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Constructionism, Creativity and Virtual Worlds

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Abstract

Constructionism places an emphasis on the process of creating personally meaningful artefacts in order to explore, test and extend understanding. To achieve this, learners engage in a creative process in which they develop skills, generate and evaluate ideas and share their knowledge and understanding through the artefacts that they create. This paper explores this process through a distributed constructionist learning experience in a non-goal orientated virtual world with 24 learners. The stages of the creative process identified by Shniederman are used as a theoretical lens to examine codes and categories generated through constant comparative analysis of data, along with the original interviews, artefacts and learners' reflections. The findings identify ways in which the features of the technology, the built environment and design of the learning experience influenced the creative process.

Keywords virtual worlds, constructionism, creativity, Second Life

1. Introduction

"A creative act is an instance of learning" [1] and throughout constructionist learning experiences there is evidence of learners engaging in the construction of creative artefacts to explore, test and extend their understanding. Creativity, programming and constructionism have been intertwined since the early days of Logo. With Scratch we have seen a continuation of this tradition, an environment purposefully designed to support creativity by providing a 'wide-wall' environment for learners to explore their own interests and create personally meaningful artefacts [2].

Virtual worlds that provide learners with programming and construction tools, in addition to avatars, communication tools and a persistent 3D environment, provide an interesting environment for learners to engage in distributed constructionist learning activities. However the tools that are available often present the learner with a high-floor barrier to initial engagement. Building on earlier work by the author to address these barriers, this paper begins to explore how learners engage in the creative process during a distributed constructionist learning activity within a non-goal orientated virtual world. This paper focuses on aspects of the learning environment designed within the virtual world as well as the design of the learning experience, drawing out features which support the creative process.

2. Background

2.1 Virtual Worlds

Virtual worlds, also known as multi-user virtual environments (MUVEs), provide multiple users with a persistent, simulated three-dimensional environment across a network of computers. Represented as avatars, users can interact with objects and other people in the environment. While some virtual worlds have explicit goals, such as Quest Atlantis [3] which

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are designed for educational purposes, others are non-goal orientated. Non-goal orientated virtual worlds, such as Second Life and Active Worlds lack a pre-designed narrative or inherent set of goals for the user to achieve, therefore encouraging creativity in their use. These virtual worlds often provide users with tools to construct and programme objects and spaces, however such tools typically present users with a high-floor barrier to be overcome before they can create personally meaningful objects.

As well as the construction of persistent programmable objects, non-goal orientated virtual worlds can afford learners a sense of immersion, embodied social presence, flexibility and opportunities for collaborative learning. This unique set of perceived educational affordances provides an opportunity for educators to develop new learning experiences in this environment, when carefully aligned with pedagogical features.

2.2 Constructionist Learning in Virtual Worlds

Few constructionist learning experiences in virtual worlds are described in the literature. Those that do, typically require learners to draw on existing knowledge of programming and 3D graphics [4]. However, as Sanchez [5] notes, many learners do not have these skills and as a result learning experiences in virtual worlds can tend towards social activities rather than construction.

In order to support learners' engagement in constructionist learning experiences in virtual worlds, tools such as Scratch for Second Life (S4SL) [6], SLurtles [7] and TATI [8] and have been designed to provide learners with low-floor (easy to use) tools to support programming and construction in the virtual world Second Life.

S4SL is a low-floor, graphical programming environment which runs externally to Second Life [6]. On the click of a button the S4SL code is compiled into the c-style Linden Scripting Language (LSL) and copied to the clipboard. The learner then simply has to open the Second Life client, create a new script and paste the LSL code in.

SLurtles (programmable turtles in Second Life) build upon S4SL, providing learners with a low-floor, high-ceiling and wide- wall programmable construction tool in Second Life [7]. Evidence suggests that SLurtles support the exploration and testing of learners' abstract understandings through the construction of concrete artefacts. However as learners have to move between the virtual world and the programming environment and the process lacks 'bidirectionality' [9] learners may lose the psychological connection between abstract code and the concrete output [10]. Although Girvan et al. [7] found that learners described using SLurtles as providing an almost immediate concrete output on which to reflect upon the abstract (*Figure 1*), it is suggested that as S4SL is a separate application, moving between the two programmes could result not only in a disconnect between abstract and concrete but also a diminished sense of immersion causing the tools and environment to be 'visible' to the learners and thus a barrier to engagement in learning as suggested by Papert [11, 12]. As such it has been suggested that an in-world version of S4SL should be developed. Tools currently in development such as TATI [8] may help to address this problem.

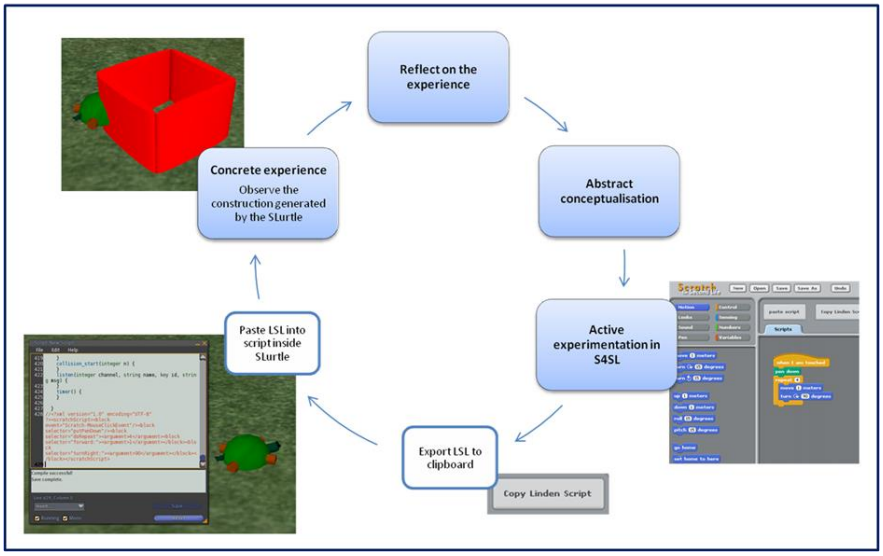


Figure 1 Process of engaging with S4SL and SLurtles [7]

2.3 Creativity

"Creativity surrounds us on all sides … but creativity is a puzzle, a paradox, some say a mystery" [13]. In order to explore creativity in constructionist learning experiences in virtual worlds, it is important to first identify what is understood by the term 'creativity'. As Kleiman [14] highlights, there is no single definition of creativity which is agreed upon across and even within disciplines. However commonly there are three clear aspects of creativity discussed in the literature: the person, the process, and the product.

Past research in the field of psychology has focused on developing personality and behaviour tests to identify the traits of creative individuals. While these traits may suggest an aptitude for creativity, Amabile [15] argues that results from such tests do not indicate what creativity is. So rather than trying to identify the traits of creative individuals, it is perhaps more useful to focus on the other two aspects of creativity: the process and the product.

Theories about the creative process which describe internal processes of forming new conceptualisations from pre-existing ideas or concepts in the person's mind [13], are similar to that of constructivist theories of learning. Interestingly Warr and O'Neill [16] draw attention to the fact that design is often a collaborative and social process involving groups of designers. These ideas and concepts are shared (with or without the support of physical artefacts) and both the creative process and creative product become socially mediated, as does knowledge in a social constructivist learning experience.

In their comparison of creative process models, Warr and O'Neill [16] identify four common, non-linear, phases to the models: analysis of the problem, generating ideas, evaluating ideas, and donating. The first phase involves analysing the problem to clarify and understand the problem which has been set. It is at this point which Amabile [15] suggests that domain relevant skills need to be developed and intrinsic motivation must be high.

Warr and O'Neill [16] describe the idea generation phase, which follows the analysis of the problem, as "the more specifically creative phase of the creative process model" (p121) after which the ideas are evaluated in terms of their creativity. In the final stage of donation, identified by Shneiderman [17] results or artefacts of the creative process are disseminated.

This approach is particularly strongly aligned to constructionism in which learners create shareable artefacts.

This leads us to the notion of the 'creative product'. Vernon's [18] definition of creativity as "a person's capacity to produce new or original ideas, insights, restructurings, inventions, or artistic objects, which are accepted by experts as being of scientific, aesthetic, social, or technological value" (p94), suggests that an artefact is necessarily created and then shared with others. A creative product is often described as creative in terms of novelty and appropriateness [15]. Novelty can be in terms of both historical novelty, in that it has never been thought of by anyone ever before; or psychological novelty, an idea which is novel to the individual [13]. However it can be argued that novelty is not creativity, without appropriateness to the problem to be solved. These concepts of novelty and appropriateness can also be applied to the evaluation of the ideas phase in the creative process model.

3. Design of the Learning Environment

Although non-goal orientated virtual worlds are not microworlds, they can be used to create constructionist learning environments. This section provides an overview of the learning experience which this research draws on and a description of the design of the in-world learning environment.

The learning experience at the centre of this research was designed to leverage the perceived educational affordances of the technology to provide opportunities for the features of constructionism to emerge. It was designed for a group of Masters level learners on a part-time postgraduate course in technology and learning, most of whom had little or no previous experience of programming or virtual worlds. The purpose of the learning experience was to provide learners with an opportunity to engage in an authentic constructionist learning activity and to a lesser extent develop an understanding of programming.

Following a brief lecture on constructionism, learners were introduced to S4SL and SLurtles during a face-to-face workshop. Following an initial demonstration of SLurtles, learners worked in pairs to programme SLurtles to complete a series of increasingly difficult challenges. Having worked out how to programme their SLurtle to move forward 1 meter, the challenges required learners to programme their SLurtles to create increasingly complex objects in the virtual world, for example 2D and 3D shapes (

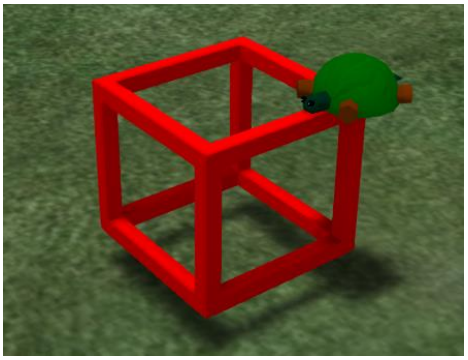


Figure 2), before moving onto the programming of those objects so that they were interactive.

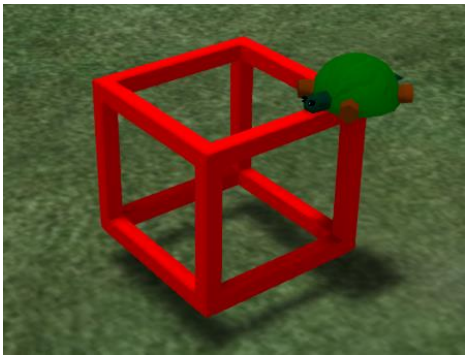


Figure 2 SLurtle created object

Learners were then presented with an assignment brief: In pairs, create an interactive installation in Second Life using SLurtles and S4SL, reflect on the experience as an individual learner and present the artefact and a pair reflection to the class. The learners then had four weeks to complete the activity before the in-class presentations and due to the 'always on' nature of Second Life, were able to engage in the activity at any time or place that suited them.

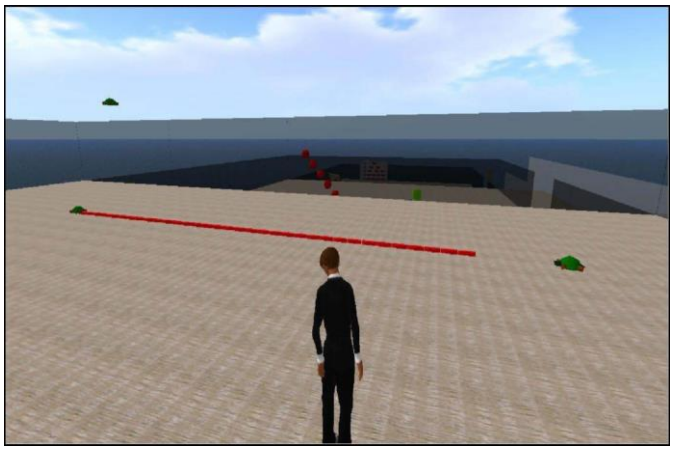
In the virtual world, a dedicated island was used with access restricted to the members of the course, including academic staff. Each pair was provided with a 40x40 meter platform in which to create their installation, with no height restrictions. Each platform was surrounded with a low, semi-transparent wall with an entrance and sign with the group number. The platforms were connected by a walkway and there were no access restrictions, which meant that learners could visit other groups' installation spaces if they wished to or simply 'look in' to their neighbours (

Figure 33). Below the platforms were two SLurtle collection points at which learners could choose SLurtles based on the shape of block they wished to create.

Figure 3 A learner's avatar in their installation space.

4. Methodology

At the workshop all 24 learners in the pilot study provided informed consent to participate in the research. Data collection took place in the weeks following completion of the learning activity. Individual, non-directive open interviews with 14 of the 24 participants provided the primary source of data for qualitative analysis. These interviews, which averaged 60 minutes, began with the participants describing what they had created and the process involved. The interactive installations were filmed to capture as much of the 3D design and as many of the interactions as possible and all participants provided their personal reflections for data analysis.

Initial analysis of the data followed the constant comparative approach, allowing the researcher to remain open to emergent findings. The codes and categories developed through this analysis were then used as an additional data source for the purposes of this study. The stages of the creative process described by Shneiderman [17] are used as a theoretical lens to analyse the data, as they align most closely with constructionist learning.

5. Findings

While the process of collecting, creating and donating involved numerous cycles within and across the three phases, for clarity these headings are used to present the findings. The design process for the installation began with exploring and generating initial ideas, followed by development, planning and construction. The majority of groups described returning to each of these stages in the design process several times over the four weeks. There was also clear evidence of donating not only at the end of the assignment through the class presentation but throughout the four weeks.

5.1 Collect

Following on from the initial workshops, learners continued to spend some time exploring how to use SLurtles and what could be created with them, which some described as "playing". This exploration also provided them with an opportunity to begin initial generation of ideas.

Although the task was deliberately open, allowing learners to explore and construct personally meaningful knowledge and artefacts, there was some evidence to suggest that

participants developed their own criteria with which to later evaluate their ideas and artefacts. Although not stated as a requirement in the assignment brief, some learners felt that they should create an installation which they could use with a group of learners. One participant explained that this was because it was a requirement for other aspects of the Masters course and therefore presumed it was a requirement of this assignment. While others related it to a personal need for their installations to be in some way relevant to them.

Examples of this were found in several artefacts, such as the creation of an obstacle course for new users to practice their avatar movement skills, by two learners who were physical education teachers, one of whom had struggled with the movement controls of their avatar (*Figure 4*). Another pair, who were both primary school teachers created an interactive retelling of the story of the three little pigs, which they said they could imagine using with their own learners.

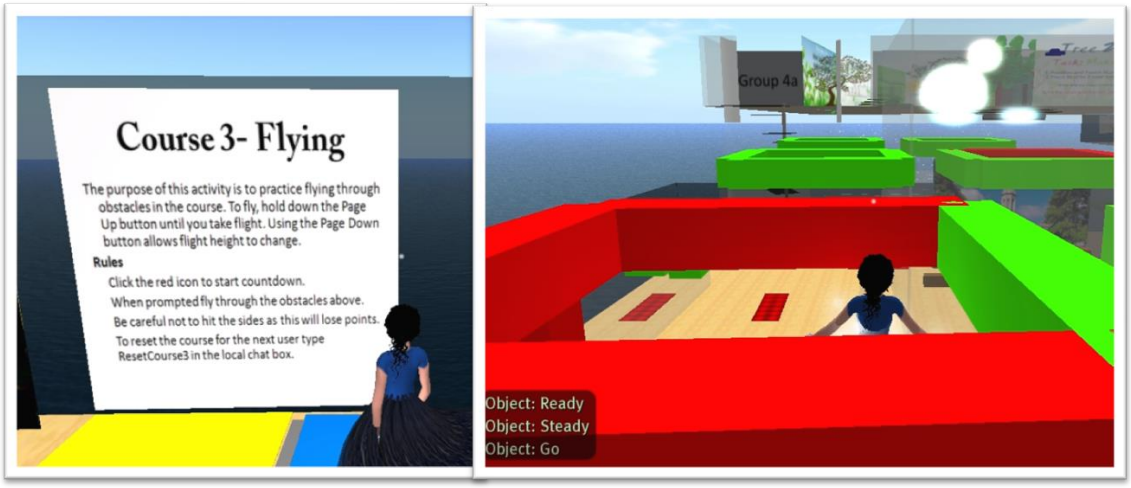


Figure 4 Images from the obstacle course.

There was evidence to suggest that the limit on the number of primitive objects (or SLurtle blocks) that could be created and the size of the construction space influenced some constructions: "*the space was very very big, and we did feel like, you feel like you want to fill it, and you can see we put that wall there, erm, just to get the sense of it being filled*". As such there was an explicit requirement (a maximum number of primitive objects) and an implicit requirement (that the space had to be filled), which influenced some of the artefacts created through the creation of unintended success criteria.

5.2 Create

Learners identified a number of influences on the ideas that they generated: The sense of presence in the virtual world, learners' past experiences and preconceptions; the sense of a public learning space; and their partner.

The sense of inhabiting the learning space via an avatar was described by several participants as supporting the development of initial ideas. For example in one reflection a participant noted: "*It was within the virtual space that we formulated the decision of what to make, something we had struggled to achieve in the offline world. I wondered if being immersed in the virtual space, while contemplating the possibilities, had helped in arriving at this decision. We were now immersed in the space, getting a sense of its scale and depth, and watching other installations beginning to take shape. I think this helped clarify a few ideas*

we had brought to the space to discuss and brainstorm. In a manner of speaking, being immersed in the space helped us realise the possibilities."

Learners' past experiences influenced many of their initial ideas. Due to the conceptual association with Turtle Graphics, some learners began with the expectation that SLurtles would provide a similar line drawing experience. However as they programmed the SLurtles to create some of their initial ideas, they found their preconceptions to be false which opened up opportunities for creativity: "*Once you get to that point you can do, there's lots of other interesting things you can do that you wouldn't have thought if it had just been a line drawing programme. So in a way, it not being as you expected to be was a good thing because it forced you to go in a completely different direction."*

Due to the public nature of the learning environment, learners were very aware that others could see and interact with their artefacts as they developed throughout the four weeks. Some identified that this influenced the design process including idea development and construction of the artefact. For example one group chose to create an interactive piano as it would "*provide an engaging and fun experience for the user through its interactivity*". Learners were also influenced by the developing artefacts of others. As one participant described it: "*looking at other people's work, and you realised, oh, you can do this as well, you know, or other people have used that so let's have a go*". This realisation influenced the design of several artefacts; yet there was no evidence in the artefacts of simple copying programmes between groups.

The learning relationship between and within pairs was one which many participants referred to in interviews and reflections. As participants were required to complete the assignment in pairs, the process of creating required learners to not only generate and evaluate initial ideas internally but to share these ideas with their partner. This was achieved by not only describing and discussing ideas but also through the creation of shareable artefacts. These artefacts provided a valuable shared representation of an idea which could then be evaluated and further developed. Some pairs created sketches to share their ideas whilst others created 'prototype' artefacts in the virtual world using SLurtles.

5.3 Donate

As described above, the process of generating and evaluating ideas within pairs required the sharing of ideas and dissemination of solutions throughout the four weeks. As each pairs' installation space was publicly accessible, all learners on the course could visit the artefacts of others, thus sharing in what they created as they created it. While a few learners did not wish to visit other groups nor for others to visit them, most learners took the opportunity to explore the artefacts created by other groups at various points during the learning experience, facilitated by the 'always on' technology. Many were keen to meet others within the virtual world to show and discuss what they had created, to both share and gain feedback, ideas and advice.

Within the walls of each platform a gap provided an entry/exit point for avatars travelling to the platform on foot. The design of several groups' artefacts incorporated this gap, placing a scripted door or 'welcome mat' (Figure 5). However some described feeling that this change to the original design of the learning space was detrimental to the otherwise public nature of the learning experience: "*we noticed some doors going up on the spaces, erm, and we thought that was quite, I don't know, well, a bit odd to be honest ... there almost seemed to be some sort of guardedness about individual projects, and so doors started to appear across some of*

the entrances to some of the spaces, and erm, I thought that was funny, I thought it sent out a message".

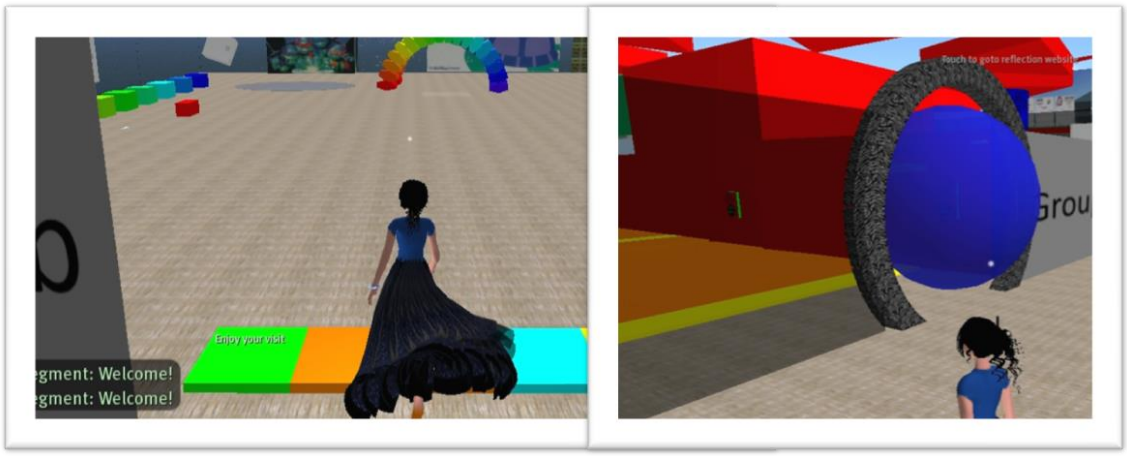


Figure 5 Welcome mat and scripted door at entry/exit points.

Despite this perception by some, each space remained publicly accessible and most groups were keen to have other groups visit and explore their artefacts. For some this even became an important design consideration: "*trying to put notes or boards at the back for people to see to give them ideas of what to play, to help them start off, if they never played the piano before*". In addition, by sharing their constructions groups gained feedback on their artefacts from others, while some groups were influenced to further develop their artefacts after they had explored others' artefacts. Observing and communicating with other avatars in the public learning environment also supported learners' sense of achievement: "*I came in one time during the assignment and there was somebody playing the piano and I thought 'now that's great*'".

In another example, although they had nearly completed before the end of the four weeks, one group wanted to be able to show the class something they wouldn't have seen prior to their class presentation: "*I don't want to have it completely done until the day before the presentation because I wouldn't want them to go through it*."

6. Discussion

By engaging in the creative process, learners were provided with an opportunity to engage in constructionist learning. However, it is not only the design of the learning experience but also the online environment which support both creativity and learning within the virtual world.

There is evidence to suggest that for learners, the process of developing their knowledge and understanding of programming was intertwined with the creating and donating phases of the creative process. It is perhaps the 'donating' phase which is of most interest in a constructionist learning experience within a virtual world, as from start to finish, learners are sharing the artefacts they are creating, exposing both their ideas and understanding to other learners.

Each pair of learners was provided with a publicly accessible platform in which to create their installations. An initially blank canvas was provided so as not to influence or constrain learners' ideas. Yet, as learners observed others constructing their artefacts their ideas were influenced.

Designing a learning experience which required learners to work together facilitated opportunities for donating, however this would not have been possible without the shared environment of the virtual world. Through the use of avatars and communication tools, regardless of location, learners were able to communicate and share their ideas and creations. Due to the always-on and persistent nature of the environment, even when one member of the pair was offline, their constructions could still be shared with the other.

Evidence also suggests that while learners were provided with an opportunity to develop the necessary domain-relevant skills to engage in both learning creative processes, facilitated by the 'always-on' nature of the environment, learners continued to engage in what was often described as 'play' to explore what as possible with SLurtles before developing initial ideas. This suggests that learners needed to understand what could be created using SLurtles before generating ideas and may be associated with the need for 'appropriateness' of ideas in creative products. Regardless of how novel the idea was, not knowing whether it could be created would prevent the idea from being developed. Being able to view the artefacts around them also provided learners with an understanding of what was possible, thus influencing what was created.

In conclusion, the virtual world provided learners with an environment to collaboratively explore, test and share their understanding through the construction of creative artefacts. Through designing the learning environment to provide publicly accessible spaces, learners were able to share these artefacts in a variety of ways without impinging on the creative process. Instead, the public nature of the environment supported the sharing of artefacts throughout the creative construction process, enhancing but also potentially limiting opportunities for learners to be creative as they explored, tested and extended their understanding. This suggests the need for further research to develop our understanding of the complex interaction between sharing artefacts, idea generation and learning processes in shared learning environments.

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