INNOVATIVE LEARNING OPPORTUNITIES WITH VIRTUAL REALITY GAME DEVELOPMENT

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Abstract

This article outlines a case study of a team of secondary school students creating a commercially deployed immersive Virtual Reality (VR) game as part of their learning. Given the limited amount of relevant literature on the learning outcomes from students creating and deploying VR games to the commercial marketplace, the study adopted a grounded theory approach to explore the initial ideas, themes and constructs that emerged from a preliminary interview study. From this study, we identified the emergent constructs in their learning process as being authenticity, agency (including processes) and innovation. Although the students developed their technical skills through this activity, most of the ideas that were expressed in the interviews related to the opportunities offered by engaging with innovative technology in an authentic context. Through dealing with stakeholders, gathering and responding to feedback, understanding design requirements and the commercial aspects of VR game development and deployment, the student team created their own powerful learning experience.

Keywords

Virtual reality, game development, authentic learning, student agency, innovation.

1. Introduction

Emerging technologies offer innovative and creative ways for students to develop and explore their own learning needs. Although not a new technology, virtual reality (VR) tools have recently become both more powerful and more affordable, leading to renewed interest in using VR in education (Merchant et al., 2014). Most educational studies of VR are still either small scale or conceptual in nature (Bacca et al., 2014), but research from the more mature area of 3D virtual learning and virtual worlds suggests enhanced opportunities for learning experiences and interactions that cannot be easily experienced or replicated through other tools (Cassard & Sloboda, 2016). The new opportunities of current VR tools have brought a wealth of new ways to better engage and teach a range of new skills and subjects (Pelargos et. al., 2017).

It is the ability for students to create their own VR products that provides the most exciting learning opportunities. Creating VR artifacts for end-users enables students to engage with a complex set of skills and experiences that go beyond just the technical aspects of coding. Due to the complexity of creating VR artifacts with older tools, much of the past research into VR has been focused on using existing VR products, with little focus on students developing their own VR experiences. Outlining the potentials of VR, Latta and Oberg (1994) provide a threetier definition of VR that captures both the key value of VR over other technologies (simulating environments that are otherwise inaccessible) and the main criteria for creating effective VR experiences (realism and two-way interaction). Their categorisation of effect (experiential and operational) captures the challenge of creating a VR product. For experiential effect, there has to be a significant personal experience in using the product, while for operational effect, users need a set of operations that they can perform within the VR environment. A number of studies have focused on the value of constructivist learning in VR environments (e.g. Winn, 1993; Huang, Rauch and Liaw, 2010), but there is also some literature on a more constructionist approach to learning with VR, based on students building their own VR systems and learning through doing so. Bricken and Byrne (1993) noted the positive impacts on student collaboration, as well as technical skills development when students were able to create their own virtual worlds. They also emphasised the “students' desire and ability to use VR constructively to build expressions of their knowledge and imagination” (p. 13). Miyata, Umemoto and Higuchi (2010) also emphasised collaboration, which provides a good context for aesthetic design and storytelling. Their educational framework for creating VR applications is based on a three-step process of divergent thinking, convergent thinking and idea crystallization.

This article describes the outcomes of an exploratory study of how one urban state secondary school in New Zealand has adopted VR to develop their students’ learning. The teachers at this school have started their own early explorations into how students can create their own VR environments and games and embed this learning within the curriculum. This exploration has culminated in one set of students creating their own commercial game which has gone on to be played by hundreds of people around the world (STEAM, n.d.). With the adoption of a grounded theory approach, this study provides an inductive development of key constructs that will be used to develop a theory on the value of VR constructionism for teaching and learning. Though the work reported here is only the first part of a larger grounded research project, it provides the initial steps for more theoretical sampling and stronger mapping of these early constructs.

In this study and the wider project, the main research question addressed is: What are the opportunities that virtual reality provides for students to construct their own learning through the process of creating their own products?

2. Methodology

This study adopts a grounded theory approach to examine the core constructs that emerged from this case study of a student-generated VR product since there is still little known about this area of study. Grounded theory starts at the level of observation and ends at the conceptual level, while the observation level includes data collection, coding and identifying themes Strauss (1987). This article outlines the first cycle of observation and analysis in our study.

This study focused on an exploration of how VR can be used to engage learners in teaching computer programming and game-based design. In late 2016, the school purchased an HTC Vive system which would be used to support their early exploration into how the school could start embedding VR into their ICT course and encourage their current focus on game-based programming. Prior to this purchase, students had been developing PC games which were largely 2D in design. VR offered significant new opportunities to further develop a wider range of games drawing on more sophisticated technologies. To help the school to get a better understanding of how VR could be used, it was first provided to a group of students from the extracurricular Game Development Club (GDC). This club included a number of students interested in extending their knowledge in programming and game design that was currently outside the scope of their current ICT class. Although these students already had coding skills, they had not experienced 3D modeling or developing within a VR environment.

The study focuses on exploring the experiences of one of the groups of students (n=4) in the GDC, who developed a VR game. Since this development was in the context of an extracurricular activity, and therefore not linked to any formal learning outcomes, the aim of the study is to identify what potential could VR bring if it was embedded into the formal curriculum, in particular, to teach programming as well as cross-curricular outcomes.

To answer these initial ideas, data was gathered through semi-structured hour-long interviews with two students involved in the development of a commercially available VR game, and one of their teachers. The artefact developed by the students is a VR game developed using Unity3D for the HTC Vive called Totally Realistic Sledding. Following several stages of planning and development, it was released by the students for sale worldwide on Steam Early Access in December 2017. In the game, the player uses the hand controllers to navigate a sled down snow-covered hills in order to avoid obstacles, collect bonuses and compete for fastest completion times.

Institutional ethics approval was gained for the study, and the parents of the students involved were asked to give their written consent for the interviews to take place. The students were interviewed onsite at their school and were also given the opportunity to demonstrate and explain their VR game to the researchers.

3. Open Coding Analysis

Our results are based on an open coding analysis of transcribed interview data collected from the two students (indicated as S1 and S2) and their teacher (indicated as T). The data was coded using emergent themes (developed from a simple content analysis of repeated ideas) and subsequently gathered together under more abstract constructs (Auerbach and Silverstein, 2003) which aligns with the grounded theory approach taken in this study. Although the interviews were semi-structured, in the event the conversations with the interviewees became very open and discursive. As a result, we used open coding without assuming any constructs based on the original interview questions, to ensure that we did not exclude any important ideas. The transcripts were coded independently by two researchers and then a common interpretation was agreed. The preliminary constructs that emerged from this analysis were:

- Authentic learning
- Agency and process
- Innovation

In the following section, we outline the themes and ideas that formed each of these constructs from the interview data. A few indicative quotes from interviewees are included for illustration.

3.1 Authentic Learning

In the authentic learning construct, two themes emerged strongly, one relating to success and achievement within the school (authentic learning to meet curricular objectives) and the other relating to success and achievement outside the school (authentic learning for real-world skills development), though these two processes were closely linked together in practice. The responsibility of staff in the school is to ensure student achievement against the set curriculum, normally measured as success within the school. However, in this case, activities undertaken outside of school met and exceeded these requirements.

"The technology curriculum was absolutely 100% covered at a far higher level than could have been done in the classroom." (T)

From the student perspective, a key experience was attaining the knowledge that had to be constructed. Creating VR games with the tools the students were using is such a recent skill set that there is little material available, and the students had to construct their own knowledge through authentic experience.

"VR games are not that transferable to regular PC games – the game design in VR has to be very different to normal games. Transferring them over doesn't really work so well." (S2)

Reaching out to the relevant community of practice was another important aspect of authentic learning within the project. A number of activities have been undertaken by the students to give them experience of the VR gaming industry out of school, such as presenting at professional networking events. Authentic engagement with the practitioner community also included an expert appraisal by a design expert. Perhaps the most significant aspect of authentic learning from this experience was the number of cross-curricular links that emerged from the game development process.

"You don't realise when you go into making a game how much other fields of school come into it - we've done things like writing developer blogs, replying to posts online and seeing what feedback people have been giving us and as asking them for more details. As well marketing, asset design, we learned a lot around that." (S2)

The overall message from this construct was that for learning to be authentic within a school context it must both engage with the external practitioner community and feedback into the requirements of the school curriculum.

3.2 Agency and process

A classroom focused interpretation of agency emphasises students being supported by teachers to actively experiment (Martin 2004). This view of student agency as a kind of partnership with teachers can be seen clearly operationalised in the setting of our study, where the teachers furnish the curricular setting. Perhaps the most important aspect of student agency in this context is the element of constructionist learning

"We're always about creation… We're not training people to be users of technology, but if you're being taught how to create the technology, implicitly you're learning to use it with a deeper insight as you go" (T)

Student agency is evident in the way that the project has been approached, whereby the students have taken responsibility for driving all aspects of the project forward. Supporting this agency is an iterative development process that allows them to adapt to feedback and direct their own learning path. Comments from the students reinforce how they were active and self-directed in developing their own learning paths.

"We entered a game design competition and managed to get second place, which gave us a big boost of recognition for the school in terms of game development" (S2)

The power of student agency is highlighted by the fact that the journey that the students are experiencing is providing new insights to the staff, who are then able to bring these back into the classroom for other students. In this sense, the students, not the staff, are driving the learning agenda. Perhaps the most important part of student agency is not just the ability to drive the learning agenda but the recognition that with this comes a responsibility to follow through the product creation process to completion.

“In terms of design, the most important thing you’ve got to do is finish a project because most people don’t. That’s what sets us apart from most people that work on stuff like this.” (S1)

One of the main aspects of student agency that came to the fore was that they were learning together and that this was very much a team-based learning experience. As a software development team, the students were working together in a similar way to professionals by developing particular areas of expertise and integrating their work products.

“Working as a team with different skills and specialisms, programming level design, asset development of 3D objects, testing, ideas etc.” (T)

Perhaps most importantly the students learnt to cooperate with their stakeholder community. As they state on the website where their game is deployed for purchase, “We want to bring this game to its fullest potential, and we can't do this alone. We believe working alongside the community will help us bring our game up to the highest standards.” (STEAM, n.d.). By distributing an early access game, the team get specific feedback. The early access model is valuable for developers who want to improve their games by interacting with their players (Lin, Bezemer & Hassan, 2018).

3.3 Innovation

A major construct was innovation. One set of criteria for defining what is important in innovation is differentiability, creativity, the probability of adoption, and need satisfaction (Elizondo et al., 2010). Differentiability, in particular, is an important property of VR.

“Putting the Vive on is not like anything else, you can’t describe it. People think it’s like TV. something that you watch people then you put it on and suddenly you’re in there don’t know what immersive means until you do it.” (T)

In terms of future capacity building, innovation drives new approaches to the learning environment, to ensure that future students can also work at the forefront of technology. An important aspect of innovation is that it releases the students’ capacity for creativity. They experienced the importance of this from an early version of the game that did not have much creative input from the team.

“It was like a procedurally generated game, so the levels weren’t actually handcrafted, so it had this robotic feel. It was just; place trees everywhere, place rocks everywhere, just dodge everything. It didn’t feel right or fun, it was just generic.” (S1)

The students have recognised the opportunities presented to them by innovative technology and compare their experience to the use of more established, less innovative approaches to creating technology products.

"Because there are so few people doing it it's easier to get started. Normal 3D games, there's so many people worldwide making them now you get completely buried under everything else but VR is a new opportunity." (S2)

The students reflected that working in an innovative space in an educational context has some specific advantages over professional game developers. They note that many commercial game development studios are unwilling to venture into VR game development because the user base is relatively small. Students, being able to commit their own time and use school resources do not need to worry about the size of their market.

"The big studios say 10,000 people is barely anything, but it would be a lot for us so it's good for us that [they] aren't touching it." (S1)

This lack of competition meant that the students were able to gain visibility in the marketplace, giving them access to a user base and the attendant feedback. Being innovative also means that the students are constructing new knowledge in an authentic context, rather than simply reusing existing knowledge from other sources.

3.4 Analysis Summary

Table 1 provides a summary of the coding analysis undertaken on the interview data and the preliminary constructs, themes and ideas identified in the data. The ideas have not been quantified for this analysis since this was a small data set and we only intended to identify emergent constructs for development in future research.

Table 1: Constructs, themes and repeated ideas in the open coding analysis

Constructs	Themes	Ideas
Authentic learning	Authentic learning to meet curricular objectives	Meeting the technology curriculum, constructing knowledge, responding to internal feedback, coding, complex development environment
	Authentic learning for real-world skills development	Responding to external feedback, competitions, expert appraisal, external deployment, cross-curricular links
Agency and Process	Learning processes	Constructionist learning, self-directed learning paths, taking responsibility, iterative prototyping
	Technical Processes	Working context, team agency, cooperative learning, working with other teams and staff
	External links	Working with experts, Working with customers
Innovation	Driving innovation	Innovation as inspiration, future capacity building, creativity
	Niche development	School as an innovation space, easier to be competitive, first mover advantage

4. Conclusion and Future Work

In this article we have provided an initial data analysis, using a grounded theory approach to a set of interview data gathered from student team members and their teacher engaged in a project to develop an immersive VR game. What emerged from our preliminary analysis were the three constructs of authentic learning, agency and process, and innovation. The main learning from this research was that the innovative and engaging nature of VR can not only enable students to create effective projects within the school but can also give them the opportunities to engage with real-world customers and developer communities. This engagement takes their learning beyond the classroom and gives them valuable experiences in product development. These experiences develop their learning not only in the technical aspects of software development but also in teamwork, development processes, how to engage with stakeholders, how to deploy products in a real-world marketplace, and how to manage commercial and financial aspects of product development.

We see this example case as a potential model for other educators to provide similar opportunities for their own students to gain authentic learning experiences in student-driven contexts, leveraging the power of innovation. Future work will involve ongoing engagement with the student team interviewed for this study, but also broader research looking at other student teams working in mixed reality software development to see whether our initial qualitative analysis can be further developed into an applicable theory.

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