International Journal for Educational Media and Technology
2018, Vol.12, No. 2, pp.35-41

Digital Building Blocks for Learning: Motivating and Engaging students through Minecraft Game-Based Learning

Peter Leong
University of Hawai'i at Mānoa USA
peterleo@hawaii.edu

Ariana Eichelberger
University of Hawai'i at Mānoa USA
ariana@hawaii.edu

Shane Asselstine
Momilani Elementary School
shane.asselstine@gmail.com

The purpose of this study is to investigate the impact of Minecraft game-based learning on students' motivation and engagement. This paper presents a study of a five-week summer interactive course designed to provide students with the opportunity to work in the virtual learning environment of Minecraft. The study seeks to answer the following questions: 1) How did using Minecraft influence students' learning experience? and 2) What were students' experiences using Minecraft as a learning tool?.

Keywords: game-based learning, engagement, motivation, K12

Introduction

Digital games have been widely used in education to provide more engagement for students. Engaging students in K-12 schools has been challenging as students often consider traditional classrooms boring. To increase motivation and engagement, teachers have integrated digital games into the classroom (McGlarty, Orr, Frey, Dolan, Vassileva, & McVay, 2012).

Minecraft is a first-person sandbox video game where players can build and craft common objects using blocks. Educators are incorporating Minecraft as a virtual learning platform into the classroom to engage and motivate students. Many educators are using the different features of Minecraft to teach different academic subjects (Nebel, Schneider & Rey, 2016; Short, 2012).

This paper presents a study of a five-week summer interactive course designed to provide students with the opportunity to work in the virtual learning environment of Minecraft. The focus of the course, which utilized a variety of skills in science, technology, engineering, and math, was project-based learning through an engaging immersive experience. In small teams, students set goals to accomplish a variety of tasks from food production to integration of technology.

Literature Review

Recent research findings indicate that motivation is an important factor to improve learning outcomes in general (Chang et al., 2013). Another factor impacting student learning outcomes is student engagement, which is defined as "the amount of physical and psychological energy that the student devotes to the academic experience" (Astin, 1993, p. 297).

Studies using game-based learning (GBL) have shown positive results in increasing both learner engagement and motivation (Charlier & De Fraine, 2013; Cheng & Su, 2012; Sung & Hwang, 2013). Abdul Jabbar and Felicia (2015), in a systematic review of gameplay engagement and learning in GBL, found that GBL supports students' skills and knowledge development especially when they feel connected emotionally and cognitively to the gameplay.

The emergence of GBL has given rise to the importance of learning theories, such as connectivism and constructionism. Constructionism, a theory pioneered by Seymour Papert, asserts that children learn best when they play the active role of the designer and constructor. Papert defined constructionism in a proposal to the National Science Foundation entitled *Constructionism: A New Opportunity for Elementary Science Education* (Sabelli, 2008) as,

> *a mnemonic for two aspects of the theory of science education… From constructivist theories of psychology we take a view of learning as a reconstruction rather than as a transmission of knowledge. Then we extend the idea of manipulative materials to the idea that learning is most effective when part of an activity the learner experiences as constructing a meaningful product.*

In a GBL environment like Minecraft, learners can build anything they can imagine. Minecraft is an open world game that has no specific goals for the player to accomplish while in default settings, allowing players a large amount of freedom in choosing how to play the game. Educators utilizing GBL must not only consider pedagogy, but also the use of effective design and building opportunities to support learning in GBL environments like Minecraft (Abdul Jabbar & Felicia, 2015).

This study is an exploratory qualitative investigation of the experiences of students in a five-week summer course using Minecraft GBL. The study set out to answer the following questions: 1) How did using Minecraft influence students' learning experience? and 2) What were students' experiences using Minecraft as a learning tool?

Methodology

This study used semi-structured interviews to gather data from participants. The interview instrument consisted of 17 open ended questions. The interviews took place in the fifth week of the five-week course. Interviews were voluntary and permission to participate was granted by the parents of 20 of the 26 students in the class. The interviews took place over the course of two days by the lead researcher and took place in a room adjacent to the classroom in which the class took place. Each interview lasted between 10 to 20 minutes. When a student finished their interview, they would be asked to send in the next student. Interviews were audio recorded using a laptop. Participants were asked about their experience with Minecraft in the class, the class content and their experiences working in small group with their classmates. Figure 1 displays example interview questions as they relate to the research questions.

RQ 1: How did using Minecraft influence students' learning experience?
How was your classroom experience using Minecraft?
Did Minecraft help to motivate your learning or rather discouraged?
Did Minecraft help you work with your classmates?
RQ 2: What were students' experiences using Minecraft as a learning tool?
Did you have any technical problems during the class activity in Minecraft? Did it prevent you from learning?
Can you say more about how easy or difficult it was to use Minecraft?
Does Minecraft suit your learning style?

Figure 1. Interview questions as they relate to research questions

Interview transcripts were individually and independently coded by the researchers using Saldaña's (2009) first and second coding cycles to look for patterns and themes within the data. In the first coding cycle, structural coding was conducted based on the research questions of the study. Structural coding is a way to initially code and categorize data and is especially appropriate for studies involving multiple participants and semi-structured data gathering methods (Saldaña, 2009). The researchers used the results of the first cycle to refine and finalize a codebook of themes which was then used in a second cycle of coding. Analytic memos were used during both coding cycles to document the process and further the discussion between the researchers.

Context of the Study

The study was conducted during a five-week summer interactive course offered by the Curriculum Research & Development Group (CRDG) Summer Programs at the University of Hawai'i at Mānoa. CRDG has offered summer programs for Hawai'i K-12 students for over 40 years. The summer programs utilize inquiry-based instruction and hands-on learning in the classroom, laboratory, field, and theater.

The summer interactive Science, Technology, Engineering and Mathematics (STEM) project-based course, entitled *Nation Building*, was taught by one of the co-authors. The course, which utilized a variety of skills in STEM, focused on

the various aspects of establishing, developing and sustaining a nation. Students were divided into teams and tasked to establish their own "nation" in Minecraft. The following scenario was presented to students at the beginning of the course:

> "Life in your home nation is unbearable. The population is dwindling due to the lack of food, or drinkable water. People are living on the streets everywhere you look. Leadership in your home nation continues to make poor decisions. They refuse to spend any effort on improving the infrastructure, advancing the technology, or trading with neighboring nations for needed supplies. Instead they spend time arguing and bickering about everything and anything. Let's not mention that there hasn't been a diamond found for decades! It's time to make a change! You find yourself on a ship sailing towards new lands and your chance to change things."

The five-week project-based course was organized into five major components with supporting learning activities to be completed by students:

1. *Establish a Nation* - Students divide into nations and develop a plan of action for the nation. Further, they assess resources and prioritize the needs of the nation.
2. *International Relations* - Students participate in trade negotiations and develop international relationships.
3. *Develop a Nation* - Students research technology advancements. They meet local and global challenges and work towards advancing the nation.
4. *A Resilient Nation* - Students face a disaster that will test their nation. They develop a plan of action to deal with crisis.
5. *The State of a Nation* - Students assess the success or failure as a nation and present an overview of their nation.

At the end of the five-week course, student teams presented their Minecraft worlds and national reports on the state of their respective nations. Figure 2 shows a screenshot of one of the Minecraft worlds created by a student team.

Figure 2. Screenshot of a Minecraft world created by a student team

Participants

Twenty of the 26 students enrolled in the summer program course participated in the study. The group was made up of 8 girls and 12 boys ranging in ages from 10 to 12 years old. Participants attended a variety of public and private schools in the Honolulu area. Most did not attend the study site charter school during the school year. All but one participant had played Minecraft prior to the class but none had used it in an educational setting. All reported that the prospect of playing Minecraft in a learning environment was what attracted them to the class. Pseudonyms have been used to identify participants.

Results

Learn and Play

The students were overwhelmingly positive about using Minecraft in an educational setting. While students had known the class would use Minecraft and had been an incentive for taking the class, they also recognized educational benefits and seemed to appreciate the addition of the learning aspect to the game. For example when asked what she liked about the class Allie stated, *"I guess the fact that we get to play Minecraft, but also that we're learning at the same time."* Angela felt that *"It's different because there's like, because we actually get to be learning things while we're playing instead of just playing."* When describing learning in this class, Nathan stated that *"They incorporated it in a game, which I thought is pretty cool. Because, it's not every day that you get to play a video game and learn."*

Collaboration

Students worked in small groups to build their nations in Minecraft. Each student had an assigned role and needed to work together to build and sustain their Minecraft nation. Many commented that they preferred playing multi-player Minecraft over the single-player versions they had played in the past. Brandon described it this way, *"In this class, I liked it a lot because I like playing multi-player Minecraft more than one person and I've only played that once or twice before with my friends and even then it was only two people."* While some like Scott felt multi-player was more fun, *"It's more fun playing Minecraft when you have a group of people."* Brandon was more specific, recognizing the limitations of being solitary. He put it this way,

> *I think that Minecraft can help you collaborate with a team because you could always go out on your own and do your own stuff, but it's going to be hard. Because I play Minecraft a lot, mostly just single player, and there's not a lot you can do without people.*

When describing her team experience Allie shared that,

> *I think I learn more as a team, because we get different varieties of people. They can throw in ideas, and then we'll take that idea, we'll put it together, and along the way I think that we learn more...it impacts how we learn, and it's like a motivational tool almost.*

However, working with others did not always come naturally to the students. For some teams it was only through continued communication that they were able to begin collaborating. Kara explained her team's experience like this,

> *The first day, we never talked to each other. We just went off in different directions and did whatever. One of them went off and built a giant house, while I was building a giant house underneath the ground. But sooner we started to talk, and then started to build, then started to just form what we'd built into something better.*

The need for communication in the multi-player Minecraft teams also appeared to be part of their appeal. Nelson put it this way, *"Like I just have someone to talk with and we can do things together and things like that."* In fact, the need to interact with group members was part of what made teamwork in Minecraft different from collaborative school projects Scott had participated in. He felt that *"it's different because there's a lot more communicating."* Communicating with teammates was what Aubrey referenced when asked to describe why she liked the class, saying *"It's very fun because I got to interact with the other kids in my group."*

Within their teams students recognized the importance of individual roles as well the need to assist each other in order to build their nation. Geri described the importance of each person's role to the overall success of the group when she said simply *"you have to rely on other people to do their job or else nothing would get done."* However, they also recognized that simply doing one's job was not enough. Nathan described it this way,

> *You had to work together. If you didn't you would fail, because when we tried doing our jobs on our own, we would get nothing accomplished. Because Ravi, he was trying to build his house, and he couldn't do it. So, we helped him and we got it accomplished.*

Justin mentioned that Minecraft itself facilitated collaboration by saying, "*Whenever something bad happens, we can always help each other fix that problem really easily within Minecraft."* Allie acknowledged that collaboration was part of why she appreciated teamwork and said *"I like working as a team. I'm not really sure why, but I just like working as a team because I just think that more gets done."* When describing what a Minecraft team needed to do in order to be successful, Angela listed *"live with each other in the game, give each other stuff, you have to like stick with the people and not give up on them."*

While collaboration was primarily spoken of in positive terms, some students mentioned interpersonal challenges arising with teammates. Some students such as Angela attributed team friction to unfamiliarity saying, *"Well, sometimes we had little arguments and stuff because I never knew these people"* while Scott cited differing team member motivations making teamwork *"a bit more difficult because sometimes you don't all want to do the same thing. Everyone wants to do these other things sometimes."* When describing her team experience, Kara mentioned *"it was interesting, because we didn't always get along. Sometimes we would blame each other. I had the most deaths and everybody would blame me because they said, oh, you're dying too much."*

Mods, Realism and Consequences

The modifications or "mods" added to the version of Minecraft used by students added a level of realism to the game that even the most experienced Minecraft players commented on, for example, Brandon mentioned that:

> *Well, just basic Minecraft wouldn't be realistic, but with the addition of the mods that he added, it made it more realistic. Like extra food, gravity, you have to actually drink water, qualities of water because you can't just go drinking water from anywhere, that would make you sick.*

Students reflected that the modifications improved Minecraft *"since he put Mods in, it's really fun"* as well as aided their learning. Scott suggested that the mods were what helped him learn more in the game, *"I think by making the game better for learning, because you can also do more things than just regular Minecraft."* Allie also referenced learning from the realism saying, *"It just almost made it realistic, almost like you're a real person building a nation. It makes you feel that way, but at the same time it's just a game, but you actually are learning."* Scott specifically mentioned learning physics due to the addition of a physics mod when saying,

> *It's a good learning experience because the module that we used that can help you learn about physics, and because we had a physics module, so we kind of just built a giant, tall building. We had to add supports in it.*

When discussing the mods and why they made Minecraft more realistic, many students referenced the fact that there were consequences for their actions or non actions. Nathan described it this way,

> *The way he put it, I think he had a Mod that made it so that it's extra realistic. Because there was temperatures. And if your water ... because if you're dehydrated and you're down, and you didn't drink any water in an hour, or like five, you would die. If you get frostbite, you would die. That's the cold. If you had heat stroke, and your brain was melting, you would die.*

Nathan also mentioned the aspect of personal responsibility that the mods introduced, that taking care of one's self in the game and contributing to the team's welfare was important personally and ultimately for the team. He also remarked on how significantly the mods had altered the game, so much so that classmates who had been Minecraft "pros" were challenged by the mods:

> *He made us do these particular jobs. Mine is, I'm in charge of water. So I have to make sure we have enough water to survive. I thought that was pretty cool, because normally in Minecraft, you don't have to worry about yourself. You don't have to go to sleep, you don't have to drink water. But what he did, it made it feel so much different. Some people, since they use the regular Minecraft, it was kind of funny that they were dying when they said they were pros.*

The students additionally seemed to recognize the pedagogical rationale for incorporating mods. They discussed how the consequences added to the game allowed for learning discussions with the instructor and feedback that informed future behaviors that could lead to more successful outcomes. David put it this way,

> *I like how our teacher was strict, so we would learn from our lessons. Like, if you die, he'd question us big time on why did we do that. Some of my teachers, like if I had a Minecraft class at (name of another school), they would just go, "Don't die." But he actually tells you why did you die, how you can not die again from that same mistake. We did this project where we knew who died the most, and what was died the most of, so we knew we could learn from our mistakes. I bet most classes don't have that.*

Another pedagogical justification for the modifications and their consequences were the opportunities they provided for the instructor and the students to connect what they were experiencing in the game with "real life" situations. Angela mentioned it in this comment:

> *Mr. Asselstine (the teacher) kept on telling us if we die, we lose a person, so we have, those people are important to us, so we to have not die and take it really seriously because in real life you can't restart.*

Students were able to differentiate between the game and real life but felt the game could in some ways bridge the gap between the two. Kara describes her experience of learning concepts in the game and the ability to apply them elsewhere this way, *"Even though it's not real life, you can't feel things, it's still sort of teaches you how to, what's the word? Do something successfully and then you can take those ideas, build them in real life."* Students also recognized that experiencing consequences in the game could help them learn about real life consequences without the dangers associated with real consequences. Stephany put it this way, *"Yeah, but you could do it in real life. It's just like you won't get hurt in real life."*

Learning Style

Students were briefly told about learning styles then asked to identify what they felt their own learning style was. Answers varied across the group, but when asked if they felt that Minecraft fit their particular style they unanimously agreed that it did. When asked why, regardless of their reported learning style, most responded that they enjoyed the active engagement the game provided. For example, Nathan said *"I learn by watching and listening, but not in this game. In this game, you want to do it, because kids like video games."* Gary who reported that he usually learned best through reading cited communication as the element that helped him learn in Minecraft saying *"We usually just ask each other. The book doesn't talk back to you, but your friends do in Minecraft, so that's why."* Scott linked his love for playing certain types of video games to his learning by saying, *"Because I really like to play video games, and first person, and exploration themes. So this is a good way for me to learn because of the way you play the game, it can change the outcome."* Nelson described why Minecraft fit his learning style this way, *"I don't know, I like Minecraft, so like it just feels good."*

Discussion and Conclusion

A five-week interactive summer course designed to provide students with the opportunity to work in the virtual learning environment of Minecraft served as the context for this study. The findings of this study have several implications for the use of game-based learning such as Minecraft.

Engagement

Students in this study were overwhelmingly positive about the incorporation of Minecraft into their learning experience. In general, they seem to find the Minecraft GBL environment to be engaging and that it fit their learning style regardless of any learning style they thought they preferred. While there has been extensive research on gaming, few empirical studies have explored how engagement impacts learning in GBL environments. Of paramount importance, engagement is found to be associated with how students feel connected emotionally and cognitively to a game's features (Abdul Jabbar & Felicia, 2015). It appears that in the GBL context, Minecraft has gameplay elements that can emotionally and cognitively engage students.

Collaboration

Our findings suggest that leveraging the affordances of multi-player mode of Minecraft as a platform can facilitate collaboration among students. Students in the study had to communicate in the multi-player Minecraft project teams which promoted collaboration. Additionally, students are aware of the importance of their individual roles to the overall success of the group as well as the need to assist each other in order to build their nation. Collaborative GBL has been found to not only foster positive learning attitudes and motivation, but also improve learning outcomes (Abdul Jabbar & Felicia, 2015; Hwang & Sung, 2013).

Mods, Realism and Consequences

Mods (short for modifications) are changes made to the original Minecraft's game content to modify gameplay, or provide more options on how players can interact with the Minecraft world (Mods, n.d). The class teacher employed mods to support the learning STEM concepts in Minecraft. Interestingly, students overwhelmingly felt that the mods added a level of realism to the game that helped their learning. The mods made students more cognizant of their personal and team responsibilities because there were consequences for their actions or non-actions. Additionally, they recognize the pedagogical rationale for incorporating mods as a way to connect what they were experiencing in the game with "real life" situations. Short (2012) contends that Minecraft's cubic geometry, functioning ecology, chemistry and physics lends itself to the teaching of many different academic subjects.

In conclusion, the incorporation of GBL into formal instruction can be a useful tool for student engagement and motivation provided it fits with the content or subject matter being taught. Care should be taken to find the right fit between desired learning outcomes and the digital games used as a vehicle for achieving those outcomes. Educators need to have an in-depth appreciation and understanding of the gameplay elements as well as the possibilities and constraints of GBL.

References

Abdul Jabbar, A. I., & Felicia, P. (2015). Gameplay Engagement and Learning in Game-Based Learning: A Systematic Review. Review of Educational Research, 85(4), 740–779. https://doi.org/10.3102/0034654315577210

Astin, A. W. (1993). What matters in college? Four critical years revisited. San Francisco, CA: Jossey-Bass.

Chang, C.-S., Liu, E. Z.-F., Sung, H.-Y., Lin, C.-H., Chen, N.-S., & Cheng, S.-S. (2013). Effects of online college student's Internet self-efficacy on learning motivation and performance. Innovations in Education and Teaching International, 51(4), 366–377. https://doi.org/10.1080/14703297.2013.771429

Charlier, N., & De Fraine, B. (2013). Game - based learning as a vehicle to teach first aid content: A randomized experiment. Journal of School Health, 83(7), 493–500.

Cheng, C.-H., & Su, C.-H. (2012). A Game-based learning system for improving student's learning effectiveness in system analysis course. Procedia - Social and Behavioral Sciences, 31, 669–675. https://doi.org/10.1016/j.sbspro.2011.12.122

Mods (n.d). In Minecraft Wiki. Retrieved October 31, 2018 from https://minecraft.gamepedia.com/Mods

Nebel, S., Schneider, S., & Rey, G. D. (2016). Mining Learning and Crafting Scientific Experiments: A Literature Review on the Use of Minecraft in Education and Research. Educational Technology & Society, 19(2), 355–366.

McClarthy, L. K., Orr, A., Frey, M. P., Dolan, P. R., Vassileva, V., & McVay, A. (2012). A literature review of gaming in education (Research report). Retrieved from http://researchnetwork.pearson.com/wp-content/uploads/Lit_Review_of_Gaming_in_ Education.pdf

Sabelli, N. (2008). Constructionism: A New Opportunity for Elementary Science Education. DRL Division of Research on Learning in Formal and Informal Settings, 193-206. Retrieved from http://nsf.gov/awardsearch/showAward.do?AwardNumber=8751190.

Saldaña, J. (2009). The coding manual for qualitative researchers (3rd ed.). Los Angeles, CA: Sage.

Short, D. (2012). Teaching Scientific Concepts using a Virtual World – Minecraft. Teaching Science, 58(3).

Sung, H. and Hwang, G. (2013). A collaborative game-based learning approach to improving students' learning performance in science courses. Computers & Education, 63, 43–51.