Chapter 15
Constructivism vs Constructionism: Implications for Minecraft and Classroom Implementation

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15.1 Introduction

The sheer proliferation and vast commercial success of video games have led scholars to investigate the cognitive benefits (Bavelier et al. 2012) and drawbacks (Anderson and Dill 2000) of the medium. In terms of learning, many scholars claim that video games give players the opportunity to experiment with knowledge in meaningful contexts (Gee 2007; McGonigal 2008; Shaffer 2006; Squire 2005).

While interest in the academic potential of video games and learning is almost as old as video games themselves (Malone and Lepper 1987), it is only recently that scholars have acknowledged that the certain popular video games implicate a different set of learning outcomes than those designed specifically for educational purposes (Bruckman 1999; Gee 2007; Ito 2008; Salen 2008). Bruckman (1999) aptly pointed out the behaviorialist principles which guide the design of educational games take learning out of context, and rely on instructor-centered style of teaching, which keep them from really engaging their target audience (p. 74).

Similarly, Ito (2008) explains that many educational video games are, "[F]ocused on curricular content, rather than innovative game play" (2008, p. 93). She provides a more in-depth justification for the market success of the "academic" (i.e., educational) video game, explaining that this software was marketed toward parents who were interested in advancing their children in the academic "rat race" (2008, p. 94).

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In the following analysis, we use our observations of *Minecraft* game play in a high school classroom to conduct a Piagetian analysis of three student made *machinima*, or films made in the game environment. We claim that *Minecraft* is an environment that assists in helping students think about a range of possibilities related to the abstract concepts of characterization and plot, and this evidences Piaget and Inhelder's (1969) description of the formal operational phase. We use Seymour Papert's (1980, 1993) discussion of constructionism to show how *Minecraft* is a pedagogical tool with roots in Piaget's constructivist theories of cognitive development. Next, we discuss our observations of the instructor in this study, and how his approach to teaching differs from traditional instruction-centered methods. Finally, we discuss the trajectory of technology integration and its relationship with instruction, as well as the effect that the organizational culture of schools has had on the implementation of constructionist tools like *Minecraft*.

The next section describes the development and success of *Minecraft*, and details the rich community of practice that has constructivist roots. This leads into a discussion of our study and our interest in using *Minecraft* as a learning environment.

15.2 Minecraft

Marckus "Notch" Persson, the game designer, created *Minecraft* to be intentionally simple and open so users could interact with environments normally impenetrable in most other online video games. Duncan's words best explain the draw of the game: "What makes Minecraft 'work' is a fascinating mix of the game's aesthetic sensibility, its mechanics, its development history, and the creative activities of its players" (Duncan 2011, p. 2). Unlike more structured game worlds, such as *World of Warcraft*, *Minecraft* presents players with an environment where successes are based on their creative and collaborative efforts. The *Minecraft* environment encourages interaction with the system in both graphical and technical forms, and the community of players use these elements to create vast modifications and new layers to the game. As a learning environment, playing the game allows teachers to give students opportunities to show how creative they can be, while also working collaboratively with others in their classes.

Minecraft shares characteristics with sandbox game worlds (such as *The Sims*) that are driven by the creative efforts of its players, rather than games that encourage a more structured narrative and set of competencies (e.g., first-person shooter games like *Call of Duty*).

15.2.1 Constructionism in the Context of Minecraft

Both Bruckman (1999) and Ito (2008) discuss the value of the construction or creative genre of video games, in which learning comes from creation and exploration.

Bruckman (1999) directly cites these games as descendants of the constructivist notion of learning (p. 77). Both Bruckman (1999) and Ito (2008) link this genre to Seymour Papert, famous student of Piaget's and the creator of the LOGO programming language, who was one of the first proponents of using digital environments to have students explore and create. The observations from this case study work from the premise that the commercially popular video game, *Minecraft*, presents a constructivist notion of learning, and has roots in *constructionism*, which is the implementation of constructivist principals into classroom instruction.

In his work on the institutional culture of schools and technology integration, *The Children's Machine*, Papert claimed, "School would have parents…believe that children love [videogames] and dislike homework because the first is easy and the second hard. In reality, the reverse is more often true" (Papert 1993, p. 4). Early on, Papert himself identified the inherent learning principles in commercial video games, but he also recognized that institutions would not be quick to recognize video games as learning objects in their natural state, hence the educational genre of which Ito (2008) and Bruckman (1999) speak.

Others hold that *Minecraft* presents a dynamic space for learning via social constructivism, where collaborators demonstrate specific skills, but also give players the ability to "learn how to learn" (Banks and Potts 2010, p. 6).

Although the modifications evidence the highly collaborative aspects of the game and the game culture, our focus is on the highly *constructivist* and *constructionist* nature of the game itself. This aspect of the game is not the first of its kind—it draws on many predecessors and developmental traditions. Of the types of games she observes in her ethnographic work, Ito (2008) forecasts that construction games (that support the more constructivist style of learning and cognitive development) will most closely align with the economic and cultural needs of future learners, and has the potential to transform the traditional modes of K-12 learning. In her words: "If I were to place my bet on a genre of gaming that has the potential to transform the systemic conditions of childhood learning, I would pick the construction genre. With the spread of the Internet and low-cost digital authoring tools, kids have a broader social and technological palette through which to engage in self-authoring and digital media production (Ito 2008, p. 115)." Here, Ito sees the construction games as a space for experimentation for the types of meaningful practices players need both in the classroom and the world. Like Ito, we agree that construction games give players the space to tinker with these concepts. Her mention of the "systemic conditions of childhood learning" also implies the need for a shift from the heavy instruction-based practices that dominate childhood.

15.2.2 Piaget's Constructivist Theory of Cognitive Development

Jean Piaget's contribution to the understanding of cognitive development is vast and has exerted influence on a multitude of classroom and family practices. Although there is a multitude of work that detail his findings, our theoretical analysis is

largely derived from his 1969 work with Bärbel Inhelder, *The Psychology of the Child*. In this work, Piaget and Inhelder spend a great deal of the text reinforcing the central tenets of their theories: that children progress through cognitive schemata, both by their biological readiness (represented by an age range), and their assimilation of new information that assists in their progression through cognitive development.

In the Piagetian notion, children must be given the tools and space to play with "reality" in order to challenge their current understandings of the logico-mathematical realities of space and time, and subsequently integrate this new knowledge into a more complex schema. A large portion of the text is dedicated to the earlier stages of *sensorimotor* (infantile) and *preoperational* (anywhere from a toddler to about 7 years old) of cognitive development. Little is discussed (both in this text and in other contexts) about the *formal operational stage*, the 'last' stage of development, where preadolescents progress to more abstract understanding of concepts, and can generalize to understand theories of behavior. Piaget and Inhelder describe this phase as, "[a] final fundamental decentering, which occurs at the end of childhood, prepares for adolescence, whose principal characteristic is a similar liberation from the concrete in favor of interest oriented toward the non-present and the future" (Piaget and Inhelder 1969, p. 134).

These observations demonstrate that individuals are accommodating their knowledge into a new schema known as the formal operational stage. In this stage, individuals can create theories and construct concepts that are removed from concrete props. Individuals in this group are able to hold those concrete experiences in their cognitive stores while also designing new possibilities that are not explicitly derived from the objects in front of them.

In all phases of his developmental model, children and adolescents come to understanding the function of reality through experimentation. For Piaget and Inhelder, knowledge is derived from action upon objects (Piaget and Inhelder 1969, p. 155). The knowledge gained from this tinkering is to extract their properties, and logico-mathematic knowledge of how the objects function in space. Piaget and Inhelder call this the "experimental spirit", which is the strongest in the formal operational stage (p. 149). It is this "experimental spirit" which is the crux of the Piagetian concept of constructivist knowledge building—that knowledge is assimilated through careful observation and testing via informal experimentation.

In this way, we see *Minecraft* as a tool that offers students (or players) the ability to garner knowledge through experimentation in the constructivist sense. As we have discussed, Piaget and Inhelder's (1969) theories of cognitive development are at the foundation of the constructivist view of cognitive development and learning. In our study, the students accommodate new knowledge in the formal operational stage via experimentation and expression in *Minecraft*. Although we discuss aspects the formal operational stage, we wish to emphasize the role of the *Minecraft* environment, which helped our participants experiment with new abstract concepts. Our primary interest is how the digital environment (and others like it) may help students in the knowledge production process.

15.2.3 Papert's Constructionism

For Papert, constructionism was the application of constructivist thought into classroom pedagogy (Kafai and Resnick 1996; Papert 1993). Papert's works (1980, 1993) serve as a bridge from Piaget's theory to pedagogical practice. His work strengthened the momentum of Piaget and Inhelder's (1969) theories, and serve as a rich translation of Piaget's intentions. Papert had very emphatic thoughts on the ways that Piaget's theories should be translated into practice. On more than one occasion, Papert (1980, 1993) wrote in frustration about the over-emphasis on Piaget and Inhelder's (1969) distinct stages of cognitive development and the obsession with incorrect assumptions children had about logico-mathematical relationships (e.g., conservation; 1980, p. 133). He felt that educators were too focused on correcting the erroneous assumptions that children had about the nature of reality. Thus, evidencing teachers' natural inclination to deliver the correct knowledge to children, instead of fostering an environment where learners might discover it. Papert asserted that the most valid pedagogical translation of Piaget's work was to position the child as a scientist, who is given space to fail and develop ways of knowing and thinking through experimentation. In his words, "Piaget has shown that children hold false theories as a necessary part of the process of learning to think. The unorthodox theories of young children are not deficiencies or cognitive gaps, they serve as ways of flexing cognitive muscles, of developing and working through the necessary skills needed for more orthodox theorizing" (Papert 1980, p. 133). The role of the educator is to provide the environment to explore these assumptions, and give space for children to "flex" their "cognitive muscles".

Papert placed the emphasis squarely on the importance of the conditions that would help children experiment, or think through ideas in concrete ways. This concrete experimentation was the prime difference between the constructionist style of instruction and the abstract knowledge delivery service style of instructionism (Papert 1993, p. 141). In the introduction of *Mindstorms* he discussed how his early understanding of the fixed and differential gear remained a structure through which he understood and excelled in mathematics (Papert 1980, p. vi). This was Papert's goal in creating the *LOGO* environment, and more importantly, Turtle, which was a digital representation of an object that children could manipulate using the *LOGO* language. Papert calls these metaphors that individuals use to understand other systems of knowledge "objects to think with" (1980, p. 11). As Papert used the differential and fixed gear metaphor as an "object to think" about mathematics, he created Turtle as a digital "object to think" about relational structures in computing (and ultimately, mathematics). Papert calls Turtle a "transitional" object which is "deliberately created as…Piagetian material, where [c]hildren relate to them, and they in turn relate to important intellectual structures" (Papert 1980, p. 187).

We claim that *Minecraft* is also a "transitional object", much like Turtle, and we see that the game environment is a valuable place for learners to relate to the environment, and intellectual structures of knowing. In the section below, we describe the study and then discuss our observations of student-made films in the

game world (i.e., machinima). We believe that the themes demonstrated in these films evidence two related conclusions. First, that *Minecraft* can assist in helping adolescents experiment with literary concepts that are more complex and varied, thus resonating with the formal operational phase of development. Second, that *Minecraft* is a "transitional object" in the sense that Papert (1980) describes, but this conclusion implicates a style of teaching that is still not widely employed in the current educational environment.

The next section describes the case study we conducted with a high school instructor and 20 student participants, followed by analysis of their creative productions in the *Minecraft* gaming environment. Specific guiding research questions were: How would high school students in an English literature class use the game environment *Minecraft* to respond to a specific curricular prompt related to characterization and plot, as required by the Common Core Curriculum? And how would the high school English teacher scaffold the use of this game environment for the students?

15.3 Research Methods

This *in situ* study took place in early 2012 with the authors collaborating with a high school instructor in the New England area of the United States. The high-school instructor proposed to use the game *Minecraft* to explore the concepts of characterization and plot with a small sample of ninth and tenth ($n=20$) grade students in his English literature course, and the university partners (i.e., the authors) would provide a communal server for all to use as a game space. The high school instructor was interested in finding new ways of achieving his curricular goals rather than having students individually write their own stories or having them read a work of literature. The researchers were interested in understanding the pedagogical value of using *Minecraft* as a classroom tool.

According to the instructor's informal survey of the class, only one male student was initially playing the game; thus, 19 out of 20 students were unfamiliar with the game and how it was played. After introducing them to the game environment, he then introduced the assignment. The desired outcome of this assignment was to produce an online video of a narrative work. This narrative would be produced and presented in a 3D film inside the game space. These 3D films are also known as *machinima*. The machinima would be developed by each group to demonstrate their understanding of the literary concepts.

The sample was a sample of convenience, which comprised two classes the high school English teacher taught, seven females and thirteen males. Students were divided into participating small groups based upon their preference for completing the related assignment. The high school instructor gave the students two options to achieve the assignment–they could use *Minecraft* to create their online video using game play captured using free software called Bandicam (Bandisoft 2013), or they could create a live-action narrative film using a camcorder. Four

female students decided to not to use *Minecraft*. The instructor then randomly assigned the remaining 16 students who chose to develop their stories using *Minecraft* into four equal-sized groups (one of which didn't finish the final film). This chapter focuses on the instructor and the students who chose to use *Minecraft* as their development tool.

The instructor carved five class periods for the students to capture their narratives using either *Minecraft* or the video camera. Prior to the first of these five class periods, the students collaborated outside of class to start to develop their storyline. The instructor gave the students a prompt that they could use to assist their creativity. The assignment was as follows:

> Parents are out of town and kid is being pressured to host a party. He/she agrees and the party quickly gets out of hand.

Then, during these class periods, the students were given access to laptop computers in the classroom to practice their stories, capture pieces in online video to review, and then time to revise their stories. The all-female group was also given time to capture their storyline using the camcorder. When the *Minecraft* groups were capturing their online video within the game, we used participant-observation to understand how the teacher interacted with them to facilitate students' use of the game environment.

After completing the data collection process, we examined our field notes from participant observation described above, as well as the students' film productions, or machinima. We used Piaget's theories about the formal operational stage of cognitive development to drive an analysis of the students' narrative films; but also, we allowed relevant themes emerge organically from the data. Our analysis was to understand the use of *Minecraft* as an instructional tool with high school students. We reconsidered our initial inquiry into the use of *Minecraft*: How do high school students in an English class use the *Minecraft* environment to address the concepts of characterization and plot?

In their work on ethnography and virtual worlds, Boellstorf et al. (2012) impart the notion that the data analysis process in ethnography should be guided by critical discussions among the researchers. As students of learning theory and cognitive development, our discussions about the data began to touch upon the grand theories posited by Piaget and Inhelder. Boellstorf et al. (2012) state that relevant theories should be "responsive to the data and research interests" (p. 162). As researchers, our interest is to help scholars and practitioners see the value of technology in the context of pedagogy and cognitive development.

15.4 Results and Discussion

Rather than code the transcripts of the films, we relied on the plot and character development concepts in the film to indicate the students' understanding of their work. This study was highly exploratory in its nature. Our paper suggests that tools like

Minecraft promote an understanding of such concepts that incorporate a broader array of possibilities, while offering an understanding of the concepts through construction via the game mechanics. The older students in our study took a complete departure from the suggestion prompt, and developed their own story, "A Burning Passion". The story features Joseph, a young man who had the unfortunate experience of watching his parents burn in a fire when he was very young—a fire that he mysteriously caused. The first scene features him weeping by his parents' graves, and refusing to go and live with his uncle because if Joseph lives with him, his uncle will soon meet a similar fate. As Joseph warns his uncle, we see a lightning bolt ignite a fire in the distance. Here the students offer us their version of characterization by introducing a character with a tragic flaw—everyone he loves is doomed to burst into flames. Although their instructor could have easily had students read *Tom Sawyer* to identify a similar type of character and complexity, the interaction with *Minecraft* gives the students an opportunity to experiment with a range of characterizations, in order to develop formula that help them to understand how this variable functions in the context of a story's plot.

In their story, "The Hole", another group of ninth graders introduce us to another type of characterization via Roy, a delusional young man who is restrained by his family because he insists on digging holes. Roy digs holes because he is instructed to do so by a fun-loving bunny rabbit, that only he sees. Beneath his house, Roy constructed an entire world where he and his bunny friend can cause destruction. When Roy expresses his distaste for the rabbit's incessant chattering (about non-sensical things), he barks at the rabbit: "Who are you, anyway?" The rabbit answers: "But Roy, I am *you*!" This type of character development demonstrates a dynamic understanding of character and the range of possibilities that can be considered when formulating characterization. Here, the students create Roy, who is odd and anti-social, but who has control in his purpose (to create underworlds), even if his mind deviates from reality. The students have developed a character with multiple personalities, using the space of the game to explore a complex range of character traits. We see this as evidencing a dynamic understanding of the abstract concept of characterization.

Another group created a horrific tale called, "Flesh Eating Predator", where three friends are trying to find a party, but they seem to show up to an empty house with a creepy host (who is potentially the predator). Two of the friends, Anna and Caroline, are concerned with the appropriate social behavior (wanting to party), but their other friend, Kelly, seems intent on saying socially inappropriate things about her dog and her mom. In this video, we see the students experimenting with social norms for their age group. The character of Kelly, who says socially inappropriate things, might represent their fears about being socially outcast. Once again, we see the students experimenting with different types of characterization, not linked to any concrete prop, but representing an amalgam of real life and mediated experiences.

In both of the stories "The Hole" and "A Burning Passion", we witness students developing characters who struggle with character flaws. These flaws offer the promise of doom, but overcoming the flaws offer the promise of stability.

In the case of "A Burning Passion", the plot centers on Joseph's struggle to be intimate with others, because he fears that they will catch on fire (as do all the people who Joseph tends to love). The development of the plot in the students' film gives them a chance to explore the concept of characterization from a multi-dimensional perspective, rather than the static identification of elements that are offered in traditional texts. We see this exploration through the lens' of Piaget and Inhelder's formal operational stage. Here, the game space offers the students the ability to play with various formulae related to the concept of character. The open nature of *Minecraft* gives the students (or players) the tools to construct characters and plots that, while archetypal in their nature, represent their own abstract understanding of characterization and character development, and are not tied to specific text. "A Burning Passion" demonstrates experimentation with a range of possibilities in terms of a story's plot.

In "The Hole", Roy, a delusional young man, also struggles with his character flaw, this time presented as a mental illness. In the final climax, Roy battles his alternate ego and destroys him in order to join the ranks of his more "normal" family. Again, the students experiment with plot lines to understand how characters resolve or succumb to their flaws. These archetypal stories demonstrate that the students have long observed these concepts in popular media and instructional material. In this case, however, *Minecraft* is a vehicle where they can experiment with those concepts in more abstract ways, ways we believe mark the maturation to more formal operational thinking.

"The Flesh-Eating Predator" narrative is less resolute. Kelly is murdered by the predator; and her friends meet a similar end. We felt that this data was not as rich in its display of characterization and plot, but we think it has less to do with the students' understanding, and more to do with the technological scaffolding that is required to use *Minecraft*. Our analysis of *Minecraft* has mostly focused on the narratives that our participants produced within the game. However, underlying the more aesthetic elements were the technical production skills that were required to create such dynamic narratives. If the students did not master the technical skills of the game, either through the scaffolding of their instructor (or via collective networks on the Internet, such as YouTube), then their exhibition of the more abstract concepts were not as successful. For example, "Flesh-Eating Predator" is not as strongly developed as the other films. Although there are underdeveloped characters and unclear plot lines, one of the major flaws of "Flesh Eating Predator" was the students' technical skill within the game. They used the same avatar for both a victim and a murderer, so it is unclear which character is which. Although all the students were amateurs, the weaker skill set in this group demonstrates the definitive link between technical skill within the online video game and the concept development.

The next section describes our observations of the style of teaching that the instructor implemented in this case study. As a part of our larger discussion, we see that this style is more hospitable to tools like *Minecraft*, but it is not the norm. We see that the more traditional instructor-centered style blocks the diffusion of technologies like *Minecraft* in the classroom. However, we do not place the blame

on teachers, but suggest that there may need to be organizational shifts in the educational system as a whole.

15.4.1 The Next New Thing

The connection between games, teaching, and learning activities has been challenging even to the most experienced teachers. As noted before, game development, as with educational software in general, has not been in sync with curriculum development or needs. The experience for many teachers using any form of media (e.g., film, video, television, "educational" software) over approximately 75 years has been the same: the new technology solution was not designed with the curriculum in mind (Cuban 1986, 2001) Cuban (1986) noted that as each new technology was introduced as the new "panacea" for education, reality in the classroom showed just the opposite (e.g. film strips breaking, projector bulbs burning out, keyboards not working, and more). These problems make it more likely that teachers used technology only as a supplement, as opposed to infusing it into the teaching and learning process, exploring student's excitement with media. "While games may provide interesting formats and add motivation to various activities, a missing critical piece is helping teachers learn how to think about games within teaching content" (Schifter 2014).

A decade ago, 100 % of all public schools in the U.S. had access to the Internet with 93 % of public school classrooms having Internet access. The ratio of students to computers with Internet access was 4.4–1. With the advent of new tablets and portable devices, and the Bring-Your-Own-Device initiative that have emerged in the last few years, this ratio has no doubt changed for the better. However, access to devices does not always translate into appropriate pedagogical use. If teachers are not prepared to use the new technology, whether software or hardware, the tendency is to not use it at all. In addition, in Schifter's review of professional development (PD) for using technology in classrooms (2008), she noted that, while "authors continuously 'recommend' sustained PD that is rooted in classroom needs and practice", the reality of most teacher PD around using technology solutions in their practice tends to be 1 day or one half-day sessions that may or may not directly relate to what they are trying to accomplish in their classroom. More likely than not, the PD is about the latest gadget that was acquired by the district, which the teacher may or may not have in their classroom.

The teacher who was the subject of this case study taught English in a high school. This is an anomaly to start with because typically the teachers who embrace the use of new technologies in their teaching are either the technology teacher, or early childhood teachers. This instructor had been exploring uses of *Minecraft* before he proposed using it as a medium for students to demonstrate their knowledge of characterization and plot. He had been collaborating with a community college teacher in California around how this new game environment might be used to explore Japanese internment camps from World War II. From his conversations

with the teacher in California, this teacher decided he would explore how the game environment could support his honors students, to give them a different way to respond to the required content around characterization and plot. As noted, rather than take an established text and analyze for characterization and plot, he chose to have his students take on the task of developing a story line along with developing the characters who would be part of the story.

As this teacher said in an interview, "My colleagues thought I was wasting time with *Minecraft* project, asking why I did not just give them a short presentation on characterization and plot and be done with it in a day." (Reeves, C., personal communication, April 23, 2012) While it would have been easier to do just that, this instructor chose to take the harder path which included introducing the students to the game environment since only one student had played the game before, and teaching them how to use the video editing tools required to create their *machinima*. The *Minecraft* project took approximately 5 weeks to complete. He also needed to support the one group of girls who chose not to use *Minecraft* in their project, but to use a traditional camcorder to record their video.

From observing the teacher within *Minecraft* working with his students, he was extremely familiar with the tools and able to help the students build and develop their characters. He stated in one interview that he showed one student how to change his avatar's skin, and that student took it upon himself to teach all the others in the class. Students took it upon themselves to teach each other the skills they were developing as they explored how to function within the game environment. And perhaps that is one advantage of *Minecraft*, in that, with the free online version of the game, a user can explore and try out new techniques, after which they become the "expert" to teach others in the classroom.

Using the constructionist approach to demonstrating knowledge, this instructor allowed his students to explore a game environment in order to demonstrate their narratives which in turn reveal their fundamental understanding of characterization and plot development. As Papert suggested, exploration and construction through the game environment allowed two of the stories to exhibit a level of understanding that met the demands of the assignment (as demonstrated through Mr. Reeve's grading using an evaluation rubric). While his colleagues were telling him to take the "easy way" and just read a story, this high school English teacher chose to give the students a challenge and to allow them to explore and construct their knowledge using an online game environment.

15.4.2 A Thousand Tiny Cuts

Papert wrote *The Children's Machine* (1993) to reflect on his experiences trying to implement *LOGO* into classroom practices, and instructionism versus constructionism pedagogical practice. He addressed those claims that were similar to Cuban's (1986, 2001), saying that the over emphasis on one particular digital tool or "transitional object" would be myopic, and couldn't possibly affect a

total sea change. Rather, reformers should think about the gradual shift, as digital tools become more popular and relevant in children's lives outside of school, they will fail to legitimize the traditional instructionist experience. He argued the overwhelming popularity of computing tools (which were infinitesimal in 1993 compared to today) would eventually forge a shift in education because students would find the instructional experience so unrelated to the learning experiences found in their everyday computing experiences. In his words, "To the extent which children reject School [sic] as out of touch with contemporary life, they become active agents in creating pressure for change. Like any other social structure, School [sic] needs to be accepted by its participants. It will not survive very long beyond the time when children can no longer be persuaded to accord it a degree of legitimization" (Papert 1993, pp. 5–6). Thus Papert claimed that the gradual influx and popularity of tools like *Minecraft* would draw power away from the instruction-based system.

This exploratory study of one high school English teacher demonstrates that there are teachers who see that the traditional, behaviorist approach to teaching does not work best for some students. Albeit, the students in this case study were honors students, which says they were already advanced in their abilities to demonstrate learning. However, the idea that technological tools, whether *Minecraft* or some other productivity tool or game environment, can support teaching boils down to whether the teacher is willing and able to take the chance. The educational environment in the United States in the early Twenty-First Century is one of testing and accountability. If introducing a game environment does not result in students doing better on the high stakes tests, teachers will not take that chance. Papert argued for students to be given the chance to explore and make mistakes, and to learn from those mistakes rather than merely memorize names, dates, and places. This teacher was willing to take that chance.

15.5 Conclusion

We see the popularity of experiences like *Minecraft* as evidencing the potential of this shift away from instructivism toward contructivism and construct*ion*ism. Our exploratory analysis revealed some of the possibilities *Minecraft* offers to learners who are exploring and experimenting with abstract concepts. Students repeatedly demonstrated an understanding of the concepts of characterization and plot that were much more dynamic than a simple identification exercise presented through a static text (e.g., *Tom Sawyer*). But more importantly, we chose to use *Minecraft* as an educational tool because it was not only so commercially popular, but had inherent learning experiences embedded in game-play.

Although our interest was to use Piaget and Inhelder's notion of the formal operational phase of development to understand the type of learning possible in

Minecraft, we believe these data evidence a growing trend in the twenty-first century classroom. We feel our analysis shows that twenty-first century technologies such as *Minecraft*, provide students with the opportunity to construct knowledge in meaningful ways and in situated environments that are highly impactful. In fact, many scholars, such as Gee and Hayes (2011, 2012) suggest that these preferred modes of learning are more salient and relevant for the current global marketplace.

The goal of any exploratory study is to understand the need for deeper inquiry, and we believe our data have evidenced the potential for *Minecraft* to provide meaningful learning scenarios of which others have discussed (Gee 2007; Shaffer 2006; Squire 2005). As we proceed, we are trying to balance the open-nature of game with the culture of standardized assessment that drives the current educational culture. We believe that a multi-modal approach is needed going forward, with quantitative analysis using structured task completion within the game, and qualitative interviews to understand the creative process within the game. Also, in future study, we will observe and evaluate the nature of the social constructivist learning that occurs in *Minecraft*. We didn't aptly capture this part of the gaming experience, and we acknowledge that it holds vast implication for how the game is experienced.

This paper reinforces the notion that there is a tension between the knowledge production that is characteristic of the game, and the instruction-based culture that dominates the contemporary classroom. As digital technologies shift the type of epistemology and modes of production that hold currency in the global market, it will be necessary to resolve these tensions in order to provide students with more valuable and meaningful skills in their professional lives. We see this small project as evidencing a much larger transformation at work.

This work is limited by the fact that the sample was a sample of convenience, limited to only one English high school teacher in one small rural district in a state in the New England part of the U.S., and limited to student participation in one spring semester only. While the teacher stated that he would have liked to have the same students use the game environment for an additional assignment, the end of the school year precluded this occurrence. Findings cannot be generalized to either other high school English classes or teachers, or other subjects taught in high school in the U.S. Additional research is needed to better understand how a virtual game environment, such as *Minecraft*, can be harnessed to support assessment of student understanding of content, as demonstrated through their activities and constructions within the game environment. Game-based learning has extensive literature (see Ferdig 2009), however, the use of virtual game environments for assessing knowledge has not been extensively explored. (Shelton et al. 2013; Schifter et al. 2010)

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References

Anderson, C. A., & Dill, K. E. (2000). Video games and aggressive thoughts, feelings, and behavior in the laboratory and in life. *Journal of Personality and Social Psychology, 78,* 772–790.

Bandisoft, Inc. (2013). Bandicam (Version 1.9.505). [Screen recording software]. http://www.bandicam.com/.

Banks, J., & Potts, J. (2010). Towards a cultural science of online videogames: Evolutionary social learning. *Cultural Science, 3*(1), 1–17.

Bavelier, D., Green, C. S., Pouget, A., & Schrater, P. (2012). Brain plasticity through the life span: Learning to learn and action video games. *Annual Review of Neuroscience, 35,* 391–416.

Boellstorff, T., Nardi, B., Pearce, C., & Taylor, T. L. (2012). *Ethnography and virtual worlds: A handbook of method*. Princeton: Princeton University Press.

Bruckman, A. (1999, March). Can educational be fun? Paper presented at the meeting of the Game Developers Conference. San Jose, CA.

Cuban, L. (1986). *Teachers and machines: The classroom use of technology since 1920*. New York: Teachers College Press.

Cuban, L. (2001). *Oversold and underused: Computers in the classroom*. Cambridge: Harvard University Press.

Duncan, S. C. (2011). Minecraft, beyond construction and survival. *Well-Played, 1*(1), 1–22.

Ferdig, R. E. (Ed.). (2009). *Handbook of research on effective electronic gaming in education* (Vols. I–III). Hershey: Information Science.

Gee, J. (2007). *What video games have to teach us about learning and literacy* (2nd ed.). New York: Palgrave Macmillan.

Gee, J., & Hayes, E. (2011). *Language and learning in the digital age*. New York: Routledge.

Gee, J., & Hayes, E. (2012). *Women and gaming: The Sims and 21st century learning*. New York: Palgrave McMillan.

Ito, M. (2008). Education vs. entertainment: A cultural history of children's software. In K. Salen (Ed.), *The ecology of games: Connecting youth, games and learning* (pp. 89–116). (The John D. and Catherine T. MacArthur Foundation Series on Digital Media and Learning). Cambridge: The MIT Press.

Kafai, Y., & Resnick, M. (1996). *Constructionism in practice: Designing, thinking & learning in a digital world*. Mahwah: Lawrence Erlbaum Associates, Inc.

Malone, T., & Lepper, M. (1987). Making learning fun: A taxonomy of intrinsic motivations for learning. In R. E. Snow & M. J. Farr (Eds.), *Aptitude, learning, and instruction: Conative and affective process analyses* (Vol. 3, pp. 223–254). Hillside: Lawrence Erlbaum Associates.

McGonigal, J. (2008). Why I love bees: A case study in collective intelligence gaming. In K. Salen (Ed.), *The Ecology of games: Connecting youth, games and learning* (pp. 199–228). (The John D. and Catherine T. MacArthur Foundation Series on Digital Media and Learning). Cambridge: The MIT Press.

Papert, S. (1980). *Mindstorms*. New York: Basic Books.

Papert, S. (1993). *The children's machine: Rethinking school in the age of the computer*. New York: Basic Books.

Piaget, J., & Inhelder, B. (1969). *The Psychology of the child*. New York: Basic Books.

Salen, K. (2008). Toward an ecology of gaming. In K. Salen (Ed.), *The Ecology of games: Connecting youth, games and learning* (pp. 1–20). (The John D. and Catherine T. MacArthur Foundation Series on Digital Media and Learning). Cambridge: The MIT Press.

Schifter, C. C. (2008). *Infusing technology into the classroom: Continuous practice improvement*. Hershey: Information Science Publishing.

Schifter, C. C. (2014). Games in learning, design and motivation. In M. Murphy, S. Redding, & J. Twyman (Eds.), *Handbook on innovations in learning*(pp. 151–166). Philadelphia: Center on Innovations in Learning, Temple University.

Schifter, C. C., Ketelhut, D. J., & Nelson, B. (2010). Presence, piaget's stages of development and middle school children perception of an immersive virtual game environment. Presented at the International Conference Cognitive and Exploratory Learning in a Digital Age (CELDA, 2010), October 16, 2010, Timisoara, Romania.

Shaffer, D. (2006). *How computer games help children learn*. New York: Palgrave MacMillan.

Shelton, A., Natarajan, U., Ketelhut, D., Felix, D., & Teufel, C. (2013). Evaluating student understanding in virtual environment-based science assessments: Comparative measures for content knowledge and inquiry. Paper to be presented at the annual meeting of the National Association for Research in Science Teaching (NARST). Puerto Rico: April 6–9, 2013.

Squire, K. (2005). Changing the game: What happens when video games enter the classroom? *Journal of Online Education, 1*(6). http://website.education.wisc.edu/kdsquire/tenure-files/26-innovate.pdf.