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PIAGET, INHELDER AND *MINECRAFT*

Catherine C. Schifter[1], Maria Cipollone[2] and Frederick Moffat[3]
[1]*Ph.D*
[2]*A.B.D.*
[3]*M.A.*
Temple University

ABSTRACT

This paper describes an exploratory study observing the use of *Minecraft* (a popular sandbox style online video game environment) in a high school English literature classroom. We use Piaget and Inhelder's (1969) constructivist theories about the formal operational stage of development to interpret the concepts of *plot* and *characterization* in three student produced films that were created within the game environment. We claim that *Minecraft* can be used as a tool to assist in the cognitive development of its players through the practice of constructed learning. *Minecraft's* popularity implies that this type of knowledge production is preferred by youth for informal learning, and has vast implications for educational curricula.

KEYWORDS

Piaget; online/video games; *Minecraft*; constructivism.

1. INTRODUCTION

The relationship between online video games and learning is an incredibly synergized and fashionable topic in academia, K-12 education, and industry. Scholars hold that online video games provide myriad opportunities for players to learn via problem solving, persistence, innovation, and a dynamic web of choices that motivate millions of players (Squire, 2005; Shaffer, 2006; Gee, 2007). These opportunities are available both to consumers and producers of online video games.

James Paul Gee (2007) compelled many to understand the benefits of online video gaming and its embodiment of deep and meaningful learning practices. Gee was certainly not the first to advocate for online video games as a form of learning (see Ito, 2008), but certainly his dissection of the challenges and opportunities inherent in online video games has drawn attention to 'good video games' (Gee, 2007, p. 12). Gee (2007) praises good video games (i.e., the most commercially successful video games) and their ability to provide players with a space for meaningful skill acquisition and collective intelligence gathering.

While academic interest in online video games and learning is almost as old as online video games themselves (close to 40 years old), it is only recently that scholars have acknowledged that the medium implicates a different set of learning practices and outcomes. Mizuko Ito's (2008) complex analysis of computer games demonstrates that traditional views about learning and curriculum can dampen the benefits of games, and take motivation completely out of the equation. When game designers try to embed games with instruction-centered K-12 curriculum, the motivational, collaborative, and engaging elements of the game are mostly lost on its audience. Ito explains that many online video games that are created with educational purposes are, "[F]ocused on curricular content, rather than innovative game play" (2008, p. 93). These games emphasize external rewards and reinforcement for very school-like tasks (p. 94). Gee's (2007) work points out that good online video games are not designed with learning scenarios in mind, rather they are naturally embedded with learning contexts.

Good (i.e., popular) online video games—which *don't* overlay traditional instructional practices onto gaming landscapes—present players with learning scenarios startlingly different from the structural elements of the typical K-12 learning environment. This study demonstrates that the knowledge produced in a very popular online video game (*Minecraft*) presents a radically different notion of learning—albeit one that may support cognitive development.

The success of online video games will depend on an acceptance of a new style of teaching and learning—one that is centered on exploration, production skills, and self (or collaboratively) authored artifacts (McGonigal, 2008; Gee & Hayes, 2011; 2012).

We see the popular sandbox game, *Minecraft* as providing these opportunities. Like the "good" online video games we have described, collaboration and collective knowledge production are a large part of *Minecraft*'s popularity. However, *Minecraft* is a unique game that promotes a very different type of learning scenario—especially in comparison to the games that others have focused on (Gee, 2007; Ito, 2008; McGonigal, 2008). In the following section, we will describe our motivation for choosing to study *Minecraft* in the context of the traditional high school classroom.

2. MINECRAFT AND PIAGET

Garnering millions in revenue (Duncan, 2011), *Minecraft's* success is not evident from its digital graphics or its game narrative. Markus "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.

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*). The game is also a descendent of digital authoring tools such as Seymour Papert's *LOGO* that intended to encourage authoring by teaching programming to students. Whether gaming or programming (or both), these tools encourage a constructivist notion of learning, where players (or students) are given tools for learning via experimentation and "tinkering" rather than conveying specific content (Ito, 2008, p. 101).

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 & Potts, 2010, p. 6). 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.

Although the modifications evidence the highly collaborative aspects of the game and the game culture, our focus is on the highly constructivist 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 with 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.

2.1 Constructivism in the Context of *Minecraft*

We see *Minecraft* as a sandbox game that is heavily entrenched in the constructivist model of learning. In the context of education, constructivism is a way of building knowledge through meaningful interaction and experimentation with content. This theory suggests knowledge and truth are not universal, but each individual 'constructs' knowledge through direct interaction with the content.

Although there are many scholars who are associated with this educational model, we focus on Piaget's constructivist theory of cognitive development in this essay because of its lineage to digital learning (we explain below). We chose Piaget's notion of the *formal operational* phase because there is little written on about the ways that technology might support transitions into this particular phase of higher order thinking. We also believed that Piaget and Inhelder's (1969) writings on the "experimental spirit" —which is crucial element to the constructivist model of knowledge production—are most clearly aligned with the culture of *Minecraft*. We did see evidence of Piaget and Inhelder's (1969) concepts in our data, but we propose in future analysis to observe these crucial social aspects.

We use Piaget and Inhelder's (1969) developmental theories about the formal operational stage to guide our analysis of the products of their game play. We argue that *Minecraft* can be seen as a tool for the exploration of concepts that aid cognitive development—whether the understanding of logico-mathematical relationships in the concrete operational stages— or in this case, the abstract understanding of hypothetical outcomes in the formal operational stages. Specifically, our data suggest that the students used *Minecraft* as a tool to explore the abstract concepts of *plot* and *characterization* that were not tethered to a specific work of literature, rather they demonstrated a more complex (beyond concrete) understanding of these concepts by considering alternative combinations of elements (while following general rules).

2.2 Theoretical Framework

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 seven 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).

The authors describe this phase as the emancipation from content, where the young individual is able to integrate his or her knowledge of concrete operations, but in a much richer, dynamic and imaginative way. He or she is no longer constrained by ego-centrism, or tethered to the physical object being in front of them. They elucidate the difference between preadolescent and adolescent understanding of the behavior of space through a series of (confusing) experiments with both age groups. In their experiments, Piaget and Inhelder asked children in the concrete operational stage and formal operational to understand what specific characteristics of a rod (made of wood, plexiglass, or metal) would make it bend when a weight was hung from it. The rods were also of varying length and width. When the children in the concrete stage would test the rods, they would attribute the bending of a rod to its length, even if when compared to another, a shorter rod of the same material would bend just as easily. The concrete group would quickly make determinations about what characteristics made a rod bendable based on one variable (e.g., length, width or material), and one possible combination of the two. The formal operational group possessed a dynamic "experimental spirit" (p. 136), whereby an individual in this stage, will test all possible combinations of rods to consider all the variables (length, width, material), and control for certain variables (e.g., do two plexiglass rods of different lengths but the same width also bend with the same amount of weight tied to them?).

Although confusing in their description, these observations demonstrate that individuals are assimilating 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 to 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 & 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* is 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 theories of cognitive development are at the foundation of the constructivist view of cognitive development and learning. In our study, the students assimilate new knowledge in the formal operational stage via experimentation and expression in *Minecraft.*

3. RESEARCH METHODS AND QUESTIONS

In early 2012, the authors collaborated with a high school instructor in New England, as a result of many shared conversations about *Minecraft* and its potential for learning. The high-school instructor proposed to use the game 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 understand the pedagogical value of using *Minecraft* in as a classroom tool.

According to the instructor's informal survey of the class, only one 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 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 ("Home", n.d.), or they could create a live-action narrative film using a camcorder. Four female students decided to not to use *Minecraft*, while the other four groups (one of which didn't finish the final film) chose to develop their stories using *Minecraft.* We know little about why these females chose not to use the virtual space, but we hope to explore these challenges in future research projects.

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, Nardi, Pearce and Taylor (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.

4. RESULTS AND DISCUSSION

Rather than code the transcripts of the films, but 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 that 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 Desire", the plot centers on Joseph's struggle to be intimate with others, because he fears that they will catch on fire (as all the people who Joseph tends to love do). 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 Inhelders' 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 "A Burning Passion", Joseph's continued struggle with his flaw (auto-pyromania?) demonstrates that students have observed many types of characters throughout their cognitive development, both via traditional print texts, films, and television. Joseph's story is reminiscent of a superhero that struggles with his powers, and is isolated from the thing he desires most: love and intimacy. In the story, Joseph finally opens his heart to another (Jessica) and has a child, only to watch them both be engulfed in flames as the dénouement to the tale. We could certainly discuss the implications of these aesthetic choices in the context of their adolescence, but our analysis is more interested in the ways that *Minecraft* provided the students with an opportunity to develop a plot in a way that demonstrates their transition to the formal operational stage. "A Burning Passion" demonstrates experimentation with a range of possibilities in terms of a story's plot. Like the children experimenting with different rods, weights, and materials in Piaget and Inhelder's experiments, the students in our study are toying with the different variables and combination of elements in the concepts of characterization and plot.

In "The Hole", Roy, a delusional young man, also struggles with his character flaw, this time presented as a mental illness. Although Roy develops an alternative personality that compels him to dig holes, and build an underworld (where the walls are lined with explosives), when his sister comes to rescue him, she is able to coax him back from his violent ways. 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.

5. CONCLUSION

Our exploratory analysis revealed some of the possibilities *Minecraft* offers to learners who are 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*).

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 21st century classroom. We feel our analysis shows that 21st 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 (Squire, 2005; Shaffer, 2006; Gee, 2007). 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.

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