2014).

Marshall states that "DT education encourages teachers to loosen the narrow, rigid processes of traditional learning and capitalise on the learner-centred principles of connection-making, inquiry, and self-directed learning" (cited in Ingalls Vanada 2014:30). "A learner-centred teacher is one who makes the shift from content delivery and nice end-products to building student capacity, co-creating learning goals, and a focus on making the learning process the primary focus" (Ingalls Vanada 2014:30).

Not every art and design teacher trains students to be creative. It is therefore important to promote teaching and learning practices to that focus on creativity and innovation. "A deep need exists for developing thinking as connected to big ideas of social consequence, in order to build students' conceptual artistic practice, creativity, criticality, and social-emotional practicality" (Ingalls Vanada 2014:21-22). Again, through interviews done with high school educators during the researcher's Honours Degree, participants indicated that they understood the value of DT but did not have the capacities to implement DT:

> DT could benefit both schools that have large numbers (where individual attention cannot be paid) as well as the student who remains introverted and would not ask the educator for assistance ….[and that]…. [the] process is simple enough for educators to facilitate the discussion of the design process (Participant C).

> Unfortunately, practicality in the classroom requires a passionate teacher who can guide his or her students along this process due to time constraints as well as number of learners' present, this of course is a significant issue in South Africa due to poor mismanagement and a shortage of reliable educators (Participant A).

In the contemporary 'digital' age we have instant access to information at greater volumes. This rapid growth of digital content and tools has changed how we create, consume and distribute knowledge. The term "knowledge-based economy" results from a fuller recognition of the role of knowledge and technology in economic growth. In the knowledge-based economy, innovation is driven by the interaction of creators and users in the exchange of knowledge. This interactive model has replaced the traditional linear model of innovation (OECD 1996:3).

1.3. The research question

How can digital technology be designed to enhance the experience of high school[1] educators teaching creative thinking strategies for resolving complex problems?

1.3.1. Sub-research questions

1. What is the current experience of high school educators related to teaching DT?
2. What is the preferred experience of high school educators in relationship to teaching DT?
3. What are the current best practices (conceptually and methodologically) of DT as identified in academic literature and existing educational course materials?
4. How can insights gained from questions one to three be synthesised and embodied in a digital prototype and related design deliverables that meet the relevant needs of the user community?

1.4. Feasibility of the study

The feasibility of the study refers to providing the evidence that the research study is achievable with regards to resources, validity and reliability, and the attainability of research objectives (Koonin, 2014), through trustworthiness. This pertains to credibility, transferability, dependability, confirmability and meeting ethical requirements which will be discussed in more detail in Chapters Four and Five.

1.5. Ethical considerations

Ethics pertains to the behaviour that is considered right or wrong and is an important factor to consider when doing research. Bertram and Christiansen (2014:66-67) describes the following three ethical principles that need to be adhered to when doing research:

1. Autonomy – Each participant must participate voluntarily and with their consent. They have the freedom to withdraw at any time.
2. Non-maleficence – The research should do no harm to any of the participants whether it is physical, emotional, social, or any other form of harm. Furthermore,

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[1] Private or government schools

information supplied by the participants needs to be kept confidential.

3. Beneficence – The research should be beneficial to the participants or to other researchers and society as a whole.

This study is designed to explore the perceptions that South African teachers have on DT in both the private and public high school education sector in Johannesburg, South Africa. Each participant in this study completed a consent form (see Appendix B) whereby they agreed to participate in this study voluntarily and were given the option to withdraw from the study at any given moment. The study posed no harm in any way to participants and all information collected was kept confidential. Any data gained in this study may have potential value for both future sectoral research or to the participants themselves as most had very little knowledge on Design Theory and its possible advantages within the educational system.

Lastly, as part of the proposal evaluation process, the FADA Faculty Higher Degrees Committee, confirmed that all practices proposed by the study met the University of Johannesburg's requirements and by default those of the South African legal framework.

1.6. Exposition of the study

In Chapter One, the purpose, background and the research approach are discussed in order to create an overview of the research study.

In Chapter Two existing research on the topic of Design Thinking (DT), relevant to this research study is presented.

Chapter Three presents the theoretical framework of the study with the main focus on Activity Theory (AT) which forms the theoretical basis that supports this study.

In Chapter Four, the methodology and research design are provided. The motivation for the selection of methodology was provided and the connection between the usefulness of these methods and the objectives of the study were made clear. This includes the

In Chapter Five, the Process phase of the study are presented with the various models assimilated form the research study to formulate wireframes and prototype.

In Chapter Six, the Process phase of the study is evaluated in terms of Invention, Relevance and Extensibility.

In Chapter Seven the findings are stated in context of the research questions, limitations of the study are acknowledged, and recommendations are made for possible future research.

CHAPTER 2. DESIGN THINKING – BACKGROUND AND CONTEXT

2.1 Introduction

In this chapter, the literature pertinent to this study will be discussed. Key themes that will be discussed include:

- An introduction and outline of the effectiveness of DT in enabling learners to creatively resolve complex problems.
- A brief introduction of the field of User Experience Design (UXD).
- A brief description of Interaction Design (IXD) products that have solved similar types of problems.

2.2 Design Thinking

The paper will largely draw on the following characteristics of DT. That it is:

1. Mainly concerned with empathy and therefore human-centred;
2. Collaborative with the aim on interdisciplinary study;
3. A problem-solving tool that can be applied to an extended range of problems outside the traditional domain of design;
4. Visualisation of ideas;
5. A prototyping of ideas/ problems to be tested and iterated.

The researcher will start by discussing the process undertaken using DT principles regarding research, analysing, strategizing, ideating, prototyping and lastly evaluating.

Figure 2.1: DT Process.

North American design company IDEO characterises DT as a human-centred process that begins with a deep understanding and empathy for the needs and motivations of people. That it is collaborative, seeking views from multiple perspectives.

Stanford University's d.school describes DT as firstly drawing on methods from engineering and design, then combining these "with ideas from the arts, tools from the social sciences, and insights from the business world" (Our way of working, [sa]). In a document titled "bootcamp bootleg" ([sa] 1-5) DT is characterised as being focused on human values; to develop a deep understanding of users and to come up with an actionable problem statement; exploring a wide solution space; prototyping ideas; and lastly, testing said ideas by collecting feedback and refining solutions.
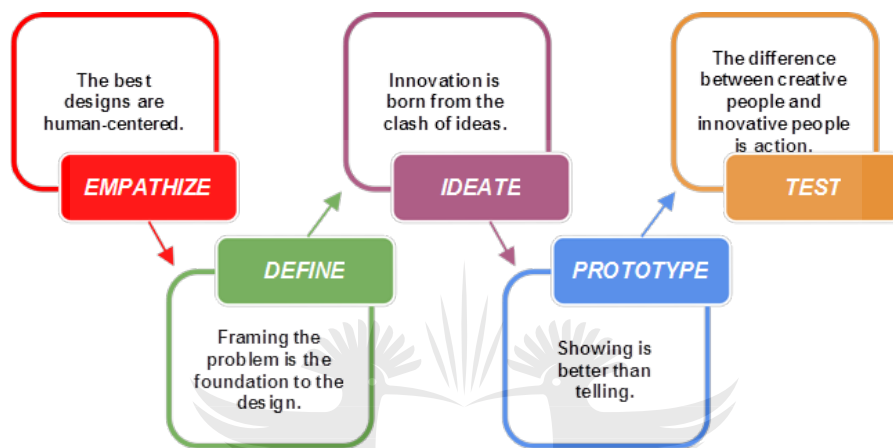
Figure 2.2: Design Thinking's five principles (cited Fenn & Hobbs 2013:3).

2.2.1 Defining Design Thinking

There are multiple models of DT that have developed over the years based on various theories and models from design methodology, education, IT, business, etc. There does, however, seem to be some confusion about what DT is and how it can contribute to successful problem solving of complex 'wicked' problems for designers, business and educators alike. Rittel describes 'wicked' problems "as a class of social system problems which are ill-formulated, where the information is confusing, where there are many clients and decision makers [with] conflicting values, and where the ramifications in the whole system are thoroughly confusing" (cited by Buchanan 1992:15).

For this purpose, this study focuses on theories and definitions available on DT within the design discourse.

The concept of DT can be traced back to as far as the 1970s and, according to Fenn and Hobbs (2013:2), it can be seen as the "umbrella term for systematic, transdisciplinary cognitive approaches to solving complex design problems

empathetically, effectively and creatively". DT's contemporary popularity is a result of its adoption by design firms such as IDEO. IDEO's Tim Brown (cited by Collins 2013:36) describes DT "as a key process that in turn enables the innovation process….[and that it] must evolve and be used by non-designers….[and furthermore that it can] be used as a problem-solving tool applied to an extended range of problems outside the traditional domain of design."
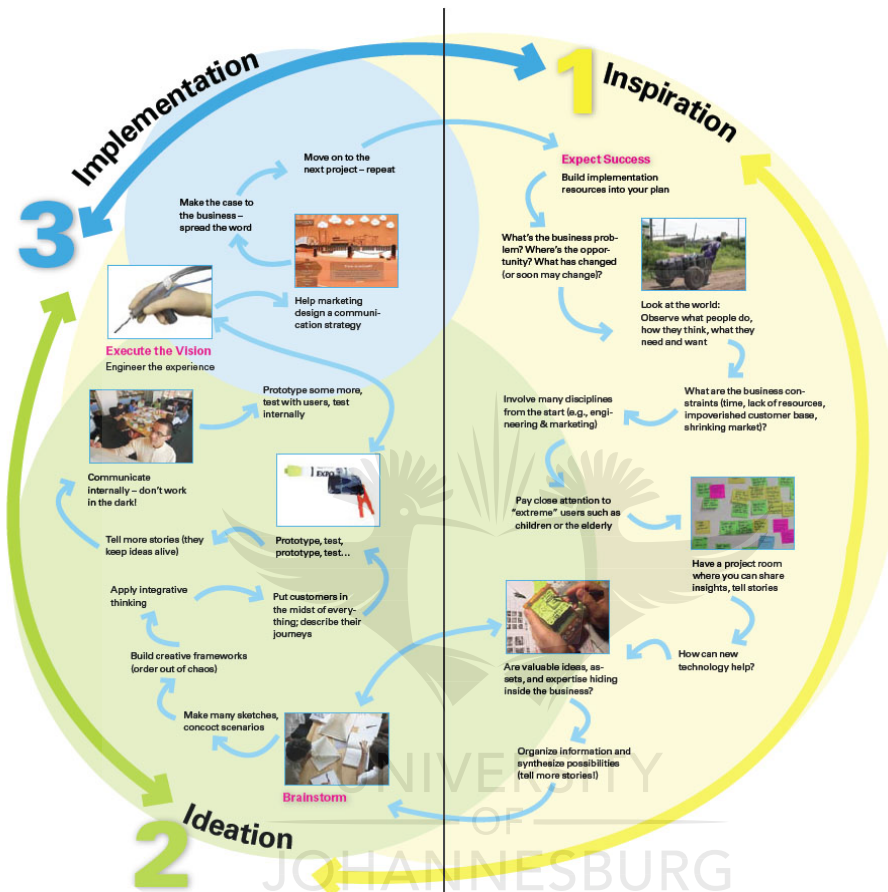
Figure 2.3: Tim Brown, IDEO DT diagram (2008:88-89).

Brown (2008:86) is of the opinion that DT is a 'Human-centered approach' (HCD) and describes the design process as a "system of spaces ...[that] demarcate different sorts of related activities that together form the continuum of innovation." IDEO's Tom Kelley explored the value which can be brought to business with collaborative pursuits between design and business by enabling innovation, and thereby changing the role of designers engaging with business (cited by Collins 2013:36).

2.2.2 Research into Design Thinking

In this section various theories within the DT paradigm will be explored and how these theories have evolved over time.

In 1971, the designer Victor Papanek described DT as, "[t]he planning and patterning of any act towards a desired, foreseeable end constitutes the design process. Any attempt to separate design, to make it a thing-by-itself, works counter to the inherent value of design as the primary underlying matrix of life. Design is the conscious effort to impose meaningful order." (Papanek cited in Pourdehnad, Wexler & Wilson 2011:4).

Roger Martin and Nigel Cross are both of the opinion that design thinkers use all three kinds of logic to understand their world, namely deductive, inductive and abductive thinking. Peirce states that "the act of creatively thinking about what can be done with the data in order to position it to the environment is what sets Abductive reasoning apart from Deductive or Intuitive reasoning" (Pourdehnad, Wexler & Wilson 2011:4).

Cross describes DT as emergent, intuitive, abductive, reflective, ambiguous and co-evolutionary. It gives more attention to the user than to the stakeholder and therefore aims to create solutions from a "user-need perspective" rather than using the traditional approach of defining a potential market (cited by Collins 2013:37). He goes on to say that DT "is concerned with how something may be rather than proving something must be or showing how something actually is" (Collins 2013:37) and have specific abilities to "produce novel unexpected solutions, tolerate uncertainty, work with incomplete information, apply imagination and forethought to practical problems and use drawings and other modelling media as means of problem solving." (Pourdehnad, Wexler & Wilson 2011:3).

He further argues that designers must be able to "resolve ill-defined problems, adopt solution-focusing strategies, employ abductive/productive/appositional thinking and use non-verbal, graphic and spatial modelling media" (Pourdehnad, Wexler & Wilson 2011:4). Cross further asserts that DT is a way of thinking that comes from a different way of *knowing*. "This different way of knowing refers to the way that human beings' interface with their world and their desire to shape their environment." (Cross cited in Meyer 2015:43) In DT, abductive reasoning is used to generate ideas and form

solutions to ill-defined problems and abduction differs from deduction and induction in that it uses the logic of speculation to suggest that something may be.

DT therefore uses abductive reasoning as a third way of reasoning to be added to deduction and induction. "A problem-solving cycle is formed, with abduction used for the generation of ideas and solutions followed by deductive reasoning for the predicting of consequences of those ideas, and then to inductive reasoning for the testing and generalization of proposed solutions." (Cross cited in Meyer 2015:43).

Of similar opinion as Cross, Martin explains that design thinkers are willing to use all three kinds of logic to understand their world, deductive, inductive and abductive thinking. (Pourdehnad, Wexler & Wilson 2011:5). Martin explains that neither analytic nor intuitive thinking alone is enough to sustain competitive advantage and that the goal of abductive reasoning is not to declare a conclusion to be true or false but rather what could possibly be true. (Pourdehnad, Wexler & Wilson 2011:5). Design thinkers are using "abductive logic but failing to make it explicit to themselves or anyone else. It is this mode of thinking that allows a designer to seek out new ways of doing things, challenge old ways of doing things and infer what might be possible." (Martin cited in Pourdehnad, Wexler & Wilson 2011:5).

Robert Bauer and Ward Eagan (2008) state that DT can be regarded as a "human-centred methodology that supports and drives effective innovation whilst Cross (2001) and Richard Buchanan (1992) describe it as 'tackling complex or 'wicked problems', as opposed to well defined problems" (cited by Withell & Haigh 2013). Thomas Lockwood defines DT as "a human-centered innovation process that emphasizes observation, collaboration, fast learning, visualization of ideas, rapid concept prototyping, and concurrent business analysis". (Liedtka 2014).

Rim Razzouk and Valerie Shute explain that DT is an "analytical and creative process that engages a person in opportunities to experiment, create and prototype models, gather feedback, and redesign" (2012:330).

According to Paul Harris and Gavin Ambrose (cited by Fenn & Hobbs 2013:3) the basic DT process includes defining, researching, updating, prototyping, selecting, implementing and learning whilst Andrea Scheer, Christine Noweski and Christoph Meinel (2012:12) offer a model that involves understanding and observing,

synthesising, ideation, prototyping, testing and iteration.
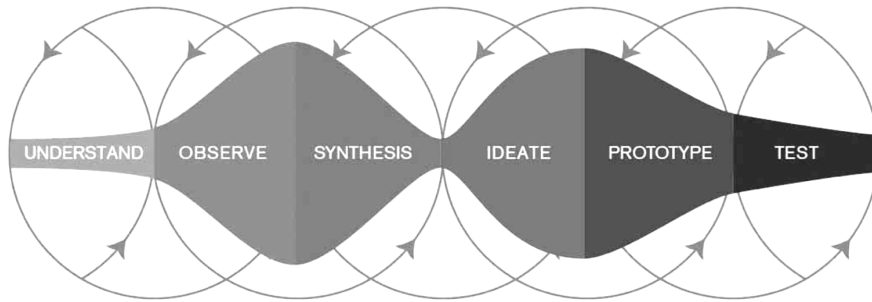
Figure 2.4:   Author unknown, DT Process (cited in Scheer, Noweski, & Meinel, 2012:12).

The starting point of the design process is in the Understand section which includes the Define and Research stages and it is this stage that the problem is defined. The third stage consist of Prototype, Select, Implement and Learn stages and this area focuses on the design solution. The ideation stage is in the middle of the other two areas "which represents the cognitive leap the design practitioner must make from the process of 'understanding' to the act of 'resolution'" (Fenn & Hobbs 2013:3).

The interest shown in DT seems to lie mostly in its human-centred heuristics and growing success. Numerous examples of these successes can be mentioned, such as IDEO (a design company in California that has designed many successful products).

There are however some theorists that feel that DT may, in fact, not be the solution to these complex 'wicked' design problems. Some view DT, within a business context, as a purely creative pursuit that offers no real, measurable results.

James Woudhuysen in an article titled *The Next Trend in Design* argues that DT has failed to live up to its expectations (cited by Collins 2013:35). Bruce Nussbaum, a former advocate of DT has, in fact, shifted his focus towards 'creative intelligence' rather than DT, whereas Dean Roger Martin from the University of Toronto, has opted to exploring different varieties of 'executive thinking' (Johansson-Sköldberg, Woodilla & Çetinkaya 2013:121).

In the last few years there has been many studies that have in essence proven the value of design (DT) in business such as the Mckinsey Report (Benedict Sheppard, Hugo Sarrazin, Garen Kouyoumjian, and Fabricio Dore 2018: [O]). If anything, the criticism of DT largely comes from the field of discursive design which is concerned

with DT lack of critical and sustainment awareness beyond that, that directly impacts immediate users and stakeholders.

Although the scholars, alluded to in the previous paragraphs, have elected to follow other perspectives when dealing with solving complex problems, the majority of opinions as explicated in this discussion suggest that DT is a very viable method that can be implemented and used in classrooms in order to stimulate creative thinking and innovation and solve complex design problems. Research done in the researcher's Honours degree echoes this statement especially when it comes to solving complex problems. Therefore, the researcher is of the opinion that the implementation of DT in the educational sector could greatly benefit teachers and students alike to yield more innovative thinking and creative design.

2.3 Characteristics of Design Thinking

Stanford University's d.school describes DT as firstly drawing on methods from engineering and design, then combining these "with ideas from the arts, tools from the social sciences, and insights from the business world" (Our way of working [sa]). In a document titled "bootcamp bootleg" ([sa] 1-5) DT is characterised as being focused on human values; to develop a deep understanding of users and to come up with an actionable problem statement; explore a wide solution space; prototyping ideas; and lastly, testing said ideas by collecting feedback and refining solutions.

Razzouk and Shute (2012:336) offer the following characteristics of a Design Thinker: that they must have a human- and environmental-centered concern; designers need the ability to visualise; that they must have a predisposition towards multifunctionality with a systemic vision; have the ability to verbally explain their creative process, have an affinity for teamwork and search for competing alternatives before making a choice.

2.4 Characteristics of creative thinking

Creative thinking can be defined as a "metacognitive process – of generating novel or useful associations that better solve a problem, produce a plan, or result in a pattern, structure, or product not clearly present before" (Hargrove 2013:492).

The North Carolina State University (2012) describes creative thinking as the "generation of new ideas within or across domains of knowledge, drawing upon or intentionally breaking with established symbolic rules and procedures".

Creative Thinking usually involves the [behaviours] of preparation, incubation, insight, evaluation, elaboration, and communication.

In the context of college teaching and learning, creative thinking deliberately and actively engages students in:

1. Bringing together existing ideas into new configurations;
2. Developing new properties or possibilities for something that already exists; and
3. Discovering or imagining something entirely new.

2.5   Summation

DT and creative thinking have great potential to yield more innovative thinking in a collaborative environment. They overlap and share many of the same characteristics. Both use interdisciplinary study techniques with a strong focus on creating new and innovative ideas within or across various domains of knowledge. Both concentrate on bringing together existing ideas into new configurations or generating novel or useful associations to better solve a problem, whether it is an existing problem or new one.

2.6   Design Thinking and education in the age of digital convergence

The development of digital media has enabled the convergence of different technologies and forms of communication at various levels of production and distribution (Yee 2007:1). The following questions then need to be considered:

• How does this influence the way educators need to design curricula for this new digital age?
• How do they bridge the gap between traditional design skills and those required for new media?
• How do they teach these skills that are needed across this wide spectrum of media and disciplines?

Blended learning may be one way of addressing these questions. The definition of blended learning can be described is a formal education program in which a student learns at least in part through online learning, with some element of student control over time, place, learning path, and/or pace; at least in part in a supervised brick-and-mortar location away from home; and the modalities along each student's learning path within a course or subject are connected to provide an integrated learning experience (Blended learning definitions [sa:sp]).

Li, Hu and Galli (2012:1) suggest that "the most common design process in the interactive design industry is user research-concept design-prototype testing" but that students sometimes fail at applying the results of "user research to improve their design using this process" and that by "combining fast concept design and user research into a single process" it could potentially solve this problem.
They go on to explain that different design processes produce different ideas and that there is a difference between creative problem solving for commercial design and that of education-orientated design (2012:2).

As mentioned before, traditional problem-solving processes in design generally involved little user involvement with a strong focus on market driven research, form and aesthetics (Chapter 2: Design processes [sa]:9). In this new framework it is suggested that designers should be more involved in socially innovative design, that the design process should be a collaborative effort, that ideas have to be prototyped and explored in a hands-on way and that the process should revolve around human-centeredness, empathy and optimism (Bjögvinsson, Ehn & Hillgren 2012:101). In this paradigm it suggests that high school children could benefit from exercising DT to solving complex problems and encourage more critical and creative thinking. Furthermore, teachers would be encouraged to implement DT into their classrooms for this to materialise.

DT can be described as emergent, intuitive, abductive, reflective, ambiguous and co-evolutionary. DT "is concerned with how something *may be* rather than proving something *must* be or showing how something *actually is*" (Cross cited in Collins 2013:37).

In contemporary design discourse designers are faced with an increasing number of complex problems which may not be easily solved using the traditional problem-

solving processes. This has resulted in an increasing focus on DT as an alternative mode to solving complex problems (Cassim 2013:1). The traditional problem-solving processes in design generally involved little user involvement with a strong focus on market driven research, form and aesthetics (Design processes [sa]:9).

In the traditional sense of the word, the designer was primarily seen as coming in at the end of the development process to concentrate solely on the aesthetics of the idea. Brown states that the designer has moved from merely playing a tactical role in making an idea look more attractive to the target audience to being more frequently consulted in a strategic capacity at the front-end of innovation (cited by Cassim 2013:192).

Buchanan argues that designers have shifted their focus from merely "creating symbols and material objects towards creating complex systems and environments; an area concerned with exploring the role of design in sustaining, developing and integrating human beings into broader ecological and cultural environments… shaping… and… adapting… where necessary" (cited by Cassim 2013:192). In a DT framework it is suggested that designers should be more involved in socially innovative design, that the design process should be a collaborative effort, that ideas have to be prototyped and explored in a hands-on way and that the process should revolve around human-centeredness, empathy and optimism (Bjögvinsson, Ehn & Hillgren 2012:101). In this paradigm it suggests that high school students could benefit from exercising DT to solve complex problems and encourage more critical and creative thinking.

Furthermore, teachers would be encouraged to implement DT into their classrooms for this to materialise. Scheer, Noweski and Meinel (2012:8) state that in our ever-changing society there is an overarching demand to equip students with meta-cognitive knowledge and the need for education to move from "transferring knowledge to developing individual potentials with the help of constructivist learning" and claim that DT, offered within a "team-based learning process offers teachers support towards practice-orientated and holistic modes of constructivist learning in projects".

Li, Hu and Galli (2012:1) suggest that different design processes produce different ideas and that there is a difference between creative problem solving for commercial design and that of education-orientated design (2012:2). They further suggest that "the most common design process in the interactive design industry is user research-concept design-prototype testing" but that students sometimes fail at applying the

results of "user research to improve their design using this process" and that by "combining fast concept design and user research into a single process" it could potentially solve this problem.

David Dunne and Roger Martin argue that within the DT paradigm "students would be encouraged to think broadly about problems, develop a deep understanding of users, and recognize the value [of] contributions of others" (cited by Withell & Haigh 2013:5).

DT has been implemented in numerous establishments with successful results. Stanford University d.school's 'bootcamp bootleg' toolkit has been used in many of these programmes which introduces a formal DT model, principles, methods and tools. According to IDEO's 'DT for Educators' framework, DT can be used to approach any challenge.

Holly Morris and Greg Warman (2015) described how the five DT principles, individually, have been successfully employed in various educational institutions. The Austin Community College (ACC) employed 'Empathy' by really getting to know their students and their findings were used to adapt their marketing strategy and course design. The next step in DT is to frame the problem and at Montgomery Community College (MCC) they redefined their objective of how they disseminate information to students. By reframing the problem, they were able to communicate more effectively. At an EDUCAUSE webinar, people were encouraged to use 'brainstorming' to create a solution to a specific problem which again reiterated the importance of free thinking and coming up with 'wild' ideas. With the next step, 'prototyping', the design team at Ball State University developed an app for students to practice activities related with higher retention and graduation rates which proved to be so successful that they decided to gamify the app. In the last step of 'testing' the University of Maryland created a short course, pre-enrolment class, that offered prospective students a means to create personalised plans to a degree which could be tested within a short period of time. This allowed the team to gain valuable feedback on the success of the course.

DT was further tested in a school in Germany in 2011 for senior learners and the results indicated that DT fosters metacognitive skills overtly by using a formalised process (Scheer, Noweski & Meinel 2012:13-14). In 2014 a studio project was introduced where Korean and Malaysian students from different disciplines in interior design and architecture worked together in a cross-cultural collaborative setting to

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address "cultural and social issues affecting urban housing" design (Kim, Ju & Lee 2015:103).

Thus, the DT phenomenon has proven to be quite successful in the tertiary educational system in parts of Asia, Europe, and the USA as well as in a variety of primary and high schools mostly in the USA (DT for Educators, [sa]:1-5).

According to IDEO's 'DT for Educators' framework, DT can be used to approach any challenge. Figure 2.5 illustrates a set of typical challenges that teachers and schools experience and an opportunity to use DT to alleviate some of the challenges. Figure 2.6 demonstrates the IDEO's design process for DT.

CURRICULUM
Every day you design ways to interact with your students around content. You can follow a design process to be more intentional about connecting this content to the interests and desires of today's learners by finding out more about the things that they do outside of school and connecting that to the content you are bringing to them.

How might I inspire students to engage in concerns of the environment?

How might I engage my students in compelling ways around learning world history?

How might I develop students to be active seekers of knowledge in subjects that they have little knowledge of?

How might I help children from disadvantaged backgrounds increase their vocabulary?

SPACES
The physical environment of the classroom sends a big signal about how you want your students to behave. Right now we tend to think of our classroom spaces as standard... kids in rows, sitting in desks. By rethinking the design of our spaces, we can send new messages to our students about how they should feel and interact in the classroom.

How might I use my classroom space in different ways to help set my students at ease?

How might I create a comfortable space that meets the many needs my students have throughout the day?

How might we reimagine our school's library for the needs and interests of today's learner?

How might we create an exciting and effective space for teachers to collaborate?

How might we design our high school campus to best engage and support today's learner?

PROCESSES AND TOOLS
Your school has already designed a set of processes or tools that may or may not be setting up your school for success. This is typically outside of the classroom and specific interactions around learning, and more around how the system operates. Every process is already designed, and thus can be redesigned! Sometimes creating tools can be essential to supporting newly designed processes.

How might I engage parents as an integrated part of their students' learning experience?

How might we recruit the best teachers to our school?

How might we re-envision arrival and departure procedures at our school?

How might we design ways to keep ourselves balanced and well?

How might we redesign our school schedule to be centered around the needs of today's families and teachers?

SYSTEMS
Not everyone can always make decisions for the system that they exist within, but everyone can contribute to the design of that system. Designing systems is about balancing the complexity of many different stakeholder needs with the needs of the operation. When designing systems, we're often setting high-level strategy such as stating visions, priorities, policies, and key communications around these ideas.

How might we reinvision curriculum for an entire district while providing for individual schools' differences?

How might we track the development of students' character traits over time to help shape our school philosophy more intentionally?

How might we connect more with our neighborhood community?

How might we use our school as an R&D hub for schools nationwide?

Figure 2.5: DT for Educators, [sa]:12.
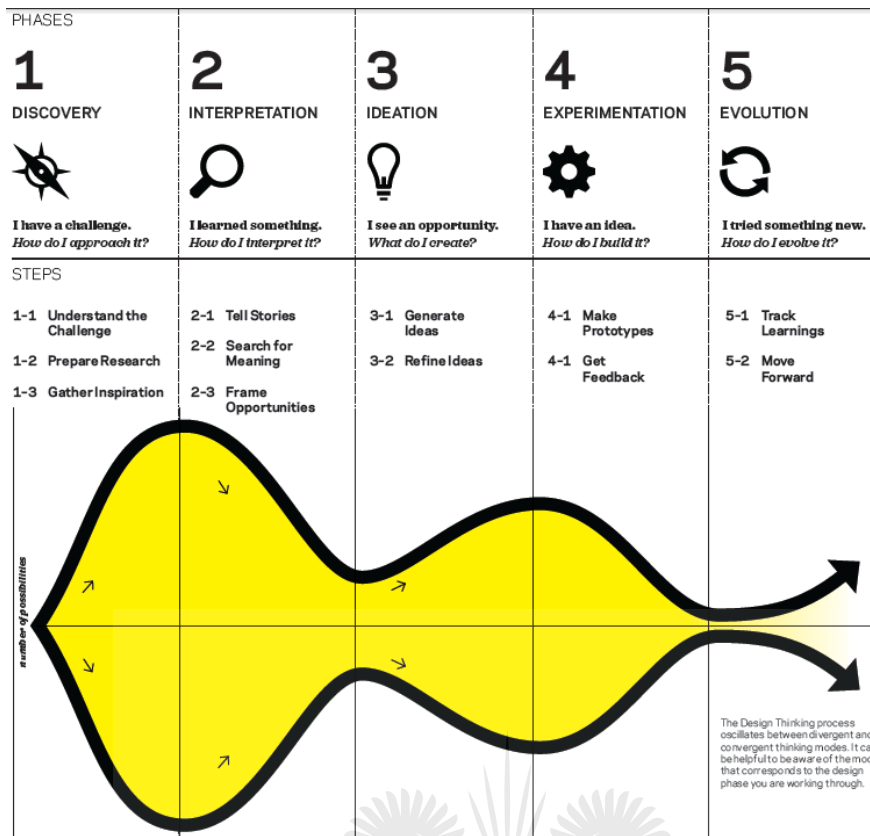
Figure 2.6: DT for Educators' process, [sa]:15

Through preliminary research done during the researcher's Honours degree it has however become apparent that DT has been poorly conceptualised and scarcely investigated in high school settings in South Africa, especially in relation to its potential role as an enabler for more creative and innovative thinking. The core insight of this study is that the concept of Design Thinking seems to be a field of interest for the participants involved in the research study. It is however clear from participant responses that the public high school education sector lacks some knowledge about Design Thinking and only engage with certain aspects of this process. Design Thinking seems to be more prolific with the private high school sector with more teachers actively involves themselves and their learners in the process. However, a selection of participants has raised some apprehension about the inclusion of the Design Thinking process.

The concerns raised are as follows:
- Lack of time: Design Thinking does not form part of a formal approach in the school curriculum and teachers are often challenged in terms of trying to introduce it into the formal CAPS curriculum work due to time constraints.

- Passionate educators: There were some concerns raised that not all teachers may be as passionate about Design Thinking as others and would therefore not be that eager to introduce the process into their coursework.

The study found that although there might be a number of concerns initially with regards to introducing Design Thinking as a formal or informal approach in the high school education sector, that this approach to stimulate creative thinking and innovation would benefit the learner especially when already introduced at school level. Teachers who are not yet completely engaged with the Design Thinking process have shown a great deal of interest in employing it into their coursework.

2.7 How Design Thinking supports innovation in K-12 education.

Technology has greatly changed the ways individuals communicate, interact, work and access information on a global scale. The DT approach, as applied to education, is particularly well-suited to respond to the dynamic challenges faced by all stakeholders today.

With the education environment, in all its elements, DT brings flexibility and rationality to the process of responding to local, even individual needs and goals. According to Stavros Yiannouka "[t]he WISE IDEO report shows how the DT mindset can expand our notions of schools and school systems beyond entrenched models" (2017: iv). He goes on to suggest that "Design [T]hinking can encourage a culture of teacher collaboration that can be leveraged for improved outcomes across subjects and learning environments" (2017: iv). Students face new dynamic realities that not only require new skills to circumnavigate success, it also includes the capacity to reflect on learning processes and the collaboration and support of peers, teachers and parents, and the various ways to explore ways forward (Yiannouka 2017: iv).

In South Africa, education is among the most challenging issues we face. These include not only the competing agendas and perspectives on teaching and learning solutions, but also the issues around the design of our schools, and the ways we encourage the development of learning itself. With the ever-evolving world and the complexities therein, students need to be able to develop skills and mindsets to adapt to these changes. Sandy Speicher explains that "[t]hinking and acting like a designer is an approach available to all of us in creating innovative, human-centered solutions to the problems we face in all facets of our lives" (ibid). Although the past decade has seen

a growing interest in the process and mindsets of DT and that practitioners look for ways to incorporate it into their work in K-12 settings with efforts to formalise the approach (ibid), the South African educational systems has proven to lack the knowledge, skills and resources to incorporate DT in school systems.

As mentioned earlier, a student "requires skills for collaboration, creativity, critical thinking, and problem solving, and these skills are increasingly becoming a focus in both K-12 and higher education settings" (ibid).

Design touches all aspects of our world and there are four mindsets that typically guide the behaviour of a designer, these include human-centred, collaborative, optimistic, and experimental (ibid). The process typically begins with defining the problem and using empathy to understand the needs of the end-user, followed by using synthesis and prototyping to develop strategic ideas, and ending with implementation (ibid). However, "minimal guidance has been offered on how to support DT in education and on what guidelines, best practices, and professional development are needed for successful implementation" (ibid).

Through research, there have been several techniques and processes created and suggested to filling this gap. It is also for this reason that the researcher has seen a gap in the South African educational system and is suggesting that a UX design project on DT could be implemented and used to foster creative thinking and problem solving in high schools in South Africa. An implication of this unknown future is that education may need to shift from its current emphasis on transferring existing knowledge to students, or "knowing," to fostering learning agility, creativity, and adapting to change (Araya & McGowan, 2016). Put differently: we need to equip today's students not just to navigate an unknown and complex world, but to reimagine that new world and lead the way. We need change-makers. DT offers many opportunities for meeting students' educational needs.

2.8   Human-centred design, user experience design and interaction design

Spencer Lanoue (2015) from IDEO defines human-centred design "as a creative approach to problem solving that starts with people and ends with innovative solutions that are tailor made to suit their needs". At a philosophical level, Buchanan describes it as "fundamentally an affirmation of human dignity… an ongoing search for what can

be done to support and strengthen the dignity of human beings as they act out their lives in varied social, economic, political, and cultural circumstances" (2001:37).

User Experience Design (UXD), Interaction Design (IxD), User Interface (UI) Design and design professionals use the term *user experience design* to refer to the thoughtful application of certain human-centred design practices, most often but not exclusively in the design of digital technologies. Additionally, UXD in industry practice is concerned with design solutions that satisfy the users' needs as well as the objectives of the organisation (UX Design Defined: [sa])

Rogers *et al* describes interaction design (IxD) as "designing interactive products to support the way people communicate and interact in their everyday and working lives" (2014:3). The focus is therefore on the practice of how to design user experiences.

2.9   Experience design

Experience Design (ExD) focuses on conducting user research in order to understand the emotions, behaviour and beliefs of the user of the intended user interface/ product. "User experience is central to interaction design … it is about how people feel about a product and their pleasure and satisfaction when using it, looking at it, holding it, and opening and closing it" (Rogers 2014:4). In line with Research through Design (RtD) this study is specifically concerned with generating a contribution primarily in relationship to users' experience needs thus, it does not emphasise organisational objects outside of the community of teachers.

Hassenzahl (2010:63,67) states that experience is primary and the technological product only a means. Thus, ExD emphasises understanding peoples' life experience before conceptualising design solutions. Hassenzahl suggests that experiences are emergent and that in ExD functionality; content presentation and interaction are the materials for creating and shaping experiences.
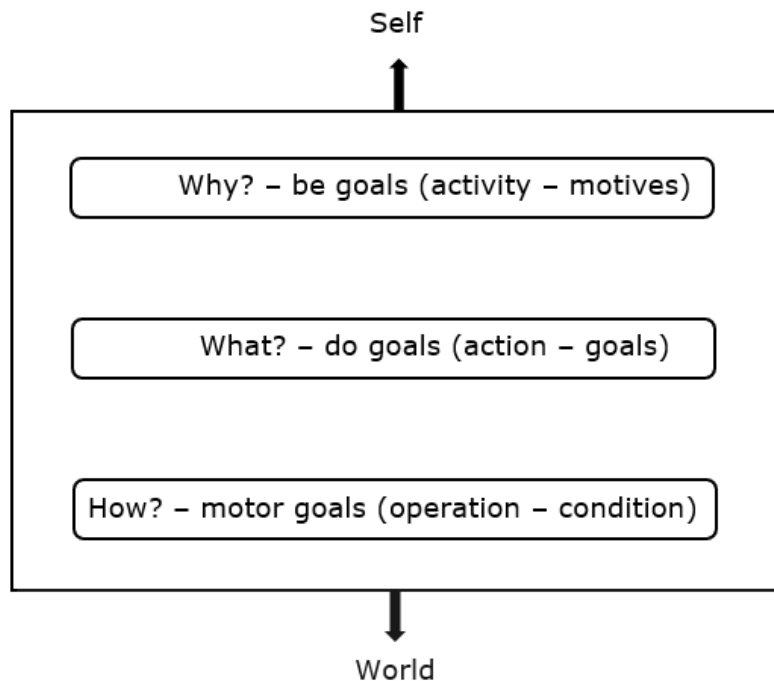
Figure 2.7: Hassenzahl, Hierarchical model of goals, 2010:44. (The terms used in the context of Activity Theory are in brackets)

Citing Activity Theory, Hassenzahl associates the fulfilment of certain psychological needs (motivations) as equivalent to providing positive experiences. He contends that it is the fulfilment of these needs that create emotion and meaning for people when interacting with technology. However, depending on the situation, the urge to fulfil these motivational needs may vary. The design opportunity arises when need deprivation over a prolonged period in which the need fulfilment is blocked, is identified (Hassenzahl, 2010:57).

Experience design focuses on identifying these blockages. Hassenzahl (2010:57) explains that fundamental to supporting human motivational need, a product must first be instrumental. He suggests that functionality and usability are necessary preconditions for need fulfilment but that functionality and usability without needs are meaningless (Hassenzahl, 2010:57).

2.10 Related work

Some examples of digital projects designed to support educators:

To start, the ClassDojo app connects teachers with students and parents to build classroom communities. This is an App that focuses on teachers, students and parents

to connect and share experiences and resources (ClassDojo, [sa]). This information is however mainly created for pre-primary school children and based mainly on the USA school curricula.
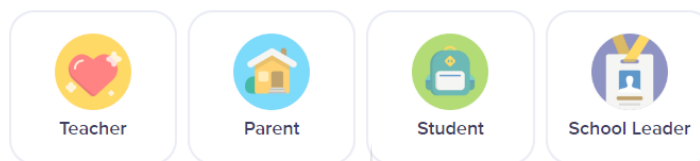
Figure 2.8: ClassDojo.

The TeacherKit is another App that makes classroom management easy for teachers, students and parents, through actions such as taking attendance, recording a gradebook, class activities, etc. (TeacherKit, [sa]). Again, and mentioned above, this product is mainly created with the focus on primary school teachers and learners.
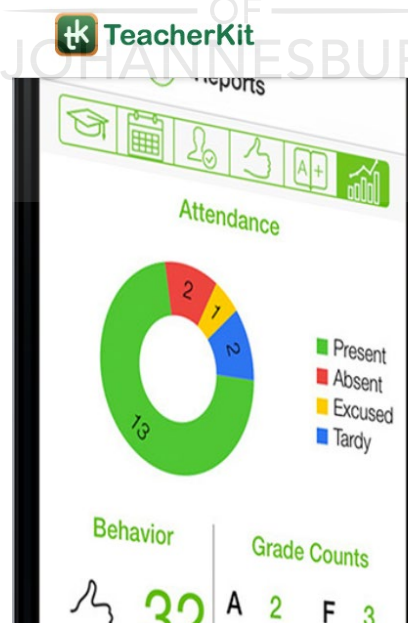
Figure 2.9: Teacherkit

Gauteng Art Teachers group on Facebook (2020) is great in sharing ideas across a broad spectrum. This group has been created by the teachers to share knowledge and information across South Africa.
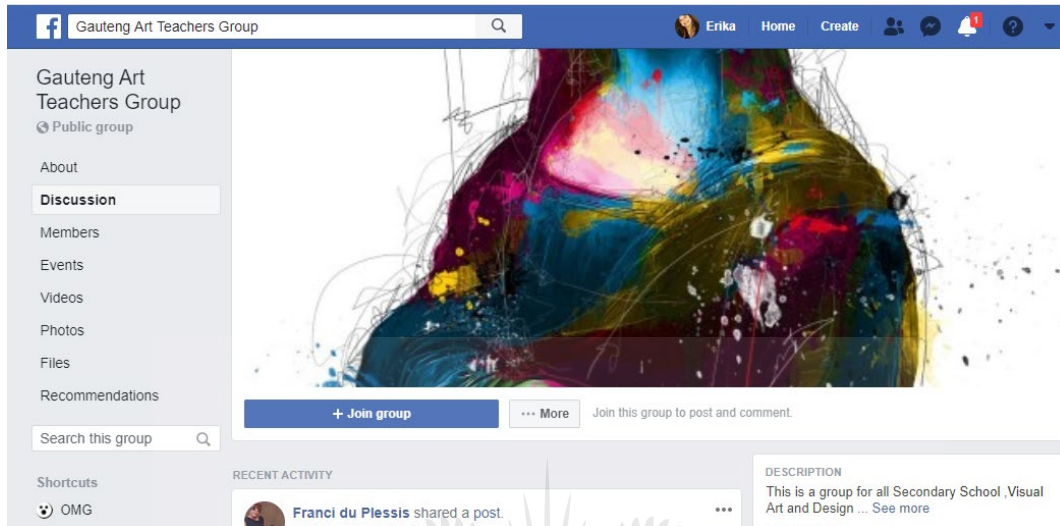
Figure 2.10: Gauteng Art Teachers Group, Facebook (2020).

WorksheetCloud is a complete online CAPS and IEB exam revision platform for Grade 1 to 12 learners in South Africa (WorksheetCloud, [sa]). This product however does not solve the problem of this research study as it does not discuss the need for teachers to introduce DT into the educational system.
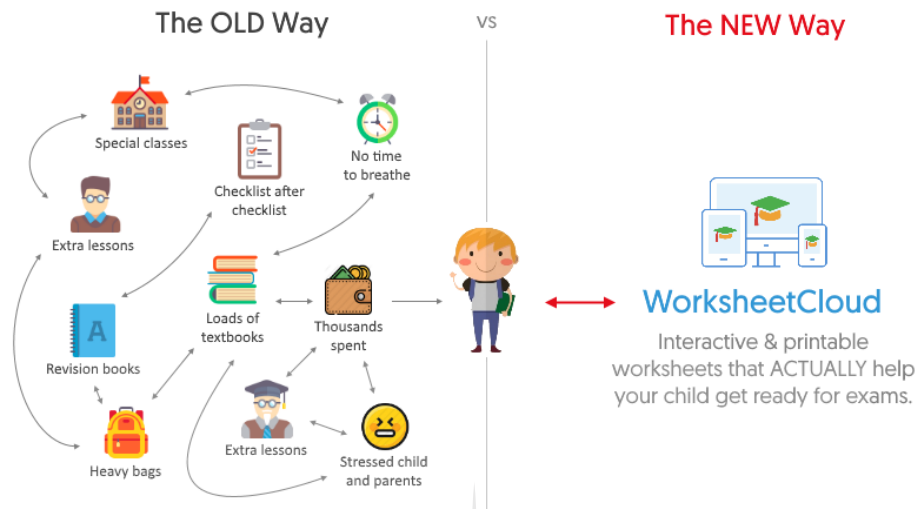
Figure 2.11: WorksheetCloud.

Figure 2.12: WorksheetCloud – worksheets.

IDEO's DT for Educators website is another tool for educators that also includes a PDF toolkit for teachers. This forum is probably one of the best that is currently available as it is concentrated on DT specifically. Educators can download free material and resources to help them within the class environment (IDEO, [sa]). However, again this is not specifically based on South African needs and are therefore not the best tool to solve the problems of the participants of this study.

Figure 2.13: Design Thinking for Educators.

HCD (Human-Centred Design) Connect is also created by IDEO. It is a free kit that aids users through the human-centred design process and supports them in activities such as building listening skills, running workshops, and implementing ideas (Human-Centred Design Connect, [sa]).

Figure 2.14: Design Thinking for Educators.

The Hasso Plattner School of Design Thinking at the University of Cape Town (d-school). Although these programmes concentrate on DT it is aimed at tertiary

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educators not high school teachers and learners (The Hasso Plattner School of Design Thinking, [sa]).

Figure 2.15: dschool.uct.

Google Classroom ([sa]) and Adobe Captivate ([sa]) are two virtual teaching platforms for students, teachers and educational institutions. For teachers it is mainly used for sharing materials, distributing assignments and marking purposes. It allows students to work across devices, take courses online, foster collaborative learning, etc.

While these digital products discussed above do, to an extent, meet certain needs they tend to be either focused on a different target market and for the most part, have a North American focus and therefore do not add much value for the South African school system. There are many institutions that offer courses on DT in South Africa, but again they are not specifically designed for high school teachers and the school environment. In other words, these digital products are not exactly focused on solving the problem in which this research study is based on; a UX design product specifically designed to enhance the experience of educators expected to teach creative thinking strategies and DT for resolving complex problems.

S **W** **O** **T**

STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
Designed especially for the South African school system; Teachers are trained in new ways of teaching; They have the opportunity to share and communicate new ideas; Learners are exposed to ways of solving "wicked" problems; Opportunity to update content in real time.	Educational gap; Lack of resources; Time constraints; Buy-in from teachers.	Produce more creative innovators; Learners will be better prepared for tertiary studies or for entering the workplace with more confidence; DT creates confidence that everyone can be part of creating a more desirable future; Learning can happen in the form of paper-based books, posters, etc.	Schools face design challenges every day that are complex and varied; Traditional learning tools and techniques may not be able to cope with these new challenges.

2.11 Summation

This chapter has looked at the background and context of DT and its perceived impact on the educational system. The study looked at the impact DT has on education especially in the age of digital convergence. An overview of User Experience design and Hassenzahl, *Hierarchical model of goals* was introduced in the context of Activity Theory that forms the theoretical framework of this study. Examples of related works were included in order to create a SWOT analysis to compare and differentiate the researcher's proposed solution to other digital products currently available in the educational sector. The next chapter will look at the theoretical concepts that underpin

the literature discussed in the previous chapter.

CHAPTER 3. THEORETICAL FRAMEWORK

3.1   Introduction

In the previous chapter existing research related to DT, UXD and IXD products was explored. In this chapter the theoretical framework of this study will be outlined. For this study, the theoretical framework covers Activity Theory. "Activity Theory maintains that human uses of technology can only be understood in the context of purposeful, mediated, and developing interaction between active subjects and the world" (Kaptelinin & Nardi 2012:2).

3.2   Activity theory

Activity Theory (AT), "a conceptual approach originating in the Russian Psychology of the 1920s and 1930s", where the key application is to support researchers and practitioners in their inquiry into the social world of people (Kaptelin & Nardi 2012:7) as well as "to orientate themselves in complex real-life problems, identify key issues which need to be dealt with, and direct the search for relevant evidence and suitable solutions" (Kaptelinin: [sa]). "AT, with its emphasis on society, culture, and development, offers a set of concepts for capturing the context of use and accounting for it in the design, evaluation, and deployment of interactive technologies" (Kaptelinin: [sa]). Lev Vygotsky developed the first-generation model of activity in the late 1920s. This was based upon a triangular model in which the "subject" and "object" are mediated by a third point representing "tools" or "artefacts" (Greenhouse, 2013:405). Vygotsky reasoned that these artefacts serve to prompt or modify our actions. AT was then further refined by Alexei Leontiev, who differentiated between the terms "action" and "activity", stating that whereas an "action" describes the act of a group, or individual, to achieve a "goal", an "activity" describes the act of a community with its own "object" and "motive" (Greenhouse, 2013:406).

While there are many alternative models of AT[2], Engeström's model of AT is known as the activity system model (ASM) and is commonly applied to understand activity as occurring within community. ASM builds on the fundamental aspects of AT theory

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[2] Other models include Leviev, Nardi & Kaptelinin , in (Nardi & Kaptelinin in 2014)

related to conceptualising motivated action. AT in various forms has been commonly applied in IXD contexts for example see Hassenzahl (2010), Benyon (2014), Sharp *et al* (2012).

Thus, in this study with a focus on supporting or enhancing the goals and motivations of teachers as a community, ASM is an appropriate conceptual model for exploration. ASM includes a number of analytical lenses such as subject, tools, rules, object, community and division of labour (Hardman 2008:65).

For example, (albeit at a very coarse level of detail), in this context, the **subjec**t of the pedagogical activity system is the teacher. The **object** represents the primary goal i.e. the teaching of DT. The **rules** are the social interaction and conventions of the education in South Africa, which either drive or hinder the subject's actions towards the fulfilment of their objects. The teacher is part of the community of teachers who participate in acting of the shared object. **Technology** includes all teaching and planning materials, equipment and physical environments. The **division of labour** refers to the negotiation of responsibilities (Hardman 2008:72-73) and tasks within an educational environment such as the role of Heads of Department, Subject Co-ordinators, Teachers, etc. **Outcomes** refer to the alignment of the goals embedded in the outcome with motivational aspects of the Object i.e. how the teaching of DT would relate to teachers' broader life motivations.
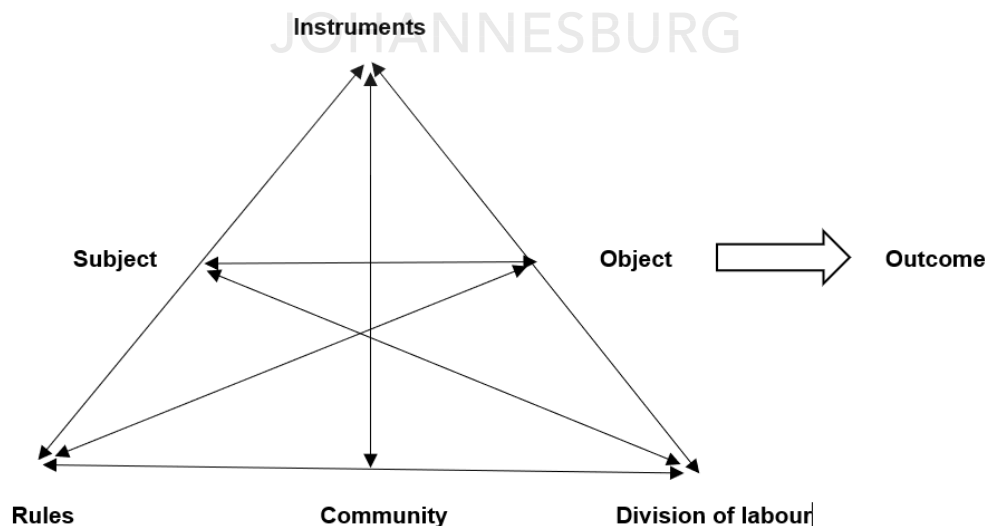
Figure 3.1: Engeström's Activity System Model.

As AT is an object-oriented study of human activity, its starting point is the "object" itself and what the "subject" wishes to change about the "object" to create a desired

outcome (Greenhouse, 2013:408). The "division of labour" occurs within the contextual, cultural and historical base of the activity system and therefore recognises that social, cultural and historical factors influence systems and individuals.

The rules of the system may refer to agreements across the service, accountability, and ethical guidelines. The tools of the activity system are an essential element of professional translation and can refer to the protocols, assessment methods and language used by each professional (Leadbetter *et al.*, 2007 cited in Greenhouse, 2013:411). The subject of this activity system is not an individual but a multi-voiced group, consisting of a range of perspectives, all of which require negotiation and translation across disciplines (Greenhouse, 2013:411). The community of the activity system includes all others involved with the service user (Greenhouse, 2013:412).

3.3   Conclusion

In this Chapter Engeström's *Activity System Model* (ASM) was discussed to illustrate how this model can inform the research. The next chapter discusses the research methodology that was used to create the final product.

CHAPTER 4. RESEARCH METHODOLOGY

4.1   Introduction

In this chapter the methodology that was used in this research study is discussed. The research method, which is the actual technique used to collect data, assists the researcher in understanding the systematic way of solving the problem, is referred to as the research methodology (Kothari, 2004:7-8).

As described in Section 1.2.1 *Purpose of the study*, the research philosophy of this study is pragmatism. The overarching method is RtD, which is in essence a second-order evaluating and structuring framework, within which a first-order practice-based design activity occurs. The first-order design process is considered the site of interest of the second-order reflective evaluation. In this sense, the design practice can be likened to the 'findings' of a more traditional approach to academic research.

The design practice of this study is the DT process, which includes: empathise/understand; strategy/define; ideate; prototype; and evaluate /test. Thus, in the empathise/understand phase of the DT study design research activities such as interviews and questionnaires were carried out in order to inform the UX design product that is conceptualised in the later phases of the DT. This point is important as many of the design research methods are common to those found in academic research, but in the context of design practice do not necessarily emphasise the same level of generalisable certainty and rigour as 'pure' research would.

4.2   Pragmatic research

Anna Rylander explains that "at the core of pragmatist thought is the view that our theories must be linked to experience or practice" that focuses on interaction and integration (2012:3). In other words, dealing with things realistically in a way that is based on practical rather than theoretical considerations.

It evaluates theories and concepts according to the success of their practical application. For a pragmatist, research starts with a problem, and aims to contribute practical solutions that inform future practice. In pragmatist research, the emphasis of the research design and strategy would be the research problem and the research

question. Your research question, in turn, would be likely to incorporate the pragmatist focus of practical outcomes (Saunders *et al* 2019: 147-148). Pragmatist inquiry therefore easily accommodates the design process as well as what we think of as "designerly ways of knowing" (Cross 2006 cited in Rylander 2012:30-31). The pragmatist approach provides the foundation for understanding and exploring the role of aesthetics in the broader context of scientific inquiry.

Design as a form of inquiry allows for exploring designers' aesthetic skills in DT, paying particular attention to embodied interactions with sketches and prototypes as well as visualization practices (Rylander 2012:38). As such design, as applied in this study, as a form on inquiry can be framed within a broader pragmatic lens.

4.3   Research Design

Christopher Frayling (1993), created the following descriptive framework for research in the arts and design:

1.   Research *into* design —research into the human activity of design.
2.   Research *for* design —research intended to improve the practice of design.
3.   Research *through* design —research focused on the medium of design activity.

This study will apply a Research through Design (RtD) methodology. RtD is a form of Practice-based Research in which a design project is the central object of the research study. In this study, the RtD method is organised in two phases namely the Process and the Evaluation Phase.

4.3.1   Research through Design (RtD)

Zimmerman & Forlizzi explains that RtD is an "approach to conducting scholarly research that employs the methods, practices, and processes of design practice with the intention of generating new knowledge" (2014:167).
It can therefore be used as a reflective practice for continually reinterpreting and reframing "problems" through a process of making and reviewing artefacts that function as possible solutions (Rittel & Webber, 1973; Schön, 1983 cited in Zimmerman & Forlizzi 2014:168). RtD provides a research approach for these types

of knowledge to be generated and disseminated within Human Computer Interaction (HCI) (Zimmerman & Forlizzi 2014:168).

RtD is primarily focused on improving the world by making new things that disrupt, complicate or transform the present state of the world. "This research approach speculates on what the future could and should be based on an empathic understanding of the stakeholders, a synthesis of behavioural theory, and the application of current and near current technology. The knowledge produced functions as a proposal, not a prediction" (Zimmerman, Stolterman, & Forlizzi, 2010 cited in Zimmerman & Forlizzi 2014: 169).

RtD focuses on three core concepts: Field research, Lab research, and Showroom research. The Field practice focuses on creating novel and much more aesthetically appealing ways for people to interact with things. The Field practice comes out of the Scandinavian tradition of participatory design and out of user centred-design practices in the USA (Zimmerman & Forlizzi 2014:168). RtD merges research practices from sociology and anthropology with design action (Zimmerman & Forlizzi 2014:168-169). Example of the Field approach is Participatory Design and Co-design Design, which are about people working together following a prototyping approach, iteratively conceiving new work designs by starting with low-fidelity prototypes and working towards higher fidelity until a final concept emerges (Zimmerman & Forlizzi 2014: 172). Field researchers "study humans and their use of design". They therefore need to understand their system of meanings. "People make sense of things and their meaning and act accordingly" (Zimmerman *et al* 2011:69).

The Lab practice is about studying things in a laboratory. This means that "something is taken out from its natural environment and brought into a controlled area where it can be subjected to experimentation [and] gives the [researcher] an opportunity to focus on one thing at a time. Almost anything can be studied in the laboratory such as design, chemical reactions, rich interaction", etc. (Zimmerman et al 2011:55).

Showroom is where research "builds on art and design rather than on science or on the social sciences [where] research is presented in shop windows, exhibitions, and galleries rather than in books or conference papers" (Zimmerman et al 2011:89). "Showroom is about exposing, debating, and reinterpreting problems and issues"

(Zimmerman et al 2011:103). However, as this research study focuses on Field research, this concept will not be further discussed.

In this study, the RtD method is organised in two phases namely the Process and the Evaluation Phase.

4.3.2   The Process Phase

The Process Phase is concerned with describing and reflection on the design project. As the design project is concerned with the design of a digital technology, these activity processes contain the following DT phases: **Emphasise, Define, Ideate, Prototype** and **Test** processes.

The design process starts with **empathy** as DT is based on a human-centred co-design model. Participants are interviewed using semi-structured interviews as well as engage with the UX designed product to provide their input. As this study investigates the concept of DT, typically used in the art, design and technology and technology fields, the sample for this research are aimed particularly at the art, design teachers from both the public and private educational sectors. Data will be collected to determine the perception of high school teachers their knowledge of the DT concept. The number of participants is limited to six in order to gain a greater depth of data. Each of the participating high schools, via their respective principals, will be contacted through telephone and e-mail requesting their participation in the study.

The e-mail included an explanation outlining the purpose of the research, and the questionnaire, in the form of a Microsoft Word document, was attached in order to prepare the respective participants for the interviewing process. All participants were afforded the opportunity to accept or decline the request. The data collected from the responses to these questionnaires during the interviewing process were then analysed making use of textual analysis. This was done in order to reduce the amount of data supplied by the participants to more manageable amounts.

In this study textual analysis is used to explore and describe how the sample group perceives DT in their respective environments. The texts collected in this study are the responses to the qualitative interviews and questionnaires conducted with the respective participants from the various schools. These will be analysed with the aim

of understanding the most likely interpretation of the responses (McKee, 2003:2). Educators will also engage with the UX designed product to provide their input through questionnaires and interviews.

A consent form was to be completed by each of the participants before the online interview schedule could commence. Participants are provided with the option to respond to the questions in a personal interview. Once the data is collected and transcribed, codes will be allocated to common patterns. On verification of these codes, DT themes were identified and then interpreted.

In part, the problem was identified, **defined** and framed during the researcher's Honours study. In this study that focuses on the UX digital product, various tools and techniques, such as the Firma model and ASM analytical frames are created for analysis of data collected and futher used to better define the solution to the problem. The Personae models and Hassenzahl's Hierarchal model of goals and Engestrom's activity system model are used to inform a design solution strategy. Analysis of data is again interpretive but will be deductively assessed in reference to firstly, at a general systemic level using the Firma Model (Fenn & Hobbs 2015:170) to understand the broad contexts of the world of teaching and secondly, using Engeström's ASM model to unpack the teachers' specific experiences of teaching DT.

Krefting (1991:215), makes use of Lincoln and Guba's model of trustworthiness for qualitative research designs, which then is appropriate to guarantee the accuracy of the study. The four criteria of trustworthiness proposed are appropriate based on the qualitative nature of this study and the evaluation of these criteria assure the relevance of the research. The researcher needed to adopt measures to ensure that the results of the study reflect an accurate representation of the truth in order for the study to have credibility (Shenton, 2004:64). Bias and prejudice needed to be avoided and the research process was guided by the research purpose and questions.

Firstly, consistency or transferability, focus on the extent to which the findings can be applied to other situations (Shenton, 2004:69). According to Maree and van der Westhuizen (2007:37) "[i]nterpretivism is based on the assumption that there is not one reality but many, and interpretivist researchers therefore carry out their studies in natural contexts to reach the best possible understanding." Due to the Interpretivist approach of the design research study, the results will not be generalised beyond this

sample, however possible guidelines for introducing DT into the school education system and how a UX design could be used to accomplish this.

Dependability on the other hand refers to the quality of the process of interrogation that happens though the data collection methods, data analysis and the theory generated from the data (Koonin, 2014:259). To promote reliability for this study, clear definitions, instructions and clear-cut examples were used for the interview schedule and coding categories (White and Marsh, 2006:32).

Lastly, to ensure the confirmability of the study, guidance on the design research process and interview questions will be discussed with peers and qualitative research experts. The study needs to be "shaped by the participants, as opposed to the motivations, interests or biases of the researcher" (William, 2006).

The design of a pre-determined set of questions in the questionnaire allowed for specific textual data to be collected without it becoming too long and tedious.

As the researcher is the one conducting the interview according to the questionnaire and writing down the responses, many of the disadvantages mentioned above are compensated for. For the purpose of the study, in order to protect the anonymity of a certain group of participants, individual interview participants will be deidentified and participated anonymously. As previously mentioned, these participants will be referred to as Participant E and Participant F, etc.

Process sketches and Customer Journey maps are created during the **ideation** phase to gain more insight on the feasibility of the digital product. In this study the researcher used various ideation processes from the insights gained during the data collection and interpretation and of the Firma model, Activity Systems Model (ASM), personae creation and Hassenzahl's *Hierarchal model of goals* that was applied to inform a design solution strategy.

During the **prototype** phase, User-journeys, wireframes, design compositions and digital prototypes are created to illustrate the design concepts. The design involves integrating the design decisions articulated in the wireframes with the insights gained in the research related to the teachers' information needs. Summative prototypes will

be iteratively **tested** by participants who represent the final user community until a reasonable proof of concept has been established.

Test – Paper prototyping and digital user testing will be used for the purpose of focusing on evaluating usability and experience concerns that were conducted. To evaluate whether the interaction design solution was relevant to the teachers in the sense that it could potentially resolve identified problems, paper prototype evaluation and prototype observational study was done by the researcher. This testing was done prior to completing the technological development of the application to ensure that the need of the users was met. The paper prototype testing involved simulating how the digital application would work by showing them the different interaction phases.

In Chapter 5 these methods are visually illustrated to show the various processes.

4.3.3   The Evaluation Phase

The Evaluative Phase will apply Zimmermann *et al's* three criteria for evaluating interaction design research within HCI (Invention, Relevance and Extensibility) to critically reflect on the contribution the design process, methods and associated concept may bring to the practice of user-centred design in South Africa, generally, and the design of a digital teaching aid for DT specifically (2007:7-8).

Invention relates to the degree to which the design research contributes an invention. The research needs to demonstrate a unique integration of various subject matters to address a specific situation and that it is situated in reference to existing literature and detail what contribution the research makes.

Relevance relates to a demonstration that the product enhanced performance. Thus, relevance of the project, for example why the altered state made possible by the design is preferable over another, is prioritised over scientific validity. This needs to be clearly communicated and supported in the research.

Extensibility is defined as the "ability to build on the resulting outcomes of the interaction design research: either employing the process in a future design problem or understanding and leveraging the knowledge created by the resulting artefacts"

(ibid). It therefore relates to the contribution of the product to the field of UXD in South Africa.

Research Strategy		Data collection and analysis	Research approaches
	Research through Design	Zimmerman et al 2011	
Process Phase			
	Empathy		
	Research	Semi- structured Interviews (Martin & Hannington 2012: 102).	
	Research	Questionnaires.	
	Define		
	Analysis	• Firma Models (Fenn and Hobbs 2015:170). • *Activity System Model* (ASM) analytical frames (Engeström).	Deductive
	Strategy	• Personae (Martin & Hannington 2012:132). • Hassenzahl's *Hierarchal model of goals* will be applied to inform a design solution strategy (Hassenzahl 2010:44).	Abductive
	Ideation		
		Process sketches	Abductive
		Customer Journeys maps (https://uxmastery.com/how-to-create-a-customer-journey-map/) will be created to gain more insight on the feasibility of the digital product.	Abductive
	Prototyping		
		• User-journeys (Martin & Hannington 2012: 196). • Wireframes (Rosenfeld et al 2015: 407). • Design compositions and Mid-fi digital prototypes, will be communicated and embody design concepts.	Abductive
	Testing		
		• Paper prototyping (https://pidoco.com/en/help/ux/paper-prototype), • Digital user testing (Martin & Hannington: 194) focused on evaluating usability and experience concerns will be conducted.	Deductive
Evaluation Phase			

Research Strategy		Data collection and analysis	Research approaches

		• Zimmermann *et al's* three criteria for evaluating RtD within HCI:
		   o Invention
		   o Relevance
		   o Extensibility
			44

Table 4.1: *Overview of research process.*

4.4   Summation

This chapter outlined the Research through Design methodology that was used in this study through a pragmatic research philosophy. The Design Thinking process phase was discussed and analysed for the purpose of illustrating how these processes informed the final digital product design.

CHAPTER 5. THE PROCESS PHASE

5.1   Introduction

In this chapter the process phase will evaluate and discuss the approaches, practices and feedback that may emerge during the research and design activities. The Process section of the study describes and reflects on the activities and methodologies involved in the co-design practice that concluded in a digital prototype. In terms of structural organisation individual sections of the Process follow the phases in the DT approach as depicted in Table 5.2.

5.2   Empathy

The design process phase will take the form of an ethnographic account of the design practice. The account is a rich, reflective description which in a manner offers the design practice as a type as a case study example. This part of the DT process focuses on human-centred design and for this reason the researcher used in-person interviews with the participants under study. For this reason, the process includes a plan to empathetically and realistically speak to South African teachers which considers issues of resources, skills, knowledge, diversity etc.

5.2.1   Interviews

Throughout the months of June and July of 2019, in-depth, semi-structured, personal interviews were conducted in-person with six teacher participants throughout Johannesburg, South Africa. Participants were purposively selected which goes some way to alleviating disadvantages of this research tool relating to incomplete answers and inability to determine openness or reflection. During these interviews the participants are given a set of questions related to DT and teaching as well as the opportunity to engage with the digital prototype. They were provided with an explanatory statement (see Appendix B) for the study in advance of the interview and were required to sign consent forms (see Appendix D) before commencement of the interview. An interview schedule containing open-ended questions will be used as a guide for the researcher in conducting the interviews (see Appendix D).

5.3   Define

This phase of the DT process revolves around framing the problem that is under study that forms the foundation to the solving of the problem, which is the digital prototype. In the next section the data that was collected during the interviews with the teachers will be evaluated to assess the needs and motivations of the teachers within this study.

5.4   Data analysis and interpretation

5.4.1   Introduction

The methodology for the design research involves a qualitative, thematic analysis of the perceptions of high school teachers, involved in art, design or technology, in both the private and the public high school education sectors in Johannesburg, South Africa. Open-ended questions were answered in a questionnaire during a semi-structured interview designed to explore the perceptions of high school teachers on DT in the education sector in Johannesburg, South Africa. For the purpose of the study, in order to protect the anonymity of a certain group of participants, individual interview participants were deidentified. These participants will be referred to Participant E and Participant F. The majority of high school teachers within the public educational sector initially displayed an unfamiliarity of the term "DT" but on further exploration of the concepts involved in DT, realised that they have in fact been applying certain aspects of DT into their design coursework.

A participant stated that she was not aware there was a formal term or approach to creative thinking in this context, but after reading the documentation on DT supplied to them in the interview and questionnaire forms, she realised that there are a selection of concepts that they indeed do use in the classroom.

Another participant was fairly well informed about the concept of DT and were applying it into their everyday design coursework.

> DT is a process of problem solving using pre-planned steps, this often includes primarily the process of identifying the possible problems that have or may arise, keeping an open mind and approaching issues with creativity… [and that] … DT can apply to coursework due to the Socratic methodology implied by the design process, the same method of asking questions where by structuring your questions around the requirements

of the brief may lead you to discover multiple answers that can culminate as a moment of realisation thus informing creative decision making (Participant C).

As mentioned above, not all participants are fully informed about the DT concept and process but all of the six participants showed a keen interest to implement the whole process of DT into their coursework.

One participant commented: "Yes of course. This subject is more learner [centred] and it seems like it can arouse creativity from learners" (Participant C). Another commented that he has found the DT process "very exciting to work with [and that] students really … [enjoy] working with it" (Participant D).

However, although all participants illustrated their interest in DT, some participants have raised some issues regarding the implementation of the process in their current environment. A participant stated the following:

… unfortunately, practicality in the classroom requires a passionate teacher who can guide his or her students along this process due to time constraints as well as number of learners' present, this of course is a significant issue in South Africa due to poor mismanagement and a shortage of reliable educators (Participant A).

The research indicated that the majority of high school teachers within the public educational sector displayed an unfamiliarity of the term DT. Teachers from the private sector were better informed about the concept of DT and were applying it into their everyday design course work, but within a short time allocation as it is not formally part of the school's curriculum. Regardless of this, all interviewees showed a great interest in the subject matter and displayed a keen interest in implementing it in their teaching. Although a few of the participants indicated that they were not aware of the DT concept or process, upon further enquiry it became clear that most of the participants are using at least two of the stages that forms part of the DT process. Brainstorming and prototyping were two parts of the process that seemed to be used most often in the classroom. However, there were participants that indicated that they are using the whole DT process, be it in different ways. Participants all agreed that using either parts of or the complete process in a design project stimulates creative thinking. Overall it seems that learners enjoy the collaboration during brainstorming procedures and that they gain more confidence using a process that makes them think more critically. This research indicates that there is a positive interest in the DT

concept and all the participants, from both the public and private sectors, indicated that they would like to see the DT process integrated as a more formal approach in the Curriculum Assessment Policy Statements (CAPS) curriculum.

Beyond this reflective account of the interview process, the generated data and insights were modelled into a range of visual representations including Firma Models, personae, and activity system models

5.4.2   Firma model

Fenn and Hobbs (2015:169) states that in order for designers to solve a 'wicked' problem, "the designer first needs to ensure that they are interpreting the 'wicked' problem accurately and this involves understanding the environment from which the problem emerges." To this purpose they suggest applying ten categorical frames for ensuring a well-rounded research investigation. Collectively these ten lenses are referred to as a Firma Model. They go on to explain the Firma model (refer to Figure 5.1) has three particular aims:

1. To provide a generic research framework that can be applied to broadly and deeply explore and define problem-ecologies.

2. To identify key areas of concern within the problem-ecology and thus assist in articulating the design strategy (i.e. how should the areas of concern be changed).

3. And lastly, to provide the basis for critiquing the resultant design solution based on the knowledge of what the problem was and the desired change. (Fenn & Hobbs 2015:170)
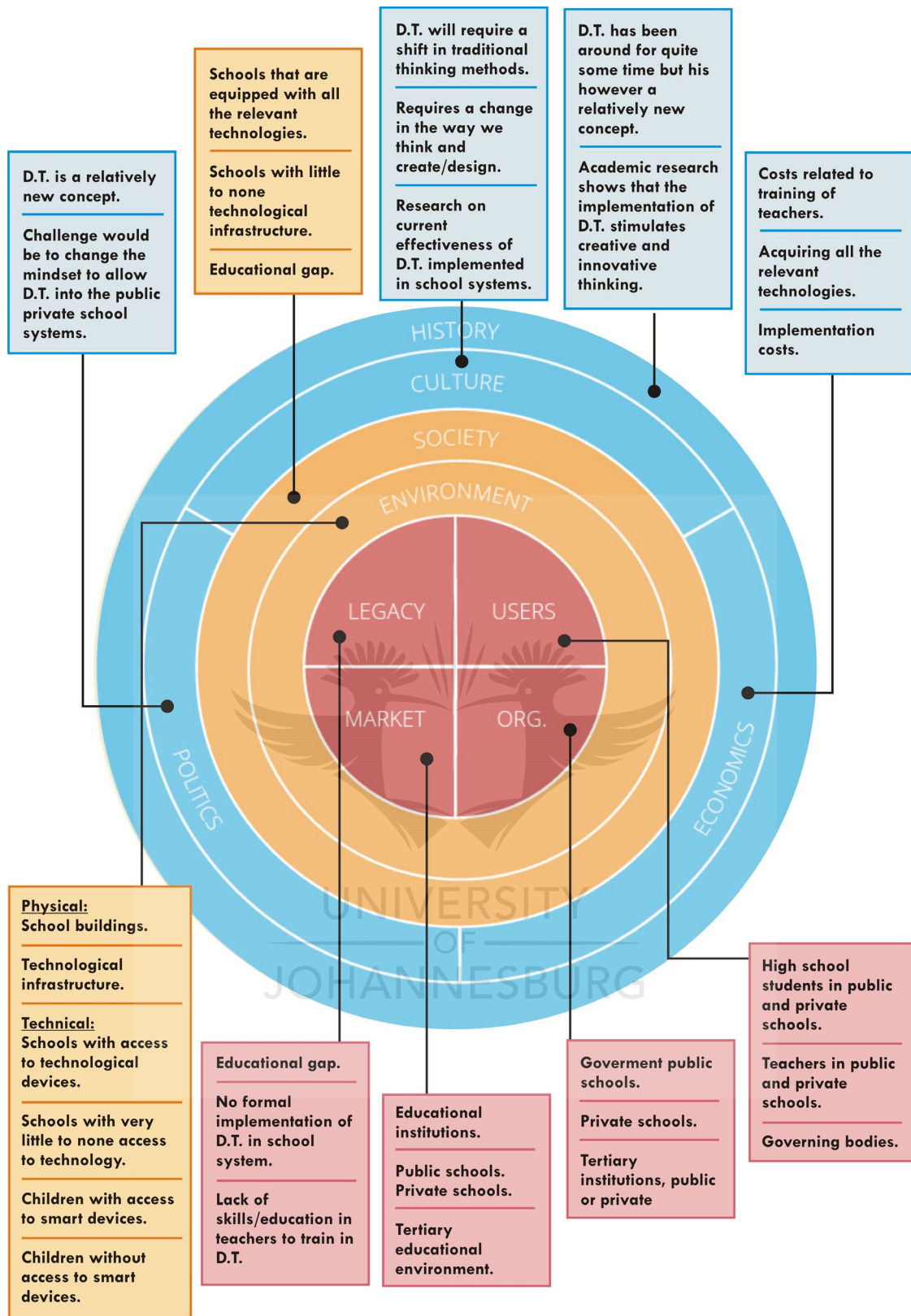
Figure 5.1: Firma model (Used to identify the problem-ecologies of the research study).

Figure 5.1 visually illustrates how the problem-ecologies in this research study was identified to inform the design strategy and to critically assess the design solution. The data that was modelled came from the interviews, observation of the use of the paper and digital prototype, as well as from the secondary research described in the

Literature Review. Some of the key insights that was discovered during this process are:

- In terms of the history of DT, is that it has been around for some time already but that it is not prevalent in South Africa and especially in the education environment.
- In the economic sector, infrastructure, implementing and training costs is an important factor especially in public high schools.
- There is also an educational gap that needs to transcend boundaries.
- DT will require a shift in the culture of traditional thinking and designing methods.

5.5 Personae

The next data visualisation method that was applied to articulate the research data were personae. Personas are detailed descriptions of individual characters used to emphasize research results. The personae framed the experience of the teachers from the viewpoint of fictitious characters that represents the different types of teacher who would potentially use the digital prototype. Each persona was modelled to represent different levels of teaching experience and knowledge. The two personae, as shown in Figures 5.2 & 5.3, represent 'Lynn', who has little knowledge about DT and 'Michelle', who illustrated knowledge about DT but stated that she has not got the time to introduce with the current school curricula.

Lynn is an art and design teacher at a public school and has been teaching for about 15 years. Although she is not aware of the DT process, she shown great interest in the concept and would very much like to more formally introduce into her teaching methodology.

Michelle on the other hand, was introduced to DT in her own studies and even though she completely believes in the benefits of DT in stimulating creative thinking she states that she does not always have time to incorporate it successfully in the classroom. It is for this reason that she indicated that she would welcome it was formally introduced as part of the school curriculum.
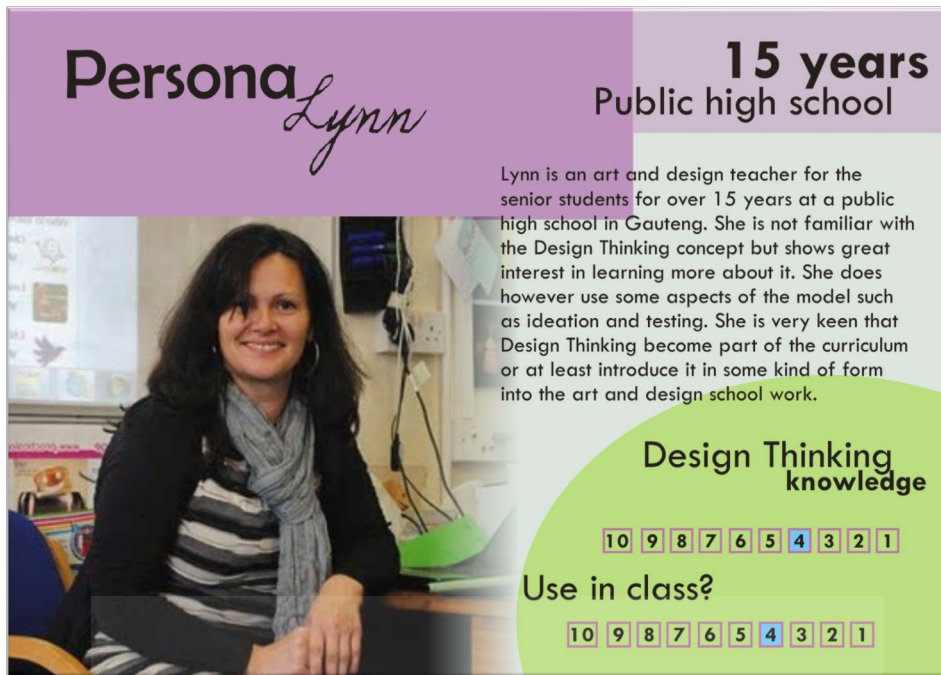
Figure 5.2: Persona A

Figure 5.3: Persona B

The research study indicates a distinct difference in the knowledge and experiences of the different participants.

5.6   Engeström's *Activity System Model*

Engeström's *Activity System Model* was discussed in detail in Chapter 3, section 3.2, but for the purpose of illustrating how it was incorporated as an analytical tool into the process phase, an overview of this model is included in this section. (See Figure 5.4).
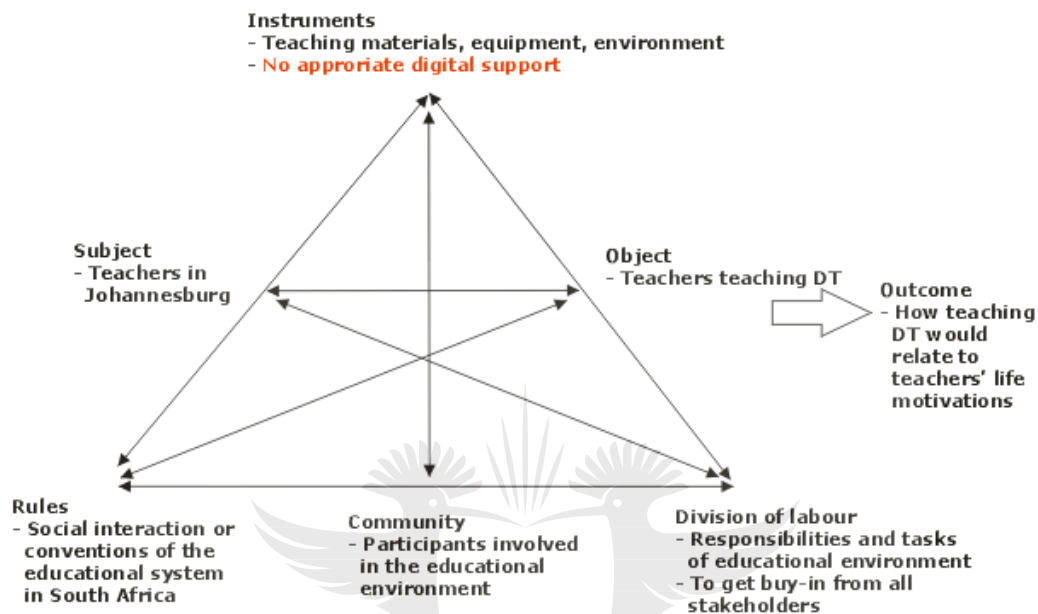
Figure 5.4: Engeström's Activity System Model.

The **subject** of the pedagogical activity system is the teacher. The **object** represents the primary goal i.e. the teaching of DT. The **rules** are the social interaction and conventions of the education system in South Africa, which either drives or hinders the subject's actions towards the fulfilment of their object Social interactions. The teacher is part of the community of teachers who participate in acting of the shared object.

Technology (instruments) includes all teaching and planning materials, equipment and physical environment. The **division of labour** refers to the negotiation of responsibilities (Hardman 2008:72-73) and tasks within an educational environment such as the role of Heads of Department, Subject Co-ordinators, Teachers, etc. **Outcomes** refer to the alignment of the goals embedded in the outcome with motivational aspects of the Object i.e. how the teaching of DT would relate to teachers' broader life motivations. The Outcomes were understood as the primary motivations or 'psychological drivers' of the teachers related to their teaching practices were framed through an analysis of the data by applying Marc Hasesnzahl's T*op10*

*Psychological needs f*ramework (Hassenzahl 2011, pg 44). The identified psychological drivers were:

- Competence
- Autonomy
- Influence
- Meaning

Identified themes and categories were interpreted with the aim of identifying any potential parallels or divergences of the perceptions of DT within the high school system in South Africa. Existing theories and previously conducted studies were drawn upon to assist interpretation in an iterative process. Meaning gained from interpretation was considered within the general context of the study. Finally, a complete and truthful account of all activities undertaken during coding, analysis and interpretation was reported.

Data was organised into more manageable units by defining the basic concepts or codes, ensuring that each relevant theme was assigned a code. Coding the text refers to scrutinising data for relevant aspects (Bezuidenhout and Cronje, 2014). Coding units were developed both deductively, based on content from the literature review drawing on existing research as well as relevant theories, and inductively based on patterns and themes which emerged from the data.

5.7   Strategy

5.7.1   Introduction to strategy

- The end design solution/s needs to enhance the experience of Johannesburg high school educators to teach creative thinking strategies for resolving complex problems.
- The condition of this resolution is to introduce DT methods and techniques into the classroom.
- Constraints include lack of knowledge of DT, time constrains, and insufficient infrastructure and technological requirements.
- The resolution to this strategy includes a digital prototype and related design deliverables that meet the relevant needs of the user community?

5.7.2 Activity Theory strategy

Hassenzahl's *Hierarchy of Goals* model is used to guide the exploration of the teachers' experiences and contexts that were discovered during the researcher's formulation of the Firma model, personas and the psychological drivers as discussed in the Sections 5.4.2, 5.5 and 5.7.6.
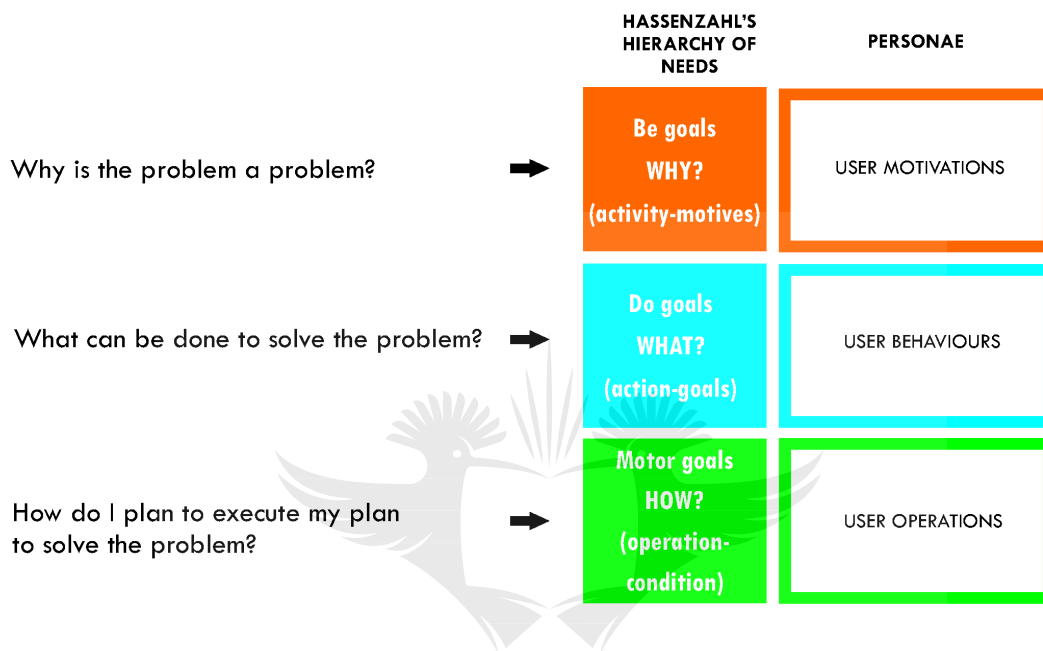
Figure 5.5: Hierarchy of Goals (needs identified of participants in the study).

5.7.3 The goal – Why?

Teachers are not capable to equip the learners with the skills they need to solve complex problems due to various factors. These include the lack of the necessary knowledge, no alternative methods currently available to traditional methods, and time constraints. This leads to a lack of competence, autonomy, influence and meaningfulness.

5.7.4 The problem – What?

By providing knowledge, advocating creative thinking and sharing of experiences teachers may gain the ability to achieve competence, autonomy, influence and meaning and therefore feel more competent to share knowledge and will be in a greater position to create an environment for more innovative thinking.

5.7.5 The solution – How?

Teachers may become more competent with a greater sense of autonomy, influence and meaning if they are provided with the necessary knowledge and skills to stimulate innovative thinking to solving complex problems, have more autonomy with the tools and techniques to provide to them in order to do this, have more influence through a strong community of practice, and create more meaning through the recognition of transformative teaching.

5.7.6 Strategy statement

The final version of the strategy was described in a strategy statement as seen in Figures 5.6, 5.7 and 5.8 below. These strategy statements apply the identified psychological drivers (user motivations) generated during the analysis of the research. The strategy formation was based on Richard Rumelt's Kernel's of Strategy (ref: Rumelt, R. 2011. Good Strategy Bad Strategy: The Difference and Why It Matters. Crown Business). This approach to developing design strategy originates in (Fenn and Hobbs, 2017)

The kernel is described as follows:

- A diagnosis that defines or explains the nature of the challenge;
- A guiding policy for dealing with the challenge; and
- Coherent actions designed to carry out the guiding policy.

Art, Design and Technology high school teachers are not always capable to equip their pupils with the skills needed to think more innovatively to solve complex problems because their need for

[A] competence   [B] autonomy   [C] influence   [D] meaningfullness

is not being met.

This is because

[A]	[B]	[C]
they lack knowledge	current school system does not adequaltly provide alternative methods of innovative thinking	time to nurture more innovative thinking to solve complex problems

Figure 5.6: Diagnosis (Problem statement).

5.7.7 Guiding Policy

By providing [A] knowledge [B] advocating creative thinking [C] sharing experiences in the educational sector,

Teachers will achieve [A] competence [B] autonomy [C] influence [D] meaning

And thus feel more competent to share their knowledge and be in a

greater position to create an environment for more innovative thinking.

Figure 5.7: Guiding Policy.

Teachers will feel [A] *more competent with a greater sense of* [B] *autonomy* [C] *influence* [D] *meaning.*

If we provide:

[A]	[B]	[C]	[D]
A better understanding of innovative problem solving and more support for learning about and discovering more innovative ways in solving complex design problems	*Self-service by means of the various materials provided to them*	*A strong community of practice*	*Recognition of transformative teaching*

Figure 5.8: Coherent Actions (Can also be considered as the design requirements).

The design strategy, informed by the insights gathered, is based around facilitating an environment for introducing DT within the school system. One which addresses the need for more innovative and creative design solutions. Key to this, the design implementation will be interactive and educational – ultimately building confidence in children and teachers to use DT in various areas of the curriculum.

Through analysing the problem statement, a variety of coherent actions were identified to create an experience model which further aided in creating a detailed experience map and customer journey. The main required experiences that were formulated are: discoverable, informed, empowered and connected.

5.8   Experience model

The last aspect of strategy was the development of an experience model. While psychological drivers are high-level categories of needs the aim of an experience models is to determine how these drivers can be contextualised by the specific strategic intent of the strategy. The result is a set of situated experiential needs that drive subsequent innovation (Fenn and Hobbs 2017).
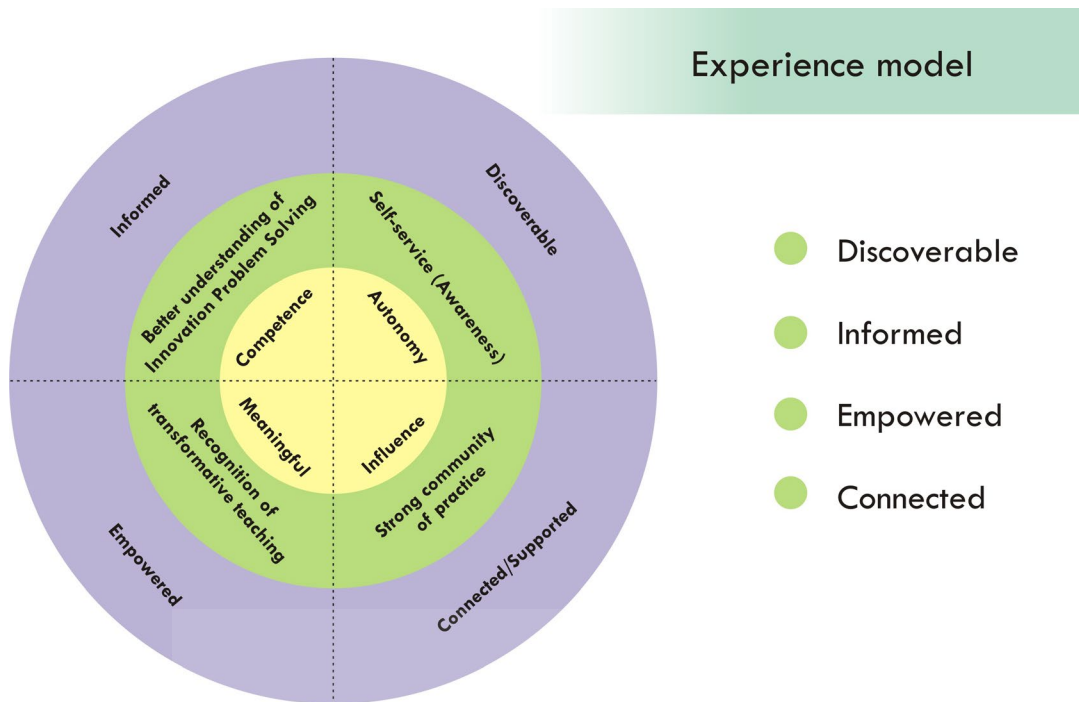
Figure 5.9: Experience Model – Breakdown.

5.9   Ideate

5.9.1   Introduction to ideation

Ideation is the creative process that includes generating, developing, and communicating of new ideas. In this study the researcher used various ideation processes from the insights gained during the data collection and interpretation and of the Firma model, Activity Systems Model (ASM), personae creation and Hassenzahl's *Hierarchal model of goals* that was applied to inform a design solution strategy.

5.9.2   Brainstorming model

Applying the experience model created the opportunity to ideate more effectively about the digital process and design and to create user journeys and user-flow diagrams.
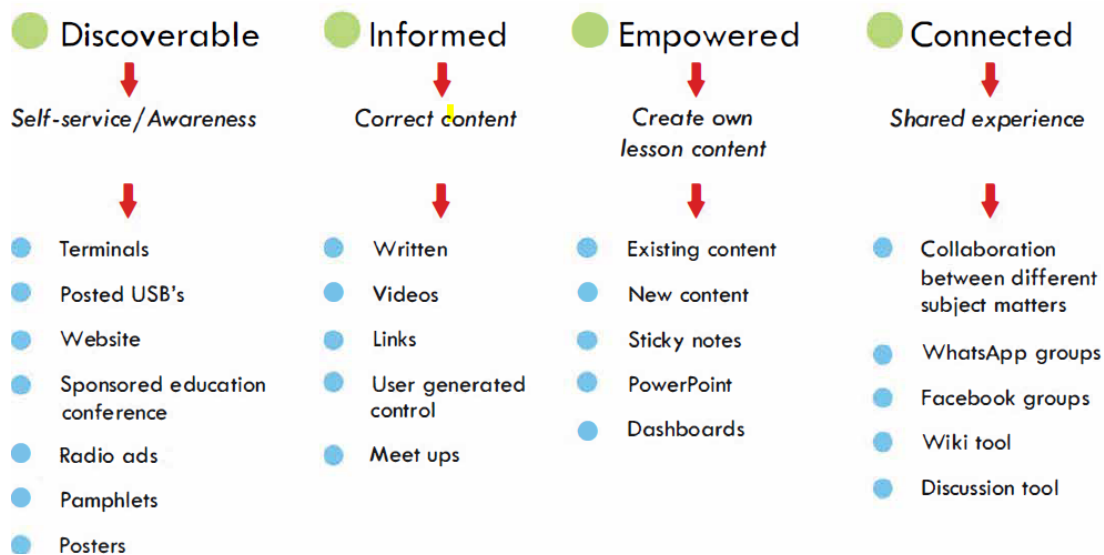
Figure 5.10: Brainstorming model (Note this diagram is a final version of a process that included much rough work and multiple brainstorming sessions).

The ideation process also included process sketches and customer journey maps with the aim to gain more insight on the feasibility of the final design - a digital product. Teachers will be given the opportunity to learn and practice DT in the classroom whilst enriching their own knowledge around innovative thinking and problem solving. A key focus of this process is on collaboration between teachers and students from similar as well as different fields of study, for example, between art and design students and IT students.

Teachers and students will be encouraged to provide feedback on various platforms to further enrich and stimulate learning. These applications could be in the form of a terminal, website, USB downloadable files, and/or posters and infographics.

5.9.3   Experience map

An experience map (also known as a customer journey) is a description of a service from the perspective of how a user would engage with the service. "An experience map is a design tool for capturing and [illustrating] key insights from complex customer interactions that occur across different channels, touch-points with a product, service or even an ecosystem. At the core of an experience map lies a customer journey model that [demonstrates a typical] journey of customers that attempt to achieve a goal or satisfy a need. The activity of building an experience map builds knowledge and user understanding across the team and other stakeholders and the map as an artefact allows designers to create and support seamless experiences through distinct phases of product/service." (Rajani 2008).

In my design process, I created an experience map (see Figure 5.11 on the following page) to explain at a high-level my final design concept.

Innovative Problem Solving (Design Thinking) Customer Experience Map

Guiding Principles

Lack of knowledge	Current school system does not adequately provide alternative methods of innovative thinking	Time to nurture more innovative thinking to solve complex problems

Customer Journey
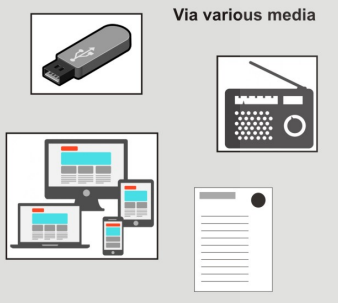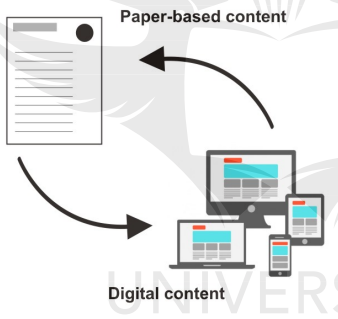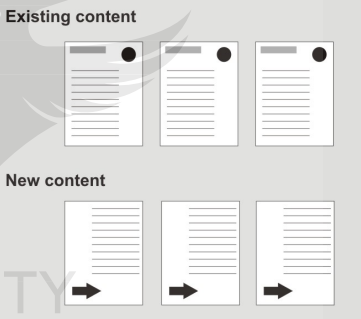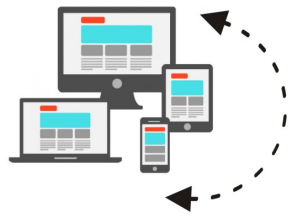
	Awareness/ Information seeking	Gaining knowledge/ Correct content	Informed/ Create own lessons	Shared experience
STAGES				
INNOVATIVE PROBLEM SOLVING	Introduction to the Design Thinking model	Learn the concepts, tools and techniques	Ability to work on existing content and create new ones	Communication and feedback
DOING	Via various media	Paper-based content / Digital content	Existing content / New content	
THINKING	- Which new concepts would I need to learn? - How will it improve my teaching? - How will this improve the learning?	- How much time will it take to learn the new concepts? - Do we have the correct resources to implement it?	- Will I be able to gain access to exiting information? - Will the information I gain give me the ability to create my own design content?	- Will I be able to communicate with other people using the same system? - In which ways will I be able to communicate and gain and provide feedback?
FEELING	Awareness	Competence	Meaningful	Influence
EXPERIENCE	Discoverable	Informed	Empowered	Connected

Figure 5.11: Experience map (User journeys demonstrate the way users could interact with the product).

5.10 Prototype

5.10.1 Introduction

A prototype is formulated through the creations of User-journeys, wireframes, design compositions and digital prototypes that are designed to illustrate the design concepts. The design involves integrating the design decisions articulated in the wireframes with the insights gained in the research related to the teachers' information needs. In this phase user-journeys are created to demonstrate how the user will potentially interact with the prototype design. This is followed with the creation of a paper prototypes followed by the design of a simulated digital prototype. The final design deliverables of the design phase prior to the production of the integrated digital prototype. The design involves integrating the design decisions articulated in the wireframes with the insights gained in the research related to the teachers' information needs (see Figures 5.11-5.14, 5.17).

5.10.2 User journeys

A user journey is a series of steps which represent a state in which a user might interact with the product you are designing. User journeys demonstrate the way users could or are currently interacting with the service, website or product. The initial design activity undertaken is a representation of the service offering of the digital design solution as depicted in Figure 5.12. The user journey was constructed by combining the six personae-driven user-journeys to explain the functionality of the digital design that includes the psychological drivers discussed in Section 5.6. For more clarity, refer to Figure 5.13.
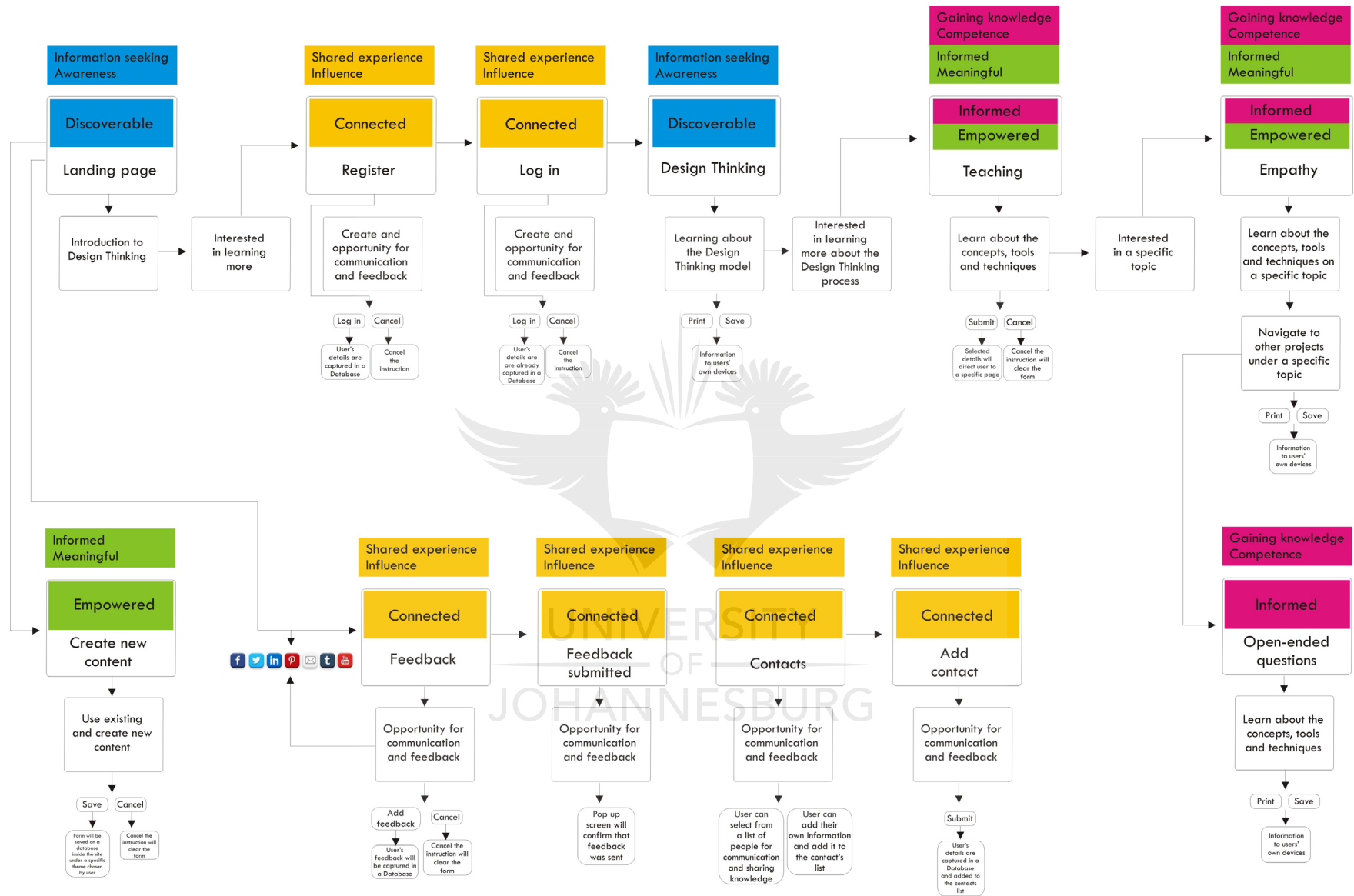
Figure 5.12: User journeys (User journeys demonstrate the way users could interact with the product).

Images below are the user journeys as discussed above, added for more clarity.
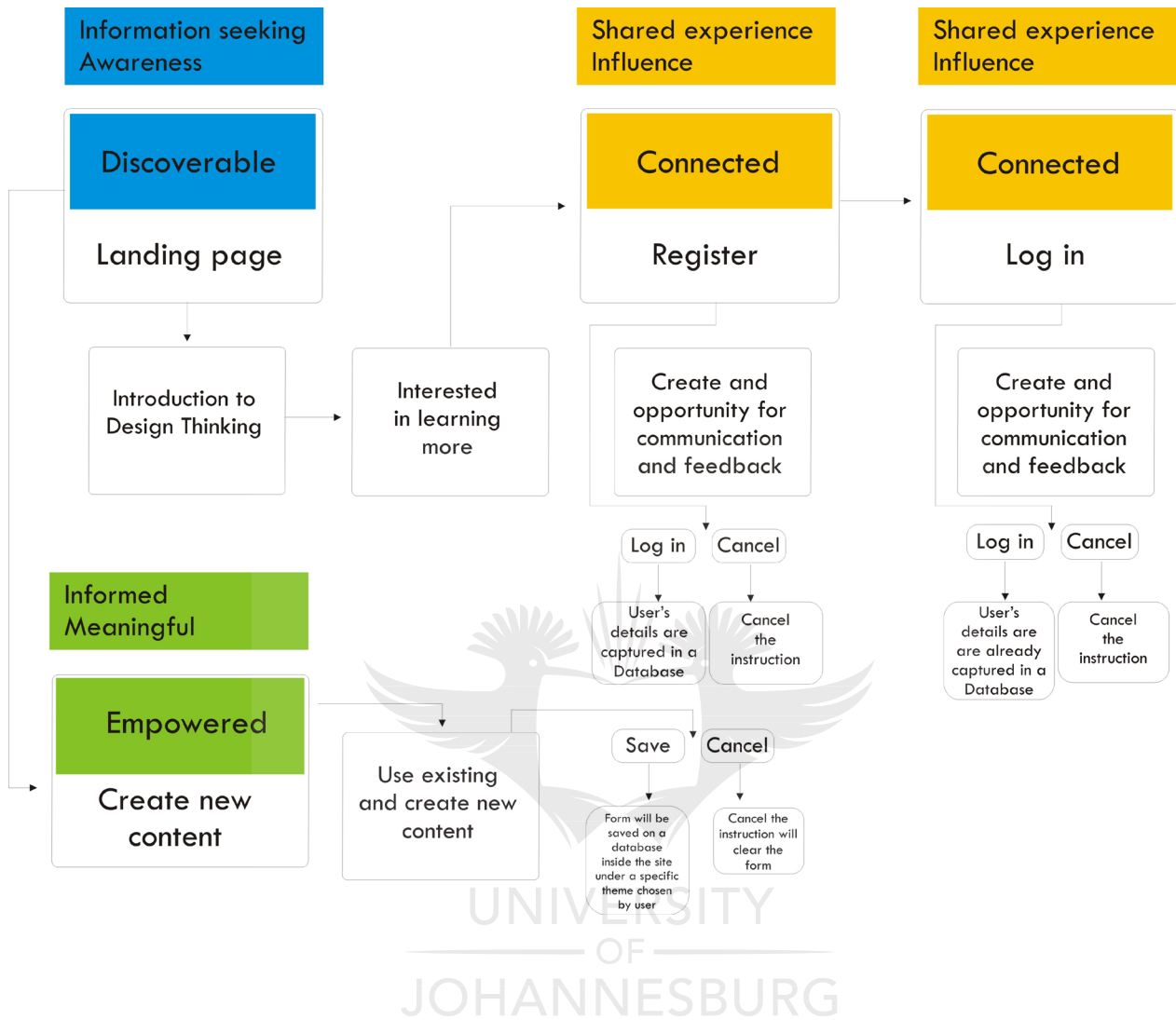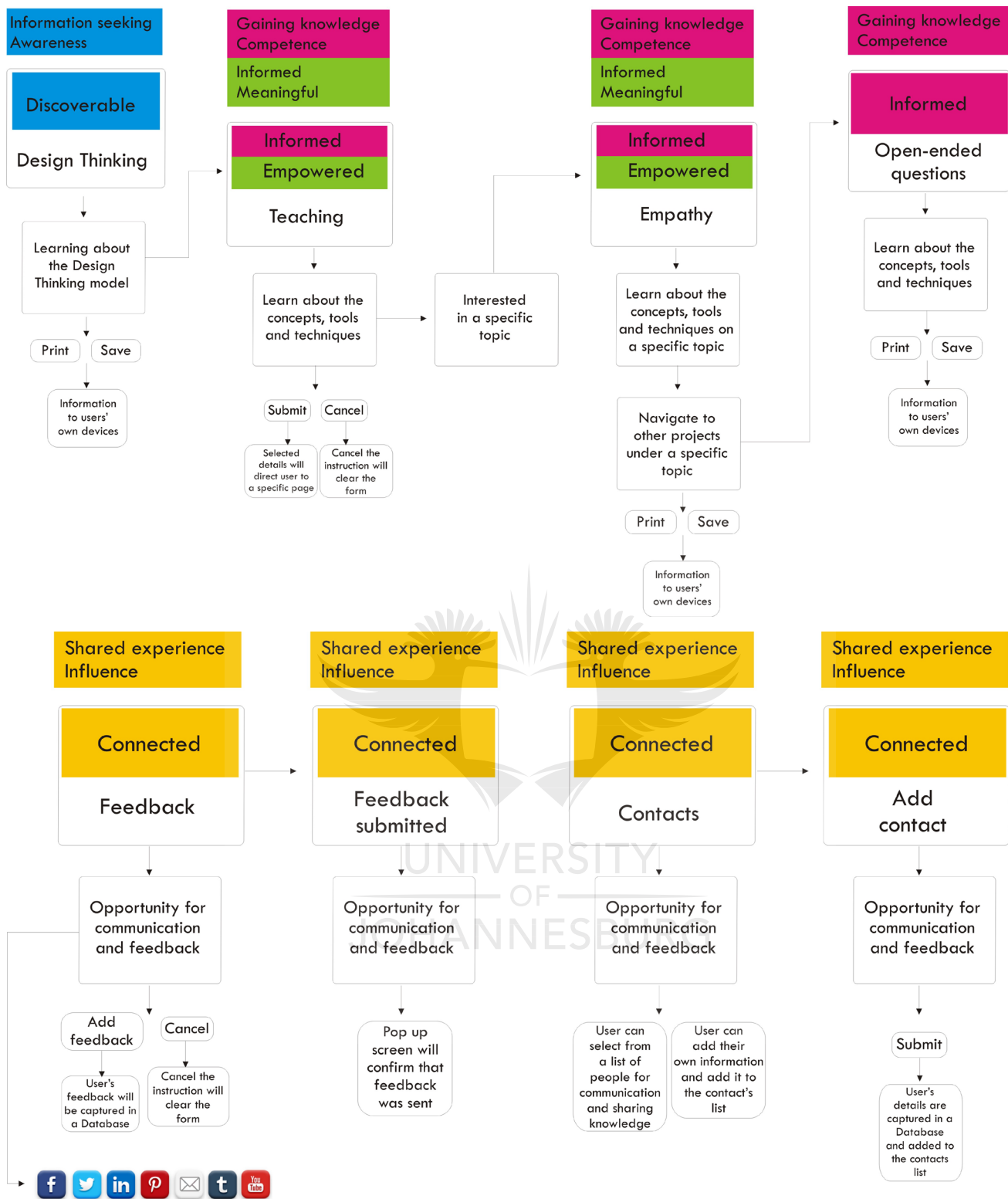
Figure 5.13: User-flow.

5.10.3 Wireframes and design comps

Wireframes are visual interpretations of a system or product's proposed content, structure and function. Wireframes depict the information architecture and design of key interface states and thus are seen as the touchpoints between the time/space orientated task-flows and the final user interface designs. The wireframe examples depicted in Figures 5.14 - 5.19 are arranged to illustrate the key aspect of the user-journeys they relate to.

Next to each wireframe is a description of the page intended purpose and underneath an example of a final page in colour. From the experience model created using the psychological needs of the participants in this study, the researcher included the main psychological drivers formulated during the analysis and strategy phases to illustrate how it is used in the framing of the problem under study. These include: Connected, Informed, Empowered and Discoverable.

Log in page

Connected
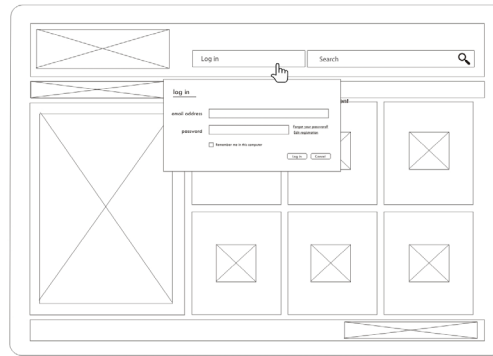
Once the user has created a profile on the Registration page, they will be directed to the Log in page where they will be able to login in with the details they used to register with. Once they have registered, they will only be directed to the login page from there on. Once they have logged in they will be able to have access to features such as projects, contacts, creating their own contents, share experiences, provide and receive feedback.

Design Thinking page

Discoverable
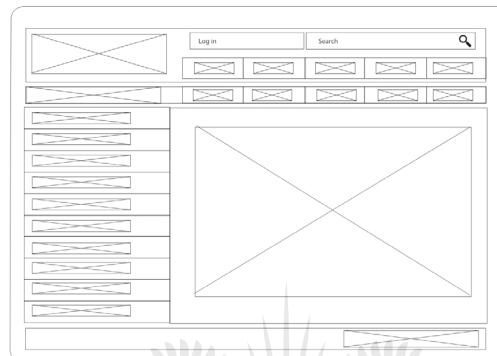
On the Home page and subsequent pages there is a link button to a page that gives the background information of Design Thinking. This page is accessible to anyone, even if they did not register or logged in. This page's primary function is to entice and inform the user of the Design Thinking concept and to encourage them to register. The user will be able to print and/or save this information on their own devices.
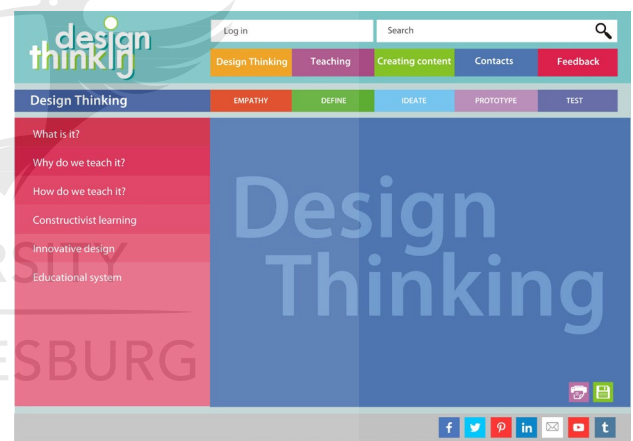
Figure 5.14: Example of the 'Log in' page and the 'Design Thinking' page (After a user registered thee will be able to log in with their own log in details).

Landing page/Home page

Discoverable
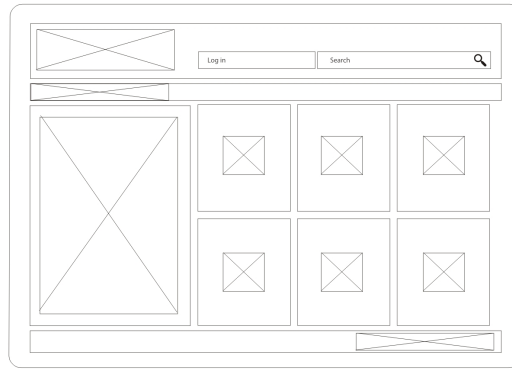
This will be the first page the user will come in contact with. This page will have the minimum of information with a brief explanation of Design Thinking, logos and relevant links to the rest of the content. The links are clearly labelled so that the user can easily know how to navigate to another section/page. There are also various social media links where users can discuss and post comments. There are various social media links that will allow the users to communicate

Registration page

Connected
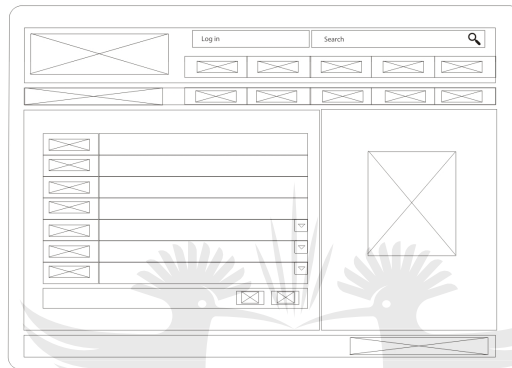
The first time the user click onto the Log in page it will direct them to the Registration page. This page will allow the user to create a profile and register to be a part of a Design Thinking group in order the share experiences and provide feedback. Users will be able to register for specific subjects as well to get more appropriate information when logging in.
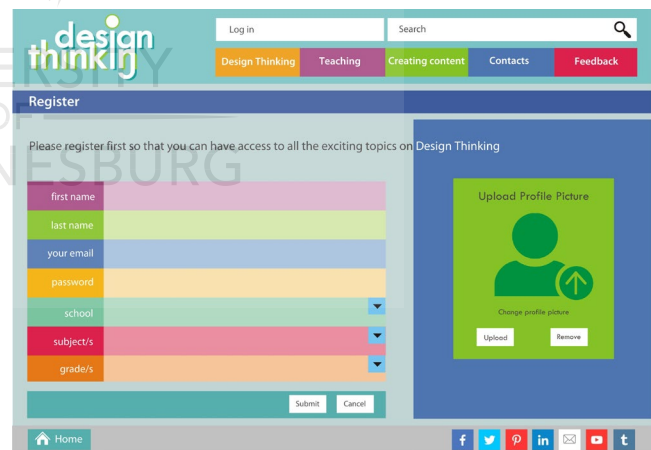
Figure 5.15: Example of the 'Home page' and the 'Registration' page (From the Home page the user has access to the different topics and the Registration page allows them to fully interact with the digital product and engage with the community).

Open-ended questions page

Informed
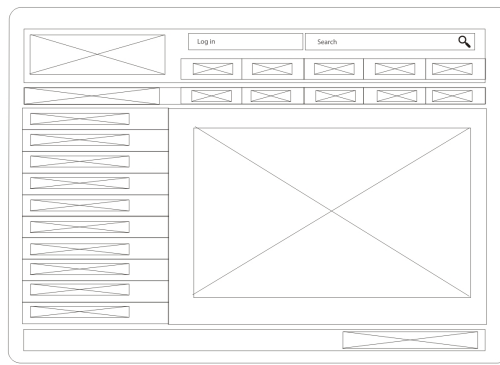
Once the user have entered the relevant information on the previous page, they will be directed to the specific page they selected. This page will have a sample project under the selected topic that they chose which they can implement into an assignment using this part of the Design Thinking process. This information the user can also print and/or save on their own devices.

Feedback page

Connected
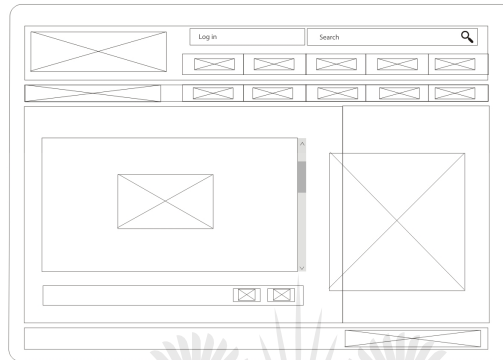
On each page their is a button linking to a Feedback page. Here the user will have the opportunity to add any feedback on a topic or just general comments. This in turn can be saved or printed for record keeping. The users will also be able to read recent posts on various subjects.
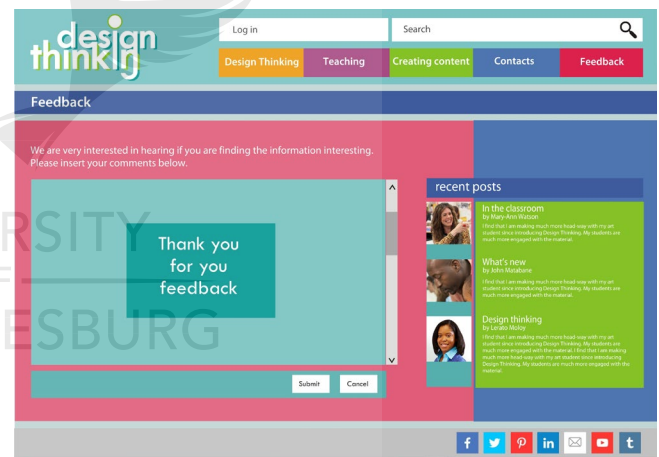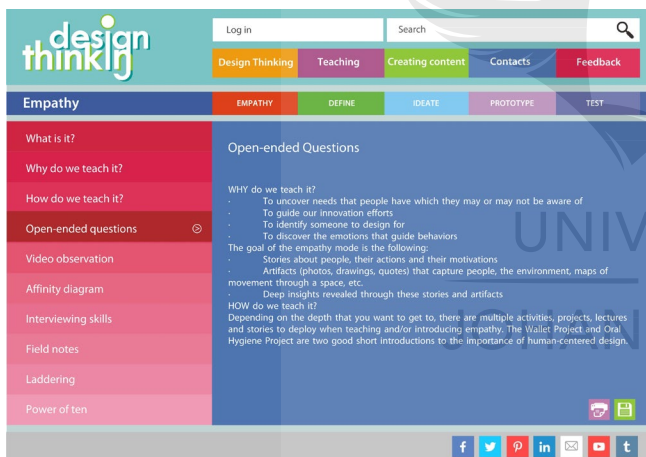
Figure 5.16: Example of the 'Open-ended questions' page and the 'Feedback page' (Here the user can provide feedback that will be shared with other users).

Teaching page	
	Informed
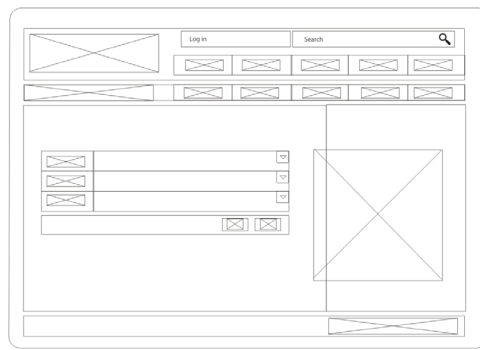
On the Teaching Design Thinking page have two different options to link to the Design Thinking process and projects. Users can use the round buttons to link to the various pages including empathy, define, ideate, prototype and test. If they want to go to a specific page they can use the more advanced option by selecting the grade, subject, module and lessons. They are further directed to a video to encourage them to watch a video that explains more about Design Thinking projects and how to use them. The page will also have a section that displaces recent posts on this subject matter.

Empathy page	
	Informed
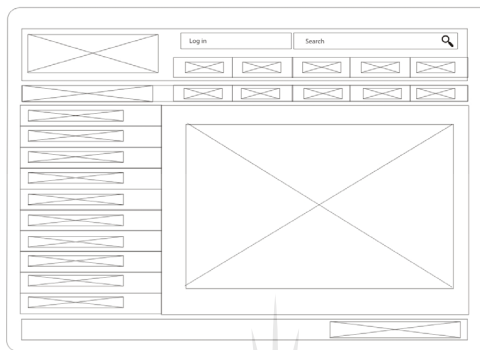
Users that clicked and the Empathy round button link will be directed to this page where they can select a variety of topics under this subject matter. When the user selects one of the topics they will be directed to a page similar to the next page where they will find projects specifically designed around a specified topic. The page will also have a section on recent posts on the various topics. The user will be able to print and/or save this information on their own devices.
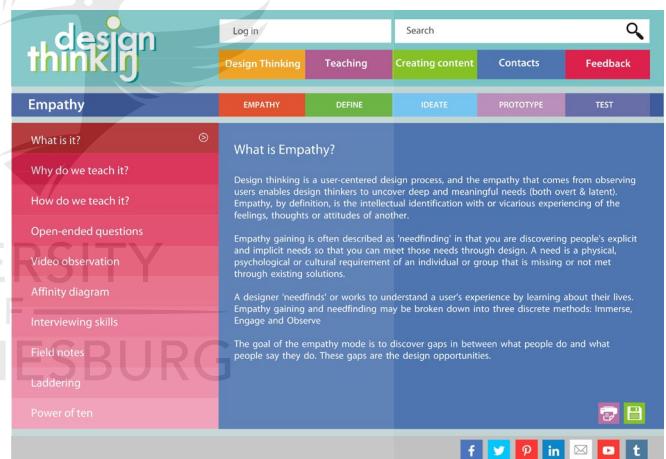
Figure 5.17: Example of the 'Teaching' page and the 'Empathy' page (These are examples of where a user can add lessons that can be shares as well as an example of the links related to the DT principles to gain more knowledge and insight).

Create new contents page

Empowered
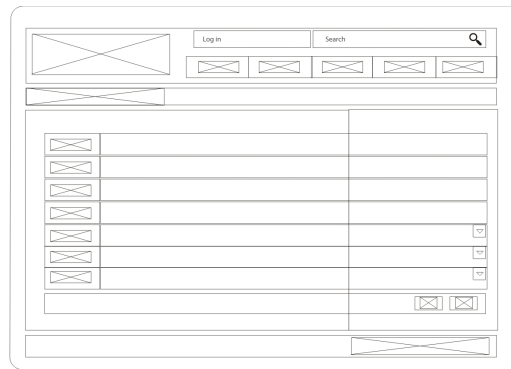
The Create new content page allows the user the use the template based on existing projects to create a new project based on the various Design Thinking processes and concepts. The user will be able to save and upload the new project onto various social media platforms in order to share the information with other users. The information will be save in the site under the specific topic that the user created.
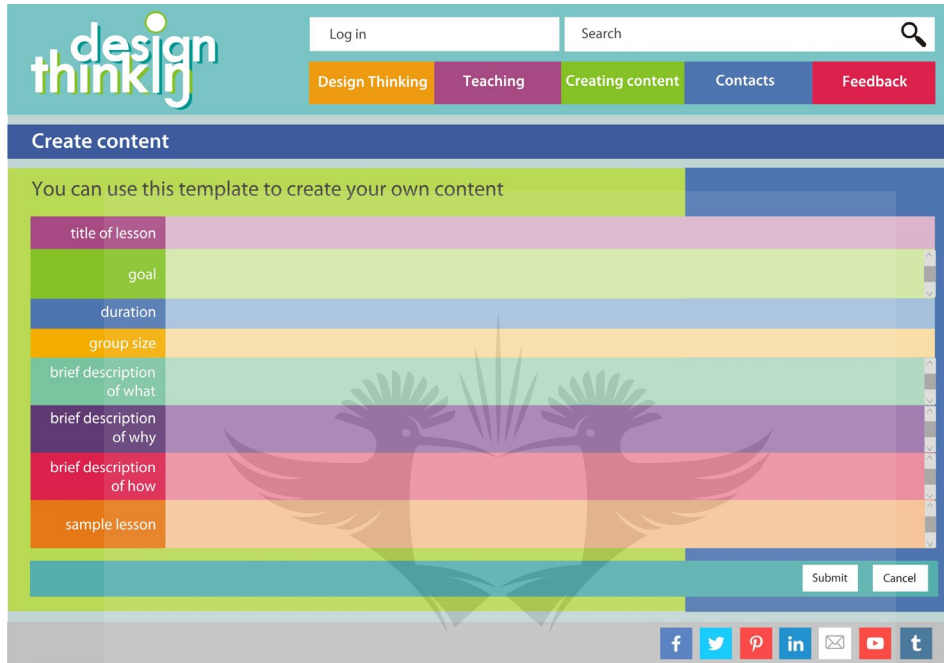
Figure 5.18: Example of the 'Create content' page (The user can use this section to create their own original content and to share this with other users).

Contacts page

Connected
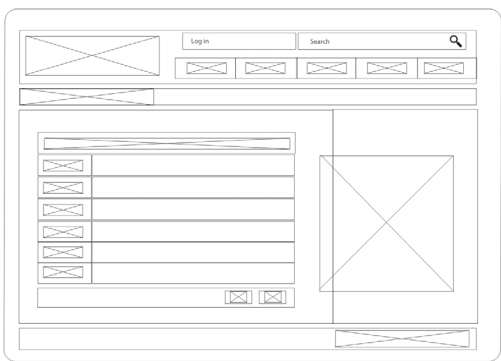
User can link to the Contacts page from the Contacts link. Here a user can gather information from other teachers that teaches a similar subject or grade specific information. A user has to be logged in to access this page and information. A user can change their own details but does not have access to these details from other contacts. However, each user has access to the email action button and will be able to contact other teachers via email. New users can click on the 'Add contact' link to add their own information to be part of the contacts list. The information will be saved in a database.

Add contact page

Connected
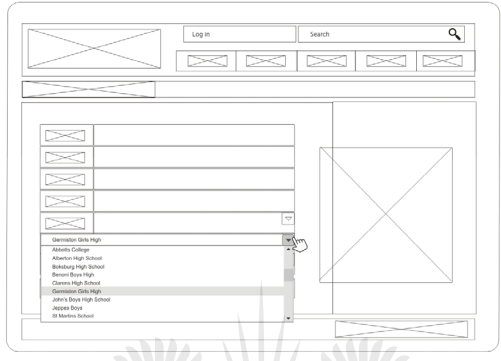
Once a user clicked on the 'Add contact' link from the previous page they will be directed to the 'Add contact page'. Here they can fill in the relevant information and add themselves to the contacts list. The user's information will be saved in a database.

Figure 5.19: Example of the 'Add contacts' page (The user may add contacts and read posts from other users).

5.11 Testing

To evaluate whether the interaction design solution was relevant to the teachers in the sense that it could potentially resolve identified problems, paper prototype evaluation and prototype observational study was done by the researcher. The prototype was

largely based on the research and evaluation done during the Honours degree where eight teachers in Johannesburg high schools were interviewed on their knowledge and use of Design Thinking within their teachings of mostly Art and Design fields.

The paper prototype evaluation was undertaken with six teachers prior to the prototype evaluation. This testing was done prior to completing the technological development of the application to ensure that the need of the users was met. The paper prototype testing involved simulating how the digital application would work by showing them the different interaction phases.

The digital prototype testing was a simulated product that gave the teachers an idea how the final digital design might look and interact with the user. Results of the prototype observations evaluations suggested that the design of the digital prototype did meet the experience needs of the teachers. The product design can be seen as meaningful as the teachers demonstrated an understanding of why the digital product could be used and what it could be used for and showed a keen interest to use it. The digital prototype was evaluated by the teachers using the following criteria and table (Table 5.2).

5.11.1 Example of the questionnaire used for the digital product

For the examining of the digital prototype, the data will be recorded using a scoring table for each participant using the following indicators:
1. Did they find the content unique?
2. Did they see the value of the designed prototype?
3. How they found the overall design of the prototype?
4. Are the colours and fonts clear and work well together?
5. How easy is it to perform common tasks?
6. How easy it is to navigate through the digital prototype?
7. Did participants find the registration process and uploading of documents user-friendly?
8. How quickly the response times were when performing certain tasks?

5.11.2 Example of the summation of the data analysis of the digital prototype
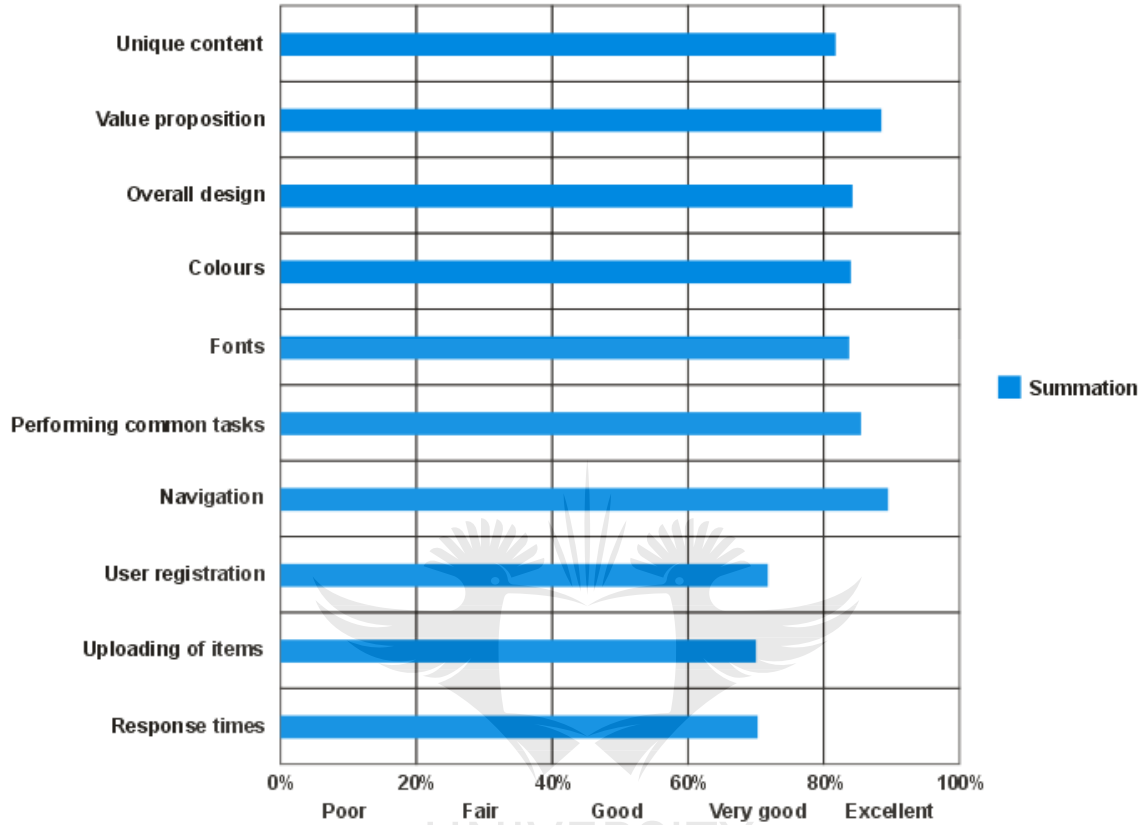
Table 5.1: *Digital prototype data analysis – summative findings.*

The following images are visual examples of the UX design of the practical prototype. An interactive version was presented to the participants so that had the opportunity to actively engage with the digital product. These was created during the prototyping phase of the DT process.
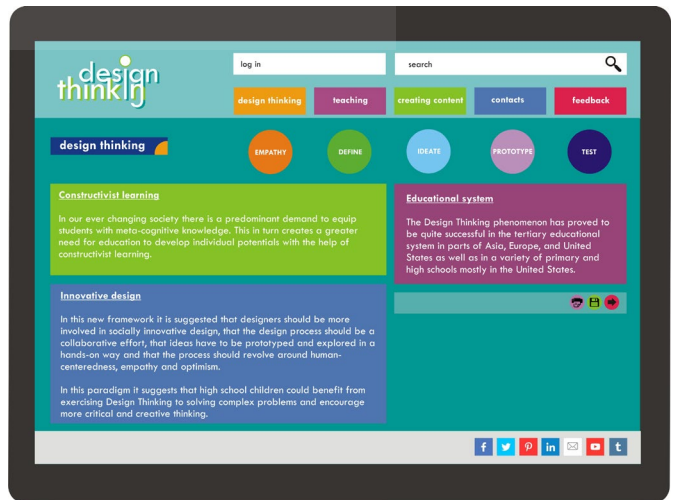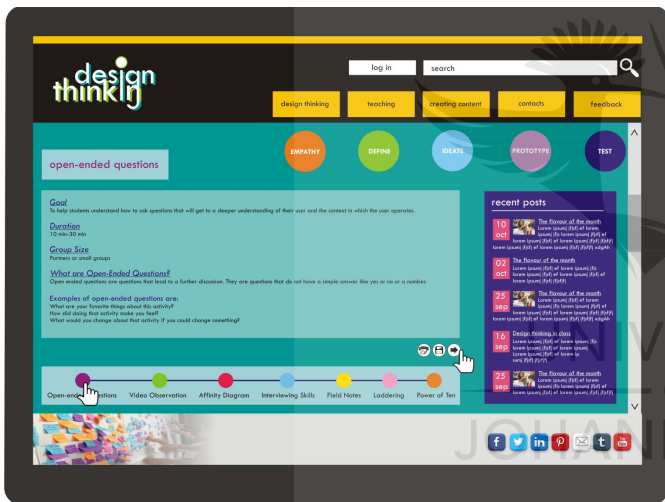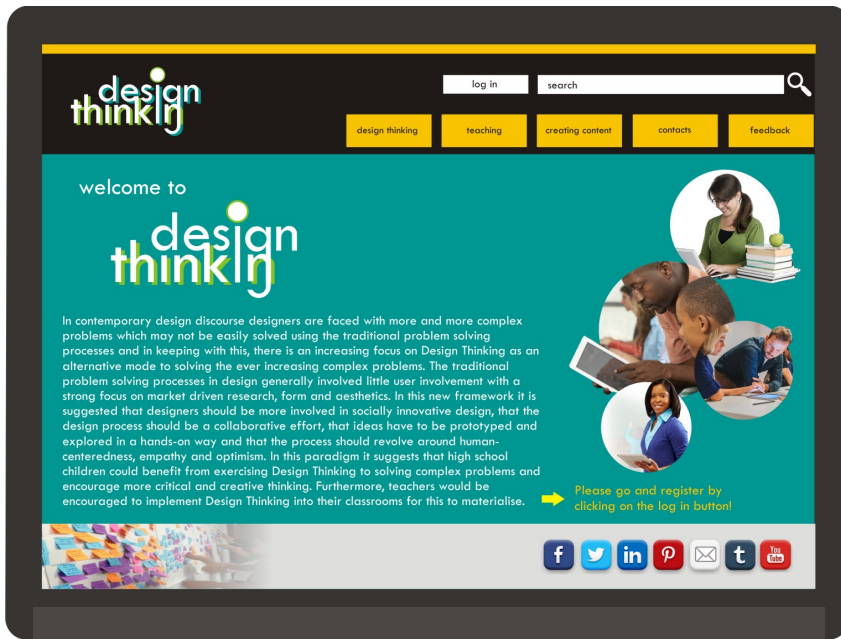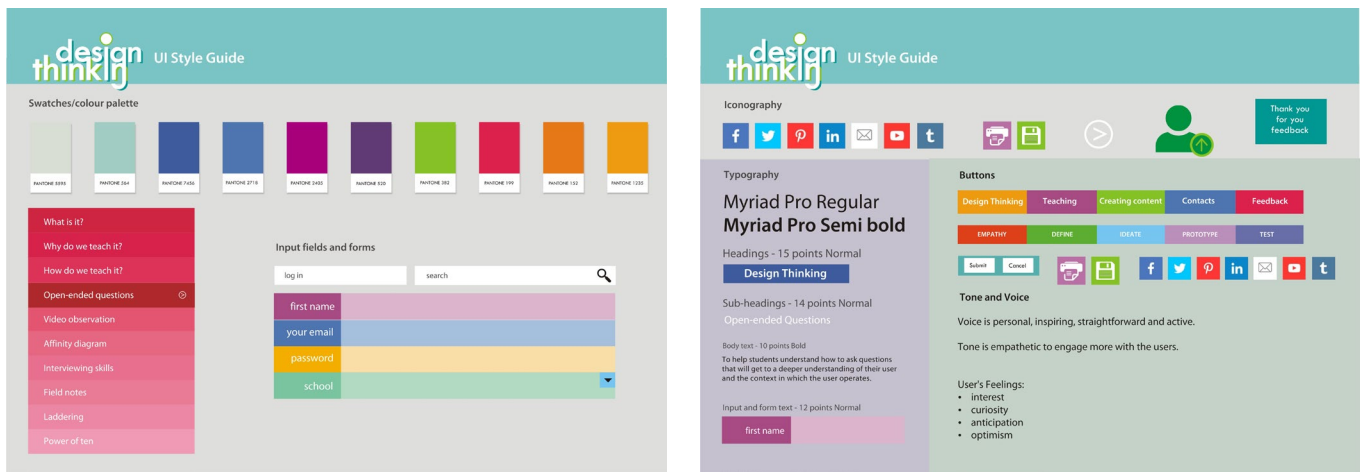
Figure 5.20: Further examples of the digital prototype and an illustration of how the UI Style Guide was created.

5.12 Overview

This chapter described how data gathered through interviews was analysed and interpreted and explained concepts of DT and its possibilities when introduced in the high school system. The chapter provided insight into teachers' perceptions of DT and the potential in increasing innovative and creative thinking at high school level.

This qualitative study was designed to explore the perceptions of DT in both private and high school design teachers', involved in art, design and technology subjects. These informed perceptions were pursued as a means to gain insight into a relatively under-researched sector. Participants answered an open-ended questionnaire during a semi-structured interview. These texts were then coded and analysed in order to deduce certain themes. The themes were then analysed in terms of their relationship to each other.

Data analysis and interpretation was conducted to ensure trustworthiness through providing detailed, authentic descriptions of data that accurately reflects the participants' working experiences.

From these findings and from the findings done in the researcher's Honours study it became clear that there is a need for teachers and students alike for formalised guidelines and best practices on DT that can scale across school systems. Although there are online resources available on the concept of Design Thinking, unless you are aware of the process and the concepts behind it, the information might be

overwhelming to introduce without some form of structured knowledge base on the subject matter and how to implement it into the school system. It is for this reason that the researcher created a UX digital product in conjunction with participants the allow for a collaborative process that focus on the needs of the end-user.

CHAPTER 6 – EVALUATION PHASE

6.1 Introduction

The value of applying the RtD criterions is that it provides a framework for the critical evaluation of the reflective design practice and as such ensures that the contribution can be regarded as research. Chapter 6 will evaluate the design process described in Chapter 5 in terms of Zimmermann *et al's* (2007:7-8) three criteria for evaluating interaction design research within HCI: Invention, Relevance and Extensibility to critically reflect on the contribution the design process, methods and associated concept may bring to the practice of user-centred design in South Africa, generally, and the design of a digital teaching aid for DT specifically.

6.2 Invention

Invention relates to the degree to which the interaction design research contributes an invention. In other words, the unique or novel features and how it differs from other related design works to address a specific situation. This research project generated a number of distinctly unique approaches to UX and UX design.

The first aspect of the research that can be identified as original is the design of the application represented in the digital prototype, which is a unique solution originating from the complexity of the teachers' situation, the availability of digital technologies and the co-design processes.

While sharing aspects of concepts and functionality with other products, the digital product is essentially a personalised product as there is no other related products that are available to specifically fulfil the needs of teachers in high schools to teach DT to create more creative and innovative thinkers.

Related product such as the ClassDojo app connects teachers with students and parents to build classroom communities and focuses on teachers, students and parents to connect and share experiences and resources. This information is however mainly created for pre-primary school children and based mainly on the USA school curricula.

The TeacherKit App makes classroom management easy for teachers, students and parents, through actions such as taking attendance, recording a gradebook, class activities, but again, mainly created with the focus on primary school teachers and learners.

Gauteng Art Teachers group on Facebook is great in sharing ideas across a broad spectrum but is seen as a more social type of communication and does not specifically focus on specifics.

WorksheetCloud is a complete online CAPS and IEB exam revision platform for Grade 1 to 12 learners in South Africa but does not solve the problem of this research study as it does not discuss the need for teachers to introduce DT into the educational system.

IDEO's DT for Educators website is another tool for educators and is one of the best that is currently available as it is concentrated on DT specifically. However, again this is not based on South African needs and is therefore not the best tool to solve the problems of the participants of this study.

The Hasso Plattner School of Design Thinking at the University of Cape Town (d-school) is another example but these programmes concentrate on DT aimed at tertiary educators and not high school teachers and learners.

While these digital products discussed above do, to an extent, meet certain needs they tend to be either focused on a different target market and for the most part, have a North American focus and therefore do not add much value for the South African school system. There are many institutions that offer courses on DT in South Africa, but again they are not specifically designed for high school teachers and the school environment.

In other words, these digital products do not solve the problem on which this research study is based on; a UX design product specifically designed to enhance the experience of educators in Johannesburg, expected to teach creative thinking strategies and DT for resolving complex problems.

The proposed digital product in this study is specifically aimed at the South African educational high school sector with the main purpose of teaching teachers the DT

process in order to enhance and stimulate creative and innovative thinking. From the literature review in Chapter 2, it has been clearly illustrated that the DT process can enable the innovation process and be used as a problem-solving tool applied to an extended range of problems outside the traditional domain of design.

6.3   Relevance

Relevance relates to a demonstration that the product enhanced performance. In other words, how the product can solve the teacher's problems. IDEO's Tim Brown (cited by Collins 2013:36) describes DT as a key process that in turn enables the innovation process that can be used as a problem-solving tool applied to an extended range of problems outside the traditional domain of design. DT has been implemented in numerous establishments with successful results. Stanford University D.school's 'bootcamp bootleg' toolkit has been used in many of these programmes which introduces a formal DT model, principles, methods and tools.

DT seems to be a field of interest for the participants involved in the research study. During the interviewing process participants clearly expressed great interest when they were able to engage with the UX digital prototype and how it could support them in creating more creative designers and innovators.

The exploration and consideration of the teachers' experience allowed for an invention of a design strategy that placed at its centre the motivations most important to the teachers.

These motivations were:
- The need to improve knowledge of DT;
- The need to turn traditional learning, thinking and design fields to create more innovative thinkers in these fields;
- Content related to the value of learning and teaching DT, registration tools, question input menus, and the ability to add additional new content and new contacts for collaboration.

All of these elements ensured that local knowledge was included, and teachers felt connected to each other and local educational networks. The functionality offering and experience of the prototype was tested by the participants and was overall viewed as

favourable. However, the testing was limited and early in the development cycle. It is for this reason the digital prototype at this point can only be viewed as a concept that contains many aspects that the teachers feel would help them to improve their capabilities across all three motivational areas.

It is for this reason that the design strategy called for a digital product that included relevant content and functionality related to teaching DT within the educational sector.

6.4   Extensibility

Extensibility is defined as the "ability to build on the resulting outcomes of the interaction design research: either employing the process in a future design problem or understanding and leveraging the knowledge created by the resulting artefacts" (ibid). It therefore relates to the contribution of the product to the field of UXD in South Africa.

Although it has been established that there are related work and digital products available, and that DT's value to design is established, there is little evidence that it has been successfully applied in a digital product (UXD) within the South African high school context. This project application of RtD and DT presents the methodology as a viable approach to co-designing interactive products with and for the educational sector.

As mentioned before, the DT process can enable the innovation process and be used as a problem-solving tool applied to an extended range of problems outside the traditional domain of design. As a research study, the application of a variety of innovative techniques and methods in the resolution of a complex societal problem.
In this study the DT process was used to establish a prototype that could potentially solve South African educators' problems in creating more innovative thinkers through teaching DT in high schools.

CHAPTER 7 – CONCLUSION

7.1   Introduction

A presentation of data collected and how the data was organised for analysis was provided in the previous chapter. The description, ordering and analysis of data has meant that researcher interpretations and constructive conclusions can be drawn for this study. The interpretations of this study are based on the sample of participants and their responses and the observations of their interaction with the DT process and the product design prototype. Findings of this research along with the existing literature review from this study will serve to draw conclusions in relation to the problem statement and research aims/purposes and research questions posed. Based on these; proposed guidelines are offered, limitations acknowledged and recommendations for further research made.

This qualitative study was designed to explore the perceptions of DT in both private and high school design teachers', involved in art, design or technology subjects. These informed perceptions were pursued as a means to gain insight into a relatively under-researched sector. Participants answered an open-ended questionnaire during a semi-structured interview. These texts were then coded and analysed in order to deduce certain themes. The themes were then analysed in terms of their relationship to each other.

7.2   A reflection on the research aims and questions of the study

The purpose of this research study is to gain a detailed understanding of high school students' and teachers' ability to solve complex problems, and how the insights gained are synthesised and embodied in a digital product and related design deliverables that meet the relevant needs of the user community. This teaching aid/ product may inform class teaching or teaching support. The final strategical concept of the product is dependent on the needs of the teachers that will emerge through the design research process.

The interpretations of the findings section in this chapter seeks to determine to what extent the research questions and the research aims/purposes that were posed, have been achieved. To recap, the aims and the research questions of this study are:

The aim of this study is to explore how digital technology can be designed by applying User-experience Design (UXD) to support the teaching activities of educators teaching DT, so that they may become more confident and knowledgeable practitioners.

7.2.1 The research question

How can digital technology be designed to enhance the experience of Johannesburg high school[3] educators teaching creative thinking strategies for resolving complex problems?

7.2.2 Sub-research questions

1. What is the current experience of high school educators related to teaching DT?
2. What is the preferred experience of high school educators in relationship to teaching DT?
3. What are the current best practices (conceptually and methodologically) of DT as identified in academic literature and existing educational course materials?
4. How can insights gained from questions one to three be synthesised and embodied in a digital prototype and related design deliverables that meet the relevant needs of the user community?

Previous research has revealed questions that required further investigation. The following recommendations were given for further areas of research valuable to the private and public high school education sectors:

*   Initially, it is suggested that a follow-on study be conducted to explore more structured ways to introduce DT in the classroom.
*   Secondly, a further study aimed at introducing DT into other subjects offered at primary and high school systems across South Africa.
*   Thirdly, a study aimed at seeking best practice for equipping teachers in both the public and private school sectors with the DT principles and methods.
*   Working collaboratively with communities and to be culturally sensitive and inclusive of students, teachers, administrators, parents, and other stakeholders.

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[3] Private or government schools

- Finally, a study into the feasibility of introducing DT as a formal approach into the CAPS curriculum work.

The core insight of this study is that the concept of DT seems to be a field of interest for the participants involved in the research study. During the research done on existing literature on education and the impact of DT to innovatively solve complex problems, the researcher is of the opinion that DT could be greatly beneficial if included in high school educational environments. It has also apparent very few teachers are actively involved or have any knowledge on the DT concept. Furthermore, teaching creative thinking still seemed to still take a more traditional focus of teaching. It is for this reason that the researcher found that there is an opportunity to create a solution to this "wicked" problem. The solution included further research in this field of interest and to present an educationally empowering plan that empathetically and realistically speaks to SA teachers and that considers issues of skills, knowledge, resources, diversity etc. The researcher decided that the best solution would be the introduction of a digital prototype that both teachers and students could use to gain the knowledge, skills and techniques for solving more complex problems but through the use of the DT concepts.

7.3   Limitations and recommendations for further study

The findings of this study have a number of ideas for future practice. The study found that although there might be a number of concerns initially with regards to introducing DT as a formal or informal approach in the high school education sector, that this approach to stimulate creative thinking and innovation would benefit the learner especially when already introduced at school level. Teachers who are not yet completely engaged with the DT process have shown a great deal of interest in employing it into their coursework. The group of high school teachers that are using DT on a more regular basis in the classroom have mentioned that they have experienced a vast improvement in the way learners engage with a design problem, and in the way they attempt to solve it. In other words, creative thinking and innovation is taking place when DT is applied as a part of the school educational system. The digital prototype was overall well received but there were some teachers that expressed their concern of how it could be implemented on a digital platform due to limitations in technical resources. These were discussed and the researcher explained that this digital prototype can easily be converted to paper-based books,

posters and so forth. The development of a full prototype that incorporates the complete interaction design and could indicate more conclusively, the value of the design methods, tools and practices applied in this study to meet the information needs of teachers in South Africa.

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Appendix A – Sample of the participant consent form

PARTICIPANT CONSENT FORM

RESEARCH TITLE: An analysis of DT and its role in high school education in Johannesburg, South Africa, and how it can be synthesised into a digital prototype.

1.   INTRODUCTION

You are invited to participate in a research study about Design Thinking and its role in High School Educational Design Thinking in the high school educational sector of Johannesburg, South Africa. The information in this consent form is provided to assist you in deciding whether you would like to participate in this study or not. If you decide to participate, you will be required to complete a set of questions about DT during an interviewing process with the researcher. You will be asked questions about your experiences and perceptions as an art/design or technology teacher in a high school education institution.

It is important that you fully understand what is involved if you agree to participate in this study. If you have any questions that you feel are not addressed or explained fully in this consent form, please do not hesitate to ask the researcher for more information. You should not agree to participate unless you are completely comfortable with the procedures followed. The interviews will be conducted by the student researcher.

The contact details of the researcher are as follows:

Email address: esteinhobel@iie.ac.za
Contact number: 082 4926 407
Office number: 011 676 8021

2.   THE NATURE AND PURPOSE OF THE STUDY

The purpose of the study is firstly to explore whether Design Thinking is being applied and exercised in the South African school system and secondly, if so, does it stimulate creative thinking and innovation. A qualitative, exploratory, textual analysis was undertaken within an Interpretivist paradigm, guided by the academic framework from IDEO's "Design Thinking for Educators" toolkit and Stanford University's "d.school bootcamp bootleg" teaching materials on Design Thinking. Qualitative interviews with open-ended questionnaires will be conducted with a selection of teachers from both the public and private high school educational sectors within Johannesburg, South Africa.

3.   EXPLANATION OF PROCEDURES TO BE FOLLOWED

You will be required to engage in an interview with the researcher. The researcher will be asking a set of open-ended questions regarding your perceptions and experiences of Design Thinking. Data gathered form these interviews will be used purely for this study and the names of the participants and respective participating schools will be held confidential.

4.   RISK(S) OR DISCOMFORT INVOLVED

As mentioned above, you will be required to engage in an interview with the researcher whom will be completing a set of pre-set questions about your perceptions and experiences of Design Thinking. However, the interview will be a once-off process and will require about two hours of your time. There is no risk to participants that requested to stay anonymous as responses will in their case be de-identified in the research report.

5.   POSSIBLE BENEFITS OF THE STUDY

Design Thinking focuses on creating a balance between human values, technology and what is viable from a business perspective. Design Thinking has the potential to improve collaboration and provide more effective ways to engage students. It provides us with a process for transforming difficult challenges into opportunities for design.

This process stimulates innovative thinking by creating new, relevant solutions that in turn creates a positive impact on society.

Design Thinking can be integrated into any programme as the focus is on creating innovative solutions to complex problems rather than relying on a specific methodology.

This research is beneficial to the design discipline as it will provide a rich description of a phenomenon. Participants will assist in exploring a relatively under-researched phenomenon which may lead to a greater understanding of the Design Thinking.

6.   WITHDRAWAL CLAUSE

- Your inclusion in this study is purely voluntary;
- If you do not wish to participate in this study, you have every right not to do so;
- Even if you agree to participate in this study, you may withdraw at any time without having to provide an explanation for your decision.

7.   CONFIDENTIALITY

ALL information gathered in this study will be held in strict confidence and only the researcher will have access to the original data. Results will only be retained for as long as required for the research purpose and will thereafter be depersonalised and presented in such a way that you will not be identifiable.

8.   CONSENT TO PARTICIPATE IN THIS STUDY

I have read the information presented to me in a language that I understand, and I understand the implications of participating in this study. The content and meaning of this information have been explained to me. I have been given the opportunity to ask questions and am satisfied that they have been adequately addressed. I understand that I am under no obligation to participate in this study and that I can withdraw from this study at any stage without having to provide an explanation for my withdrawal. I hereby volunteer to take part in this study.

I have received a signed copy of this informed consent agreement.

I consent to the following:	Yes	No
Participation in an in-depth interview.	☐	☐
The data that I provide during this research may be used by Erika Steinhobel in future research projects**.	☐	☐

PARTICIPANT

Full Name and Surname: _____

Signature: _____

Date: _____

WITNESS

Full Name and Surname: _____

Signature: _____

Date: _____

Appendix B – This was provided to the participant via e-mail before the interviews took place.

Using Design Thinking in Education

By Erika Steinhöbel

Design Thinking focuses on users and their needs, encourages brainstorming and prototyping, and rewards out-of-the-box thinking that takes "wild ideas" and transforms them into real-world solutions.
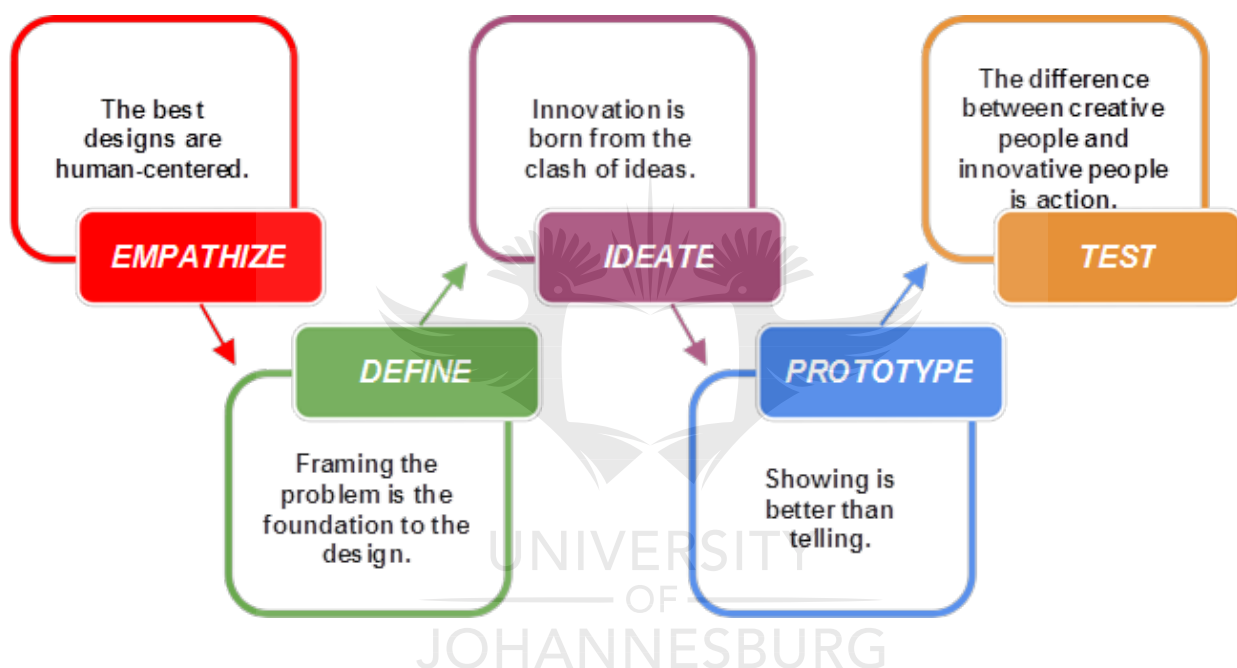
Figure 1. Design Thinking's five principles

Empathy

By centring our work on users, we create empathy with them. With people for whom we feel a strong connection, it is easy to empathise because we know them in an intimate way — we know what they like and dislike, what they love, what makes them tired, what irritates them. With that knowledge, we know better how to meet their needs. With users, we don't typically have that sort of knowledge, and this deficit makes it difficult to design truly responsive solutions to their problems.

Achieving Empathy

Typically, when we seek to understand users, we turn to tools such as surveys and focus groups. Although these methods work well to provide a superficial level of knowledge, there are limits to surveys that block the development of empathy. One key challenge is that, sometimes, what people say they do and what they actually do can be quite different. It's not that people are deliberately trying to mislead; it's just that they sometimes "mis-remember." For example, when you ask students about their study habits in a focus group, they'll often describe their intentions rather than their actual behaviours.

One way to mitigate this tendency is to ask for specific examples about extreme scenarios. For example, if you want to understand students' experience with school, you might ask: "What was the absolute best experience you had in a class?" or "What was the worst experience you ever had studying for a test or working on a particular assignment?" Such specific, extreme examples can provide insight into how people truly respond to the conditions of their environment and lessens the impact of the social desirability bias (which more typically contaminates responses to general questions like, "What are your study habits?")

Another challenge with these tools is that we don't always know which questions are most relevant until we observe people *in situ*. For example, if we observe students studying during their subway commute, we'll instantly realise the need for questions specific to the environment's challenges — such as how they contend with the noise and crowding, and how they take notes while standing in a moving train — that might not occur to us if we're formulating the questions while sitting at a desk.

Observing people in context not only allows us to ask better questions, it also provides data that we can begin to triangulate on some of the thoughts and feelings that really motivate users. These methods allow us to know people at a level that enables responsive design.

Framing the Problem

The next step in Design Thinking is to frame the problem. This step is absolutely critical, because where you start a design challenge has much to do with where you end up.

Three Questions

We know that a great design challenge starts with a user focus. It should also be broad enough to give us the opportunity to innovate yet narrow enough that we'll know where to start. To help frame the challenge, we suggest that you ask three simple yet powerful questions:

- Who is your user and what benefit are you trying to provide? This helps put the user at the centre of your efforts.
- Why do you want to do this? This helps broaden the frame if it's too narrow.
- What's preventing you from doing it? This can help you narrow the frame to a reasonable starting point.

Although they might seem basic, projects often start with misguided assumptions that fall away once these three questions are seriously considered.

Brainstorming

The next step is ideation, or *brainstorming*. For those who have experienced bad brainstorms, the term can often elicit eye-rolls and deep sighs. However, with great preparation and discipline, brainstorms are an amazing source of small sparks that can combine and ignite into powerful solutions.

In this phase of the Design Thinking process, quantity is far more important that quality. Indeed, "bad" ideas often give rise to good ideas when they juxtaposed with other ideas and new options arise from grafting and modifying them.

Key Challenges and Solutions

Brainstorming sounds simple, but it's not easy. Our natural human tendency is to present small, safe ideas and spend a lot of time debating them down to something that is a half-step more exciting than the status quo. We end up with things that we've seen work before that don't take us much past where we are. But as Nobel Laureate

Linus Pauling put it, "The best way to have a good idea is to have lots of ideas." You must move away from the safe ideas; its fine to catalogue great ideas you're excited about, but don't fixate on them at the expense of ideas waiting to emerge. To encourage the development of ideas, there are some simple rules IDEO uses that you can use around brainstorming.

The Rules of Brainstorming

To create as much fodder as possible for the best possible solutions, IDEO has several rules for brainstorming:

- Defer judgment (on your own ideas and those of other people)
- Encourage wild ideas
- Build on the ideas of others
- Stay focused on the topic
- Have one conversation at a time
- Be visual (i.e. find a way to visually express your ideas)
- Go for quantity

The facilitator can play a big role in making sure everyone has the opportunity to have the floor and share their ideas; this, in turn, gives everyone else a chance to build on those ideas.

Although having "rules" here might seem counterintuitive, it helps formalize brainstorming and rescue it from a common view: that brainstorming is somehow a bit silly or ridiculous (even though we know it can generate good ideas and expand our thinking). Calling the session a "brainstorm" is also important; it communicates that you're wrestling with a challenge and it's time to assemble a diverse group of people to collaborate on possible solutions.

Prototyping

Next up is prototyping. Typically, in the ideation/brainstorming phase at many organisations, ideas are written on Post-It notes in a few words. In the prototyping phase, we expand on these ideas, taking them beyond the safe four corners of that small, yellow square. In the prototyping phase you will be taking a solution and making it multidimensional by creating another way to access it and show it to a potential

user. That could be a storyboard (a series of scenes that take the potential user through the solution step-by-step, or a physical mock-up of a product or program to address a user need.

Storyboards are a relatively simple but powerful tool for moving an idea into a prototype; they are used frequently by the creative people at Pixar, the film studio that produced hits including "Toy Story," "A Bug's Life," and "Finding Nemo."

Conveying Ideas

The value of storyboards is that they move your idea beyond the Post-It note by

- creating a shared understanding of the story;
- exposing story flaws and things that just don't make sense; and
- inviting diverse teams to explore key aspects of the story.

Storyboards are just one way to achieve these benefits. You can also use simple sketches or handmade constructions. Other options include role playing and acting out user interactions, perhaps using video. All of these prototyping ideas help you take an idea from a few words on a Post-It note to something more meaningful that can help you and others think more deeply about an idea and how it might work.

Testing

In testing, you extend prototyping efforts into a live environment. Also, when you test, you're creating small invitations for real users to change their behaviour and then learning from their responses. In so doing, you can convert some of your assumptions into knowledge.

No Failure

Discussing his own early efforts, Thomas Edison noted that, "I have not failed. I've just found 10,000 ways that won't work." That is, there's really no such thing as failure. In DT, testing doesn't use the scientific method; we're not testing to see if something is false or potentially true. Rather, a DT experiment is an attempt to grow your idea and figure out what you must do to ensure the idea's ultimate success.

Applying Design Principles Now

So, what can you do to start using Design Thinking right away?

- Introduce the user perspective into the conversation whenever you can. Think about the person or people buying your product or service and what they would want.

- Use the brainstorming rules. And brainstorm. Integrate the practice of bringing forward multiple ideas as much as you can.

- Seek inspiration through analogues. Look outside your department and outside education for successful innovations and think about how they might apply in your context.

What can I use Design Thinking for?

You can use DT to approach any challenge.

However, there are a consistent set of challenges that teachers and schools seem to face, and they center around the design and development of learning experiences (curriculum), learning environments (spaces), school programs and experiences (processes and tools), and system strategies, goals and policies (systems).

Sometimes these challenges are tackled by a district team— especially for the more complex challenges that involve multiple stakeholders; sometimes challenges are addressed at the school level, with a core team of representative educators driving the process; and sometimes these challenges are addressed by educators or small teams of educators themselves... which is where grassroots change begins to happen.

CURRICULUM

Every day you design ways to interact with your students around content. You can follow a design process to be more intentional about connecting this content to the interests and desires of today's learners by finding out more about the things that they do outside of school and connecting that to the content you are bringing to them.

How might I inspire students to engage in concerns of the environment?

How might I engage my students in compelling ways around learning world history?

How might I develop students to be active seekers of knowledge in subjects that they have little knowledge of?

How might I help children from disadvantaged backgrounds increase their vocabulary?

SPACES

The physical environment of the classroom sends a big signal about how you want your students to behave. Right now we tend to think of our classroom spaces as standard... kids in rows, sitting in desks. By rethinking the design of our spaces, we can send new messages to our students about how they should feel and interact in the classroom.

How might I use my classroom space in different ways to help set my students at ease?

How might I create a comfortable space that meets the many needs my students have throughout the day?

How might we reimagine our school's library for the needs and interests of today's learner?

How might we create an exciting and effective space for teachers to collaborate?

How might we design our high school campus to best engage and support today's learner?

PROCESSES AND TOOLS

Your school has already designed a set of processes or tools that may or may not be setting up your school for success. This is typically outside of the classroom and specific interactions around learning, and more around how the system operates. Every process is already designed, and thus can be redesigned! Sometimes creating tools can be essential to supporting newly designed processes.

How might I engage parents as an integrated part of their students' learning experience?

How might we recruit the best teachers to our school?

How might we re-envision arrival and departure procedures at our school?

How might we design ways to keep our-selves balanced and well?

How might we redesign our school schedule to be centered around the needs of today's families and teachers?

SYSTEMS

Not everyone can always make decisions for the system that they exist within, but everyone can contribute to the design of that system. Designing systems is about balancing the complexity of many different stakeholder needs with the needs of the operation. When designing systems, we're often setting high-level strategy such as stating visions, priorities, policies, and key communications around these ideas.

How might we reinvision curriculum for an entire district while providing for individual schools' differences?

How might we track the development of students' character traits over time to help shape our school philosophy more intentionally?

How might we connect more with our neighbourhood community?

How might we use our school as an R&D hub for schools nationwide?

Sources:

http://er.educause.edu/articles/2015/1/using-design-thinking-in-higher-education

http://dschool.stanford.edu/wp-content/uploads/2011/03/BootcampBootleg2010v2SLIM.pdfm/DTtoolkit_v1_062711.pdf

http://www.designthinkingforediucatora.cpm/DToolkit_v1_062711.pdf

Appendix C − Signed Letters of Informed Consent

Participant A
PARTICIPANT CONSENT FORM

RESEARCH TITLE: An analysis of Design Thinking and its role in high school education in Johannesburg, South Africa, and how it can be synthesised into a digital prototype.

1.   INTRODUCTION

You are invited to participate in a research study about Design Thinking and its Role in the High School Educational Sector. The aim of the analysis is to explore perceptions of high school teachers on Design Thinking in the high school educational sector of Johannesburg, South Africa. The information in this consent form is provided to assist you in deciding whether you would like to participate in this study or not. If you decide to participate, you will be required to complete a set of questions about Design Thinking during an interviewing process with the researcher. You will be asked questions about your experiences and perceptions as an art / design teacher in a high school education institution.

It is important that you fully understand what is involved if you agree to participate in this study. If you have any questions that you feel are not addressed or explained fully in this consent form, please do not hesitate to ask the researcher for more information. You should not agree to participate unless you are completely comfortable with the procedures followed. The interviews will be conducted by the student researcher.

The contact details of the researcher are as follows:

Email address: esteinhobel@iie.ac.za
Contact number: 082 4926 407
Office number: 011 676 8021

2.   THE NATURE AND PURPOSE OF THE STUDY

The purpose of the study is firstly to explore whether Design Thinking is being applied and exercised in the South African school system and secondly, if so, does it stimulate creative thinking and innovation. A qualitative, exploratory, textual analysis was undertaken within an Interpretivist paradigm, guided by the academic framework from IDEO's "Design Thinking for Educators" toolkit and Stanford University's "d.school bootcamp bootleg" teaching materials on Design Thinking. Qualitative interviews with open-ended questionnaires will be conducted with a selection of teachers from both the public and private high school educational sectors within Johannesburg, South Africa.

3.   EXPLANATION OF PROCEDURES TO BE FOLLOWED

You will be required to engage in an interview with the researcher. The researcher will be asking a set of open-ended questions regarding your perceptions and experiences of Design Thinking. Data gathered form these interviews will be used purely for this study and the names of the participants and respective participating schools will be held confidential.

4.   RISK(S) OR DISCOMFORT INVOLVED

As mentioned above, you will be required to engage in an interview with the researcher whom will be completing a set of pre-set questions about your perceptions and experiences of Design Thinking. However, the interview will be a once-off process and will require about two hours of your time. There is no risk to participants that requested to stay anonymous as responses will in their case be de-identified in the research report.

5.   POSSIBLE BENEFITS OF THE STUDY

Design Thinking focuses on creating a balance between human values, technology and what is viable from a business perspective. Design Thinking has the potential to improve collaboration and provide more effective ways to engage students. It provides us with a process for transforming difficult challenges into opportunities for design.

This process stimulates innovative thinking by creating new, relevant solutions that in turn creates a positive impact on society.

Design Thinking can be integrated into any programme as the focus is on creating innovative solutions to complex problems rather than relying on a specific methodology.

This research is beneficial to the design discipline as it will provide a rich description of a phenomenon. Participants will assist in exploring a relatively under-researched phenomenon which may lead to a greater understanding of the Design Thinking.

6.   WITHDRAWAL CLAUSE

- Your inclusion in this study is purely voluntary;
- If you do not wish to participate in this study, you have every right not to do so;
- Even if you agree to participate in this study, you may withdraw at any time without having to provide an explanation for your decision.

7.   CONFIDENTIALITY

ALL information gathered in this study will be held in strict confidence and only the researcher will have access to the original data. Results will only be retained for as long as required for the research purpose and will thereafter be depersonalised and presented in such a way that you will not be identifiable.

8.   CONSENT TO PARTICIPATE IN THIS STUDY

I have read the information presented to me in a language that I understand, and I understand the implications of participating in this study. The content and meaning of this information have been explained to me. I have been given the opportunity to ask questions and am satisfied that they have been adequately addressed. I understand that I am under no obligation to participate in this study and that I can withdraw from this study at any stage without having to provide an explanation for my withdrawal. I hereby volunteer to take part in this study.

I have received a signed copy of this informed consent agreement.

I consent to the following:	Yes	No
Participation in an in-depth interview.	✓	☐
The data that I provide during this research may be used by Erika Steinhobel in future research projects.	✓	☐

PARTICIPANT

Full Name and Surname: Lynn Meyer

Signature: LMeyer

Date: 10 | 6 | 2019

WITNESS

Full Name and Surname: Mary Hartley

Signature: M.Hartley

Date: 10 / 6 / 2019

I have received a signed copy of this informed consent agreement.

I consent to the following:	Yes	No
Participation in an in-depth interview.	✓	☐
The data that I provide during this research may be used by Erika Steinhobel in future research projects.	✓	☐

PARTICIPANT

Full Name and Surname: DERREK HIBBERT

Signature: DHibbert

Date: 24 JULY 2019

WITNESS

Full Name and Surname: Sharon Brown

Signature: SBrown

Date: 24 July 2019

I have received a signed copy of this informed consent agreement.

I consent to the following:	Yes	No
Participation in an in-depth interview.	☑	☐
The data that I provide during this research may be used by Erika Steinhobel in future research projects.	☑	☐

PARTICIPANT

Full Name and Surname: Charles Mashego

Signature: ChaleMashego

Date: 19 June 2019

WITNESS

Full Name and Surname: John Thompson

Signature: _____

Date: 19 June 2019

I have received a signed copy of this informed consent agreement.

I consent to the following:	Yes	No
Participation in an in-depth interview.	☑	☐
The data that I provide during this research may be used by Erika Steinhobel in future research projects.	☑	☐

PARTICIPANT

Full Name and Surname: Michelle Kraukamp

Signature: MKraukamp

Date: 12 July 2109

WITNESS

Full Name and Surname: Delwin Munsamy.

Signature: Dwrms

Date: 12 July 2014

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I have received a signed copy of this informed consent agreement.

I consent to the following:	Yes	No
Participation in an in-depth interview.	☑	☐
The data that I provide during this research may be used by Erika Steinhobel in future research projects.	☑	☐

PARTICIPANT

Full Name and Surname: Anonymous

Signature:

Date: 11 July 2019

WITNESS

Full Name and Surname:

Signature:

Date:

I have received a signed copy of this informed consent agreement.

I consent to the following:	Yes	No
Participation in an in-depth interview.	☑	☐
The data that I provide during this research may be used by Erika Steinhobel in future research projects.	☑	☐

PARTICIPANT

Full Name and Surname: Anonymous

Signature:

Date: 11 July 2019
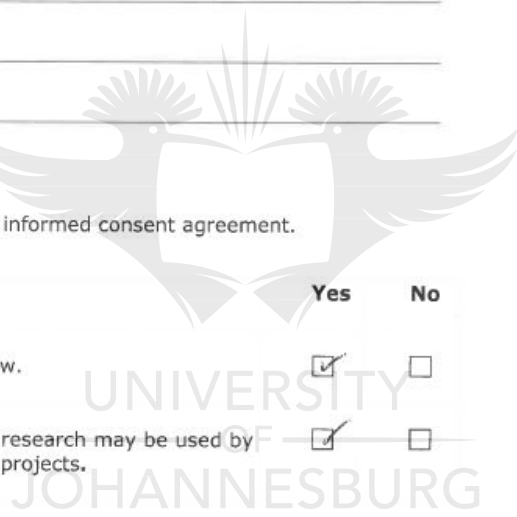
WITNESS

Full Name and Surname:

Signature:

Date:

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Appendix D - Sample of the type of interview questions.

Interview Guide

Questions:

<u>**Section 1**</u>

1.   What is your experience of teaching art, design or technology?

2.   What do you enjoy about teaching art, design or technology?

3.   What do you find difficult about art, design or technology?

4.   If you could improve one thing about your current approach to teaching art, design or technology, what would it be?

5.   How do you prepare learning content?

6.   What things/people help you to conceptualise your teaching?

7.   What are the current support structures [people, equipment, resources] that support you as a teacher?

<u>**Section 2**</u>

1.   After reading the supporting materials or from your own experiences, please describe your understanding of Design Thinking?

2.   Do you apply or would like to apply Design Thinking or aspects of Design Thinking in your teaching?

    a.   If yes:

- Please describe how you have applied it?

- How have you applied Design Thinking into the subject matter?

- Enquire whether they found it useful?

- Enquire if they found anything difficult

    b.   If no:

- Please describe why not?

- List individual issues and follow up.

- Knowing more about Design Thinking and its principles, would you like to introduce it into your classes?

3.   Do you make use of specific technologies to further enhance the learning experience? (please list the specifics)
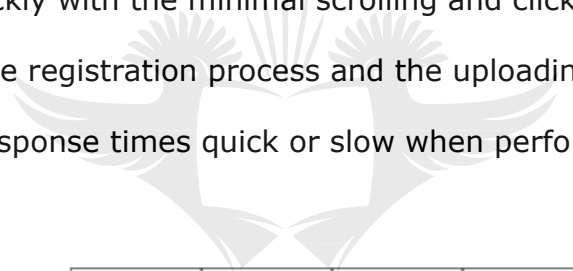
Please describe how/ contexts of use?

4.   What motivates you to teach?

Section 3 – Digital prototype

Please see table below and indicate your answers as per each question.

1.   Do you find the design/content compelling and unique?

2.   Do you find any value in the designed prototype?

3.   How do you find the overall design of the prototype?

4.   Do you find the design engaging, with readable fonts and colours?

5.   How easy is it to perform common tasks?

6.   How easy it is to navigate through the digital prototype Can you complete common tasks quickly with the minimal scrolling and clicking?

7.   How do you find the registration process and the uploading of documents?

8.   Did you find the response times quick or slow when performing certain tasks?

	Poor (0%)	Fair (20%)	Good (40%)	Very good (60%)	Excellent (80-100%)
Unique content					
Value proposition					
Overall design					
Colours					
Fonts					
Performing common tasks					
Navigation					
User registration					
Uploading of items					
Response times					

9.   Do you think the prototype could be an effective tool you could potentially use to introduce Design Thinking more effectively?

10. How do you think it will change the mode of teaching in the classroom?

11. In your opinion, do you think students would prefer to engage and interact on this platform?

Participant A

Questions:

<u>Section 1</u>

1. What is your experience of teaching art, design or technology?

    "I have been teaching for 15 years but are not aware of the Design Thinking process or concept."

2. What do you enjoy about art, design or technology?

    "Being a creative person myself, I really enjoy teaching art and design and to share my experiences with the students."

3. What do you find difficult about art, design or technology?

    "Well, to start off with, some students choose this subject as they think it is easier than other subjects, but then they lack the passion to make a success of it. Also, art material can become expensive and not everyone can afford to purchase all the necessary materials which puts them at a disadvantage. Also, being at a public school, we do not always have the required resources to do our jobs properly."

4. If you could improve one thing about your current approach to teaching art, design or technology, what would it be?

    "Have better processes in place to give the learners a rich and meaningful learning experience."

5. How do you prepare learning content?

    "In 15 years, things have changed a lot, especially with technology.

6. What things/people help you to conceptualise your teaching?

    "We really work in isolation here as there are so many students and we don't really have the time to spend a lot of time talking to each other about our different subjects."

7. What are the current support structures [people, equipment, resources] that support you as a teacher?

As mentioned above, apart from the resources provided from the Department of Education, which is really not a lot, we have to come up with our own ideas to make classes more interesting."

Section 2

1. After reading the supporting materials or from your own experiences, please describe your understanding of Design Thinking?

"I must be honest; I do not really have much knowledge on this topic. However, after reading the material that was sent to me, I realise that I do use aspects of the Design Thinking process such as ideation and testing."

2. Do you apply or would like to apply Design Thinking or aspects of Design Thinking in your teaching?

"Definitely, I found the information very interesting and can see how valuable it could be for the students."

3. Do you make use of specific technologies to further enhance the learning experience? (please list the specifics)

"Probably the Internet mostly."

4. What motivates you to teach?

"I have been teaching for so long, I think I am just used to it. I cannot see myself doing anything else."

Section 3 – Digital prototype

Please see table below and indicate your answers by marking on a scale from 0% to 100% for each question

1. Do you find the design/content compelling and unique?

2. Do you find any value in the designed prototype?

3. How do you find the overall design of the prototype?

4. Do you find the design engaging, with readable fonts and colours?

5. How easy is it to perform common tasks?

6. How easy it is to navigate through the digital prototype Can you complete common tasks quickly with the minimal scrolling and clicking?

7. How do you find the registration process and the uploading of documents?

8. Did you find the response times quick or slow when performing certain tasks?

9. Do you think the prototype could be an effective tool you could potentially use to introduce Design Thinking more effectively?

   "Yes. I still need to get my head around it all, but I am excited for the possibility to use it one day."

10. How do you think it will change the mode of teaching in the classroom?

    "It will make a big difference, especially in the field I am teaching in."

11. In your opinion, do you think students would prefer to engage and interact on this platform?

"Oh yes, today's learners are born with technology. So would definitely prefer to study this way."

Participant

Full name and Surname: _Lynn Meyer_

Signature: _Lmey_

Participant B

Questions:

<u>**Section 1**</u>

1. What is your experience of teaching art, design or technology?

    "Teaching 5 years in total, I really enjoy the learners and the school is very supportive when it comes to additional resources etc."

2. What do you enjoy about teaching art, design or technology?

    "I enjoy the creative space. I did art at school as well, so I wanted to become an art teacher."

3. What do you find difficult about teaching art, design or technology?

    "To get learners to really engage with a project. The tend to take shortcuts and not complete the projects to the required specifications."

4. If you could improve one thing about your current approach to teaching art, design or technology, what would it be?

    "Try and get learners to be more motivated and explore their full potential."

5. How do you prepare learning content?

    "I create additional assignments for them to bring in new ways of thinking, however, only some student really engages in doing these assignments properly."

6. What things/people help you to conceptualise your teaching?

    "I had a very good art teacher at high school and learned a lot from her."

7. What are the current support structures [people, equipment, resources] that support you as a teacher?

    "The school I teach at has good resources and equipment. I would like to engage more with other teachers so that we can share some ideas."

<u>**Section 2**</u>

1. After reading the supporting materials or from your own experiences, please describe your understanding of Design Thinking?

    "I have had some exposure with it in the past but have not actively engaged with it."

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2. Do you apply or would like to apply Design Thinking or aspects of Design Thinking in your teaching?

    "I would like to apply it in the classroom, I can definitely see the benefits."

3. Do you make use of specific technologies to further enhance the learning experience? (please list the specifics)

    "Yes, we do. We have computers and some learners also have their own equipment such as iPad's or laptops etc."

4. What motivates you to teach?

    "As I mentioned before, I love the creative space."

Section 3 – Digital prototype

Please see table below and indicate your answers by marking on a scale from 0% to 100% for each question.

1. Do you find the design/content compelling and unique?

2. Do you find any value in the designed prototype?

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4. Do you find the design engaging, with readable fonts and colours?

5. How easy is it to perform common tasks?

6. How easy it is to navigate through the digital prototype Can you complete common tasks quickly with the minimal scrolling and clicking?

7. How do you find the registration process and the uploading of documents?

8. Did you find the response times quick or slow when performing certain tasks?

9. Do you think the prototype could be an effective tool you could potentially use to introduce Design Thinking more effectively?

"Definitely think so. Even though I have not used Design Thinking much, I think we can definitely benefit having it as a tool to use."

10. How do you think it will change the mode of teaching in the classroom?

"I would hope that it motivates learners to become more engaged in projects."

11. In your opinion, do you think students would prefer to engage and interact on this platform?

"For sure, the new type of learner wants to use technology, they get tired of books."

Participant

Full name and Surname: _michelle Kroukamp_

Signature: _mkra_

Participant C

Questions:

<u>**Section 1**</u>

1.   What is your experience of teaching art, design or technology?

"Teaching 4 years in total: I taught design process and thinking skills to design students."

2.   What do you enjoy about teaching art, design or technology?

"It is an area full of possibilities."

3.   What do you find difficult about teaching art, design or technology?

"To teach students who do not share the same enthusiasm… most art and design students are passionate about design! But it is a struggle without passion, despite talent."

4.   If you could improve one thing about your current approach to teaching art, design or technology, what would it be?

"Spend more time looking at international course material."

5.   How do you prepare learning content?

"I structure my teaching according to what the students should achieve, and the principles and theories they need to know in order to achieve the practical outcomes. Then I used to show examples, after introducing the principles. (not before)."

6.   What things/people help you to conceptualise your teaching?

"The internet is perhaps the greatest tool in the Visual arts and Design class as it inspires students with its immediacy vs. books that students tend not to engage with. This allows the free flowing format of brainstorming to continue without interruptions."

7.   What are the current support structures [people, equipment, resources] that support you as a teacher?

"Online environment has enormous potential."

Section 2

1. After reading the supporting materials or from your own experiences, please describe your understanding of Design Thinking?

"Design thinking would be approaching the creative process in an innovative and creative way, identifying potential issues that have or may arise, and systematically attempt to create possible alternate solutions to these problems. Design Thinking is at the core of how a designer act, think, frame and solve problems. It is therefore integral to the development of a designer. It is both process and thinking."

2. Do you apply or would like to apply Design Thinking or aspects of Design Thinking in your teaching?

"Design thinking can apply to coursework due to the Socratic methodology implied by the design process, the same method of asking questions where by structuring your questions around the requirements of the brief may lead you to discover multiple answers that can culminate as a moment of realisation thus informing creative decision making."

3. Do you make use of specific technologies to further enhance the learning experience? (please list the specifics)

"For non-designers – I use soft-simulation and collaborative groups in a creative environment to experience the Design Thinking approach. I would for example also bring wax crayons, wool, boxes… toys… clay… anything to break the box. To think with their hands….they often cannot visualise – so these "tools" can help them show what they mean."

"Designers –I spend more time on visualising solutions – since designers develop this as core skill. But not really technology driven… more scamping."

4. What motivates you to teach?

"I suppose it is in your blood – and you teach what you want to learn more about."
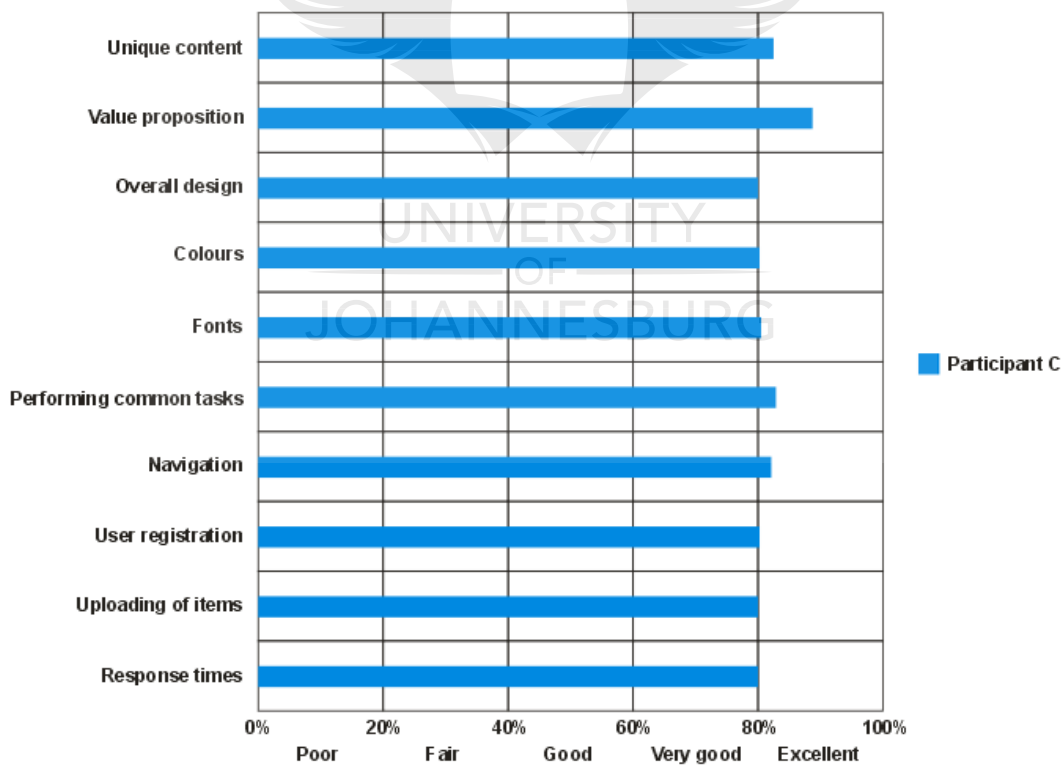
5. What motivates you to teach?

"I suppose it is in your blood – and you teach what you want to learn more about."

Section 3 – Digital prototype

Please see table below and indicate your answers by marking on a scale from 0% to 100% for each question.

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5. How easy is it to perform common tasks?

6. How easy it is to navigate through the digital prototype Can you complete common tasks quickly with the minimal scrolling and clicking?

7. How do you find the registration process and the uploading of documents?

8. Did you find the response times quick or slow when performing certain tasks?

9. Do you think the prototype could be an effective tool you could potentially use to introduce Design Thinking more effectively?

    "Definitely. There are online sites where you can get information on Design Thinking but having everything in one place will be so much better. And especially

as we can update the site all the time with new information and guidelines or examples."

10. How do you think it will change the mode of teaching in the classroom?

    "I feel that a more structured approach in the CAPS curriculum will most certainly benefit both schools that have large numbers (where individual attention cannot be paid) as well as the student who remains introverted and would not ask the educator for assistance, this process is simple enough for educators to facilitate the discussion of the design process however perhaps it should be noted that some students arrive on ideas in a different way and therefore will need assistance adjusting to such a format."

11. In your opinion, do you think students would prefer to engage and interact on this platform?

    "These new age students are so technologically minded that I think it would be the perfect platform for them to use."

Participant

Full name and Surname: _DERREK HIBBERT_

Signature: _DHibber_

Participant D

Questions:

Section 1

1.   What is your experience of teaching art, design or technology?

"I teach mostly technology subjects. It is ok, I just struggle with the classrooms that does not always have what we need."

2.   What do you enjoy about teaching art, design or technology?

"I studied technology, so I enjoy teaching it."

3.   What do you find difficult about teaching art, design or technology?

"Like I said, the lack of resources and students sometimes struggle as they do not understand the subject very well."

4.   If you could improve one thing about your current approach to teaching art, design or technology, what would it be?

"Working computers and more time in the classroom with the learners."

5.   How do you prepare learning content?

"I receive most of the material from the school."

6.   What things/people help you to conceptualise your teaching?

"It is difficult in this subject because there are not a lot of teachers that teach this subject."

7.   What are the current support structures [people, equipment, resources] that support you as a teacher?

"Only the things the school gives me."

Section 2

1.   After reading the supporting materials or from your own experiences, please describe your understanding of Design Thinking?

"I am not sure what it is really about. I would like more information on it."

2.   Do you apply or would like to apply Design Thinking or aspects of Design Thinking in your teaching?

"No, I don't."

3.   Do you make use of specific technologies to further enhance the learning experience? (please list the specifics)
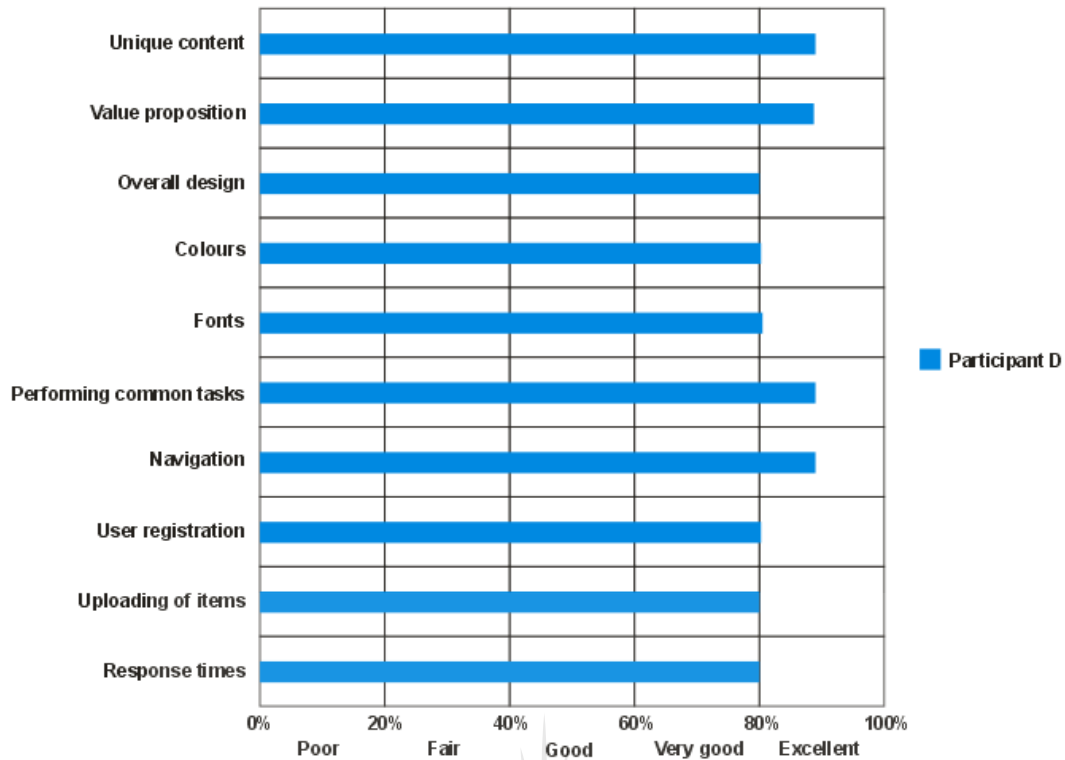
"Just the computers we have in class."

4.   What motivates you to teach?

"I must be honest; my mother was a teacher and she wanted me to become one as well."

Section 3 – Digital prototype

Please see table below and indicate your answers by marking on a scale from 0% to 100% for each question

1.   Do you find the design/content compelling and unique?

2.   Do you find any value in the designed prototype?

3.   How do you find the overall design of the prototype?

4.   Do you find the design engaging, with readable fonts and colours?

5.   How easy is it to perform common tasks?

6.   How easy it is to navigate through the digital prototype Can you complete common tasks quickly with the minimal scrolling and clicking?

7.   How do you find the registration process and the uploading of documents?

8.   Did you find the response times quick or slow when performing certain tasks?

9. Do you think the prototype could be an effective tool you could potentially use to introduce Design Thinking more effectively?

   "As I said, I do not really understand it well enough. I do like the technology used to explain it."

10. How do you think it will change the mode of teaching in the classroom?

    "These learners today want to work on computers so I think it will help."

11. In your opinion, do you think students would prefer to engage and interact on this platform?

    "Yes, I think so."

Participant

Full name and Surname: _Charles Mashego_

Signature: _Chymoshy_

Participant E

Questions:

<u>Section 1</u>

1. What is your experience of teaching art, design or technology?

    "I have been teaching for a total of 8 years, some included design and technology."

2. What do you enjoy about teaching art, design or technology?

    "It is very satisfying to see learners create new things and the skills that they display. I have always enjoyed the creative environment, so I am very pleased that I got the opportunity to teach it"

3. What do you find difficult about teaching art, design or technology?

    "I would not really say I find it difficult; it is more challenging as you want to see that learners enjoy the opportunity to think out of the box."

4. If you could improve one thing about your current approach to teaching art, design or technology, what would it be?

    "I would like to have more time with my learners, but I know they have other subjects they also need to focus on."

5. How do you prepare learning content?

    "I am very fortunate to have support from the school and Head of Department. This makes it easier when we need to get additional resources or organise outings for the learners."

6. What things/people help you to conceptualise your teaching?

    "I am part of a teachers' group on Facebook and on occasions we share ideas and examples of good learning practice. I would however like to see more of such interactions."

7. What are the current support structures [people, equipment, resources] that support you as a teacher?

    "We have good support structures at the school. Learners are provided with the necessary equipment and resources that they need to complete projects."

Section 2

1. After reading the supporting materials or from your own experiences, please describe your understanding of Design Thinking?

    "There are discussions on the Facebook group related to Design Thinking, but it seems to be still a rather new concept overall."

2. Do you apply or would like to apply Design Thinking or aspects of Design Thinking in your teaching?

    "Absolutely, there are great interest shown by various teachers in this field of study."

3. Do you make use of specific technologies to further enhance the learning experience? (please list the specifics)

    "The school has computers and learners have tablets to view, download, research, etc. information and resources."
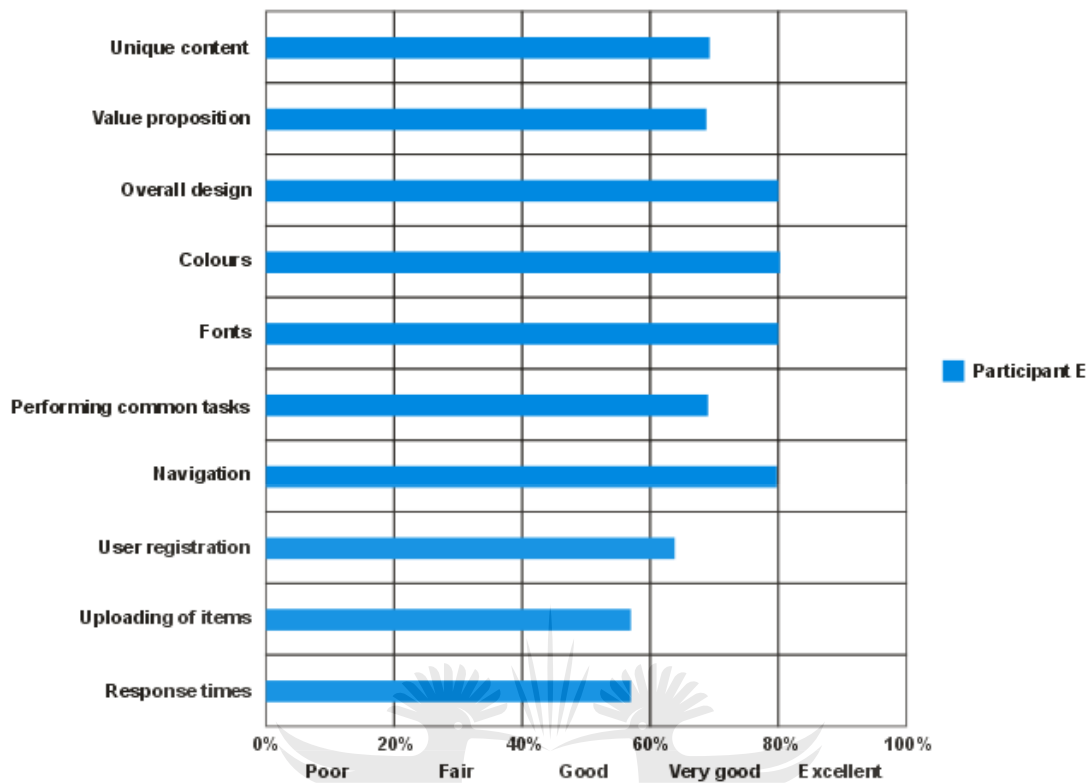
4. What motivates you to teach?

    "I love teaching, always have and always will. I want my learners to excel in the work. It gives me great pleasure when I see that they are also enjoying the subject."

Section 3 – Digital prototype

Please see table below and indicate your answers by marking on a scale from 0% to 100% for each question.

1. Do you find the design/content compelling and unique?

2. Do you find any value in the designed prototype?

3. How do you find the overall design of the prototype?

4. Do you find the design engaging, with readable fonts and colours?

5. How easy is it to perform common tasks?

6. How easy it is to navigate through the digital prototype Can you complete common tasks quickly with the minimal scrolling and clicking?

7. How do you find the registration process and the uploading of documents?

8. Did you find the response times quick or slow when performing certain tasks?

9. Do you think the prototype could be an effective tool you could potentially use to introduce Design Thinking more effectively?

    "I think so, I am very interested to see how this idea evolves and I would be interesting to implement in the classroom."

10. How do you think it will change the mode of teaching in the classroom?

    "Well, learners have the technological tool to access the material and I would love to teach in the manner."

11. In your opinion, do you think students would prefer to engage and interact on this platform?

    "I truly think so. As I mentioned already, they have access to the necessary tools."

Participant

Full name and Surname: __Anonymous_____

Participant F

Questions:

<u>**Section 1**</u>

1.   What is your experience of teaching art, design or technology?

   "It has its challenges. The school does not always have everything that we need to successfully teach these subjects."

2.   What do you enjoy about teaching art, design or technology?

   "I am not really that familiar with these subjects as I only started last year teaching design and technology. Doe to the lack of available staff I was asked to teach these classes because I studied art years ago. So I am still trying to find my feet."

3.   What do you find difficult about teaching art, design or technology?

   "For the same reason as stated above."

4.   If you could improve one thing about your current approach to teaching art, design or technology, what would it be?

   "Get the necessary support. I feel isolated as these are not subjects that any of my colleagues have taught before so I do not really have anywhere to go to get support."

5.   How do you prepare learning content?

   "I basically rely on the subject material that the school and education department supply me with."

6.   What things/people help you to conceptualise your teaching?

   "This is not an easy question to answer as I do not have the right background to teach these subjects at the moment."

7.   What are the current support structures [people, equipment, resources] that support you as a teacher?

   "Very little."

Section 2

1. After reading the supporting materials or from your own experiences, please describe your understanding of Design Thinking?

    "Not much. I find the topic very interesting and would really like to get to know more about it."

2. Do you apply or would like to apply Design Thinking or aspects of Design Thinking in your teaching?

    "No but would like to introduce it."

3. Do you make use of specific technologies to further enhance the learning experience? (please list the specifics)

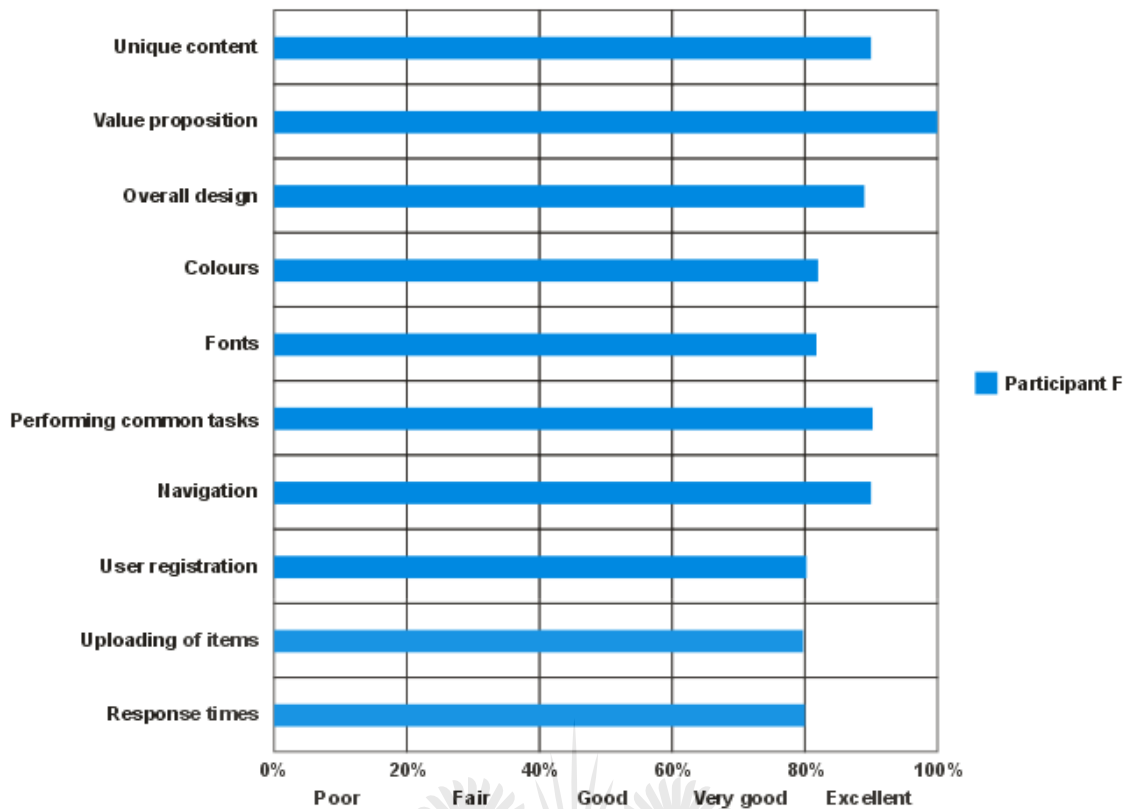   *"Not really. We just use the internet when we can."*

4. What motivates you to teach?

    "Not much at the moment as I have already explained, I seriously lack support."

Section 3 – Digital prototype

Please see table below and indicate your answers by marking on a scale from 0% to 100% for each question.

1. Do you find the design/content compelling and unique?

2. Do you find any value in the designed prototype?

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7. How do you find the registration process and the uploading of documents?

8. Did you find the response times quick or slow when performing certain tasks?

9. Do you think the prototype could be an effective tool you could potentially use to introduce Design Thinking more effectively?

    "I love it and are interested in learning more."

10. How do you think it will change the mode of teaching in the classroom?

    "I think it will greatly benefit me as well as the learners."

11. In your opinion, do you think students would prefer to engage and interact on this platform?

    "Yes, if they had what they needed to access it."

Participant

Full name and Surname: __Anonymous_____