Advances in Game-Based Learning

Carmela Aprea
Dirk Ifenthaler *Editors*

# Game-based Learning Across the Disciplines

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# Chapter 17
# Could Minecraft Be a School?


## What Are the Transdisciplinary Implications of This Game-based Learning Environment?

**Bryan P. Sanders**

## 17.1 Minecraft: A Learning Environment

School tends to repeat itself. Educators and administrators often choose projects and practices from prior years. Something that worked before likely will work again. This assumption dominates the thinking and proliferation of "downloadables" readily available for free and for purchase on the Internet today. Computers in classrooms are often used to digitize and distribute worksheets and exercises that were once on paper. Computers are less used by students for computing or work that could only be done with a computer than they are for completing tasks within a generically designed content management system that favors administrator oversight, information dissemination, and information gathering.

Traditional school arrangement supports the generalized and simplistic use of computers as an electronic grade book or paper collection and dissemination tool. The traditional school model relies on predetermined student outcomes for the grade level and course completion. The prerequisites for gaining entrance into higher levels of a subject combined with established and planned curricula suggest narrow pathways to getting educated and earning degrees. However, one can simultaneously expect to hear discussion of teaching the whole child and read school mission statements about the importance of the individual student, holistic goals that become difficult to achieve in a lockstep environment. School as an institution seems to be of two minds about how to engage with the students' interest and also maintain order and focus. Flexibility and responsiveness to students are often exchanged for standardization.

In the USA, the national criterion-referenced assessments show flat progress for many years. Any growth in test scores within any of the standard subjects at the

B. P. Sanders (✉)
Loyola Marymount University, Los Angeles, CA, USA



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three benchmark grades, 4th, 8th, and 12th, is slight and not sustained in a steady manner over time since 1992 (NAEP, 2020). Standardized and predictable experiences for students have yet to demonstrate an impact on how much content they can understand and retain for tests. And while there exist pilot programs and thought experiments in individual schools and classrooms that advocate for different approaches to learning environments, most students are guided along well-worn paths to graduation and matriculation.

Game-based learning environments present new ways for students to encounter, interact with, and create information. Minecraft is a block-building game environment where the player can theoretically create almost anything imaginable. It can be used in a sandbox style without health and score points, or it can be played in a manner aligned with game objectives and obstacles. Sandbox style is called "creative mode" and gives players unlimited access to all of the items in the game without having to find or craft them. The objective style is called "survival mode" and it requires players to battle creatures as well as find all resources to craft more advanced items. In either case, though, the software architecture of Minecraft is open enough to allow both the sandbox and the objective approach to be modified, and this adds significant value to its reach, intrigue, and purpose. Custom components can be created or imported to make the game environment match the intended look, feel, or purpose. As a computer game, it is the first of its kind to reach over the culture war lines to grab the attention of gamers and educators alike.

Furthermore, Minecraft grows in its potential as a virtual learning environment when collaboration occurs. It aligns with the constructivist philosophy and offers many entry points for students to engage. The current education version can allow thirty players at once in a shared world, and the original Java version of the game can allow thousands of players. Collaboration and sharing are further encouraged in Minecraft since there is no official instructional manual or official manner in which the game must be played. This openness aligns with constructivist principles due to the reliance on the players themselves to develop the materials. And in the 10 years since its inception, Minecraft has inspired people of all ages to create and share innumerable guides, articles, videos, and playable worlds. While this serves as a testament to the power and reach of Minecraft as a game-based learning environment, some criticism of Minecraft comes from the strong possibility that students' skills and knowledge of the game far exceed their teachers'—this unusual power relationship may deter educators from engaging in a new approach.

Of late, there is a marked increase in interest and use of Minecraft: Education Edition in schools. Microsoft's education department created an opt-in cohort of educators willing to volunteer to work on Minecraft: Education Edition lessons, activities, units, teacher training, and campus deployment at schools around the world. The game has significant interest and logged gameplay hours from both children and adults in schools, but is it malleable and engaging enough to move away from mostly completing lessons, activities, and units? Could Minecraft be a school? What are the implications for teaching and learning if schools stopped requiring a planned curriculum and instead engaged in an immersive game-based learning environment?

## 17.2 Current Research on Minecraft in Education

Many proponents of new pedagogical approaches still have concerns regarding student performance on traditional criterion-referenced assessments. These concerns are not new and have been addressed with some studies over the decades, though their impact appears to be small when taking a longitudinal look at the dominant culture of traditional schooling. In an important case study conducted in 1990, Dr. Seymour Papert led the way with Idit Harel to demonstrate and document how a constructionist approach using computers could help students acquire knowledge and have memorable learning experiences. Indeed, the study showed the positive impact of their Logo mathematics experimental approach where students worked on computers in an interactive learning environment covering traditional material. The same material taught to a control group via traditional methods resulted in the students in the experimental group scoring higher on a classroom examination than the students learning via the traditional method (Harel & Papert, 1990). Thirty years later, however, this remains an open question for some educators and policymakers.

A recent though small study of using gamification in Minecraft as an intervention "to help respondents improve their understanding and skills in probability" indicated an increase in performance on a traditional paper-pencil test. This was measured by a pretest and posttest method with Minecraft used as an experiential approach in between (Ming, 2020). A qualitative method was also mixed into this study that offered students an opportunity to examine and reflect on the remedial efforts and their impact on helping them understand the material.

A study of this sort is still needed on a large scale across continents to test for impact in bigger sample sizes. If replicated, it will be useful to see if these conclusions using Minecraft gameplay hold true. Ming argues that it can "positively impact students' abilities to master mathematical concepts and skills. The use of these gamification elements can help students cope with the difficulties they face as well as facilitate and speed up their task of solving. Minecraft can enhance students' confidence and curiosity as they work hard to complete the tasks provided in the Minecraft virtual world." (Ming, 2020) These claims are tempered by the sample size but also reside in a thoughtful and powerful subsection of constructivist learning that focuses on student-centered experiences with games and projects. A growing number of educators have combined their traditional classroom approaches with computers, and while software companies dominate the public conversation, more researchers than ever before are studying Minecraft.

A recent literature review study of 28 articles published between 2012 and 2019 found in the ProQuest database about Minecraft in educational settings demonstrated some intriguing trends in student behavior and educator attitudes toward the use of the game. The review also raised some worthwhile provocations for further pursuit in research and action, such as highlighting the problem of time that classes face when they engage in a game-based learning experience. Furthermore, many

educators encounter tensions from stakeholders as informal and formal learning coupled with pedagogy are blended together via games.

The study "examined Minecraft integration strategies in classrooms, as well as student benefits in terms of engagement, interest, academic achievement, and knowledge acquisition." (Baek et al., 2020) A noteworthy limitation acknowledged in the study points to a need to continue looking for ways to quantify some of the observations and hunches that educators and researchers have about Minecraft: "The lack of related verified theory or frameworks only indicates the scarcity of experimental studies employing Minecraft; there are significantly more qualitative than quantitative studies of Minecraft in education." (Baek et al., 2020) Also of interest is that the 28 articles they studied had a majority focus on elementary school, language arts, and playing the game instead of engaging in other activities, such as building in Minecraft or modifying the game. This can serve as inspiration to continue studying the use of Minecraft as an educational environment and help determine where educators go next when considering creating immersive experiences for students. Certainly, some of the articles in the review focused on other grade levels, subject matters, and activities in the game, but this weighted set of data suggests a trend of how Minecraft might so far be used and understood by teachers and researchers alike.

The table below organizes the data put forth by Baek et al. and will help anchor some thinking. The authors of the study highlighted specific educational benefits and educational experiences students can encounter in classroom Minecraft gameplay (Table 17.1).

While the majority of the work covered in the 28 articles from the literature review by Baek et al. emerged from Language Arts lessons, the table summary demonstrates far more documented potential for using Minecraft in school. Not only a range of subjects was documented but also many mindsets and pedagogical stances. That said, the documented use in the articles studied by Baek et al. tends to be supplementary lessons or companion experiences to immerse in content, while simultaneously the authors acknowledge that full immersion provides the greatest gameplay for students to discover and uncover new features and ways to collaborate. Some educators were described as encountering issues of time management and task management, which is at odds with a fully immersive gameplay approach that might follow student inquiry and choice to co-create the curricula.

As the number of classrooms with Minecraft gameplay grows, and the research about them grows in kind, more opportunities to refute or confirm some of these findings will emerge. However, the suggestion is clear that if families and educators were willing to forego imposed restrictions from external sources then there would exist far different data for researchers to analyze, as "curriculum inflexibility also offers resistance to incorporating digital game play." (Baek et al., 2020) This desire to decouple the classroom from the curriculum connects to the idea designed into the Harel & Papert (1990), which boldly abandoned the traditional method in its research design hypothesis.

Yet another recent review of 59 articles regarding digital game-based learning environments ventured into a similar territory but with a specific focus on studying

**Table 17.1** Summary of ideas regarding Minecraft uses found in 28 articles discussed by Baek et al. (2020). Any of the benefits in column one can link with any of the experiences in column two

| Educational benefits of using Minecraft | Educational experiences students can have in Minecraft |
|---|---|
| Hands-on learning<br>Immersive learning<br>Constructive learning<br>Connect and interact with previously studied materials<br>Exploration of material, landscapes, and structures<br>Independence of thought<br>Stimulate curiosity and creativity<br>Interact with objects<br>Connect to personal experience<br>Alternative to memorization<br>Alternative to static images<br>Capitalize on student interest, motivation, and engagement<br>Encourage deeper knowledge of specific subjects and specialized knowledge<br>Promote global participation and intercultural competencies<br>Increase interest in writing topics<br>Facilitate writing topics<br>Develop literacy and information literacy<br>Develop composition skills<br>Employ problem-solving and critical thinking<br>Stimulate critical thinking, creativity, and collaboration<br>Reduce student self-perception of barriers to learning<br>Steady stream of student-generated peer communication<br>Boost student drive to learn<br>Reticent students emerge as leaders<br>Flipped classroom potential<br>Promote informal learning processes | Experiment with and simulate socioeconomic and environmental conditions (Biology)<br>Generate different biomes and explore a variety of naturally occurring materials (Biology)<br>Create models of biological structures (Biology) |
| | Illustrate the phases of matter through simulations (Chemistry)<br>Interact with a three-dimensional periodic table (Chemistry)<br>Simulate phenomena (Chemistry) |
| | Build recognizable structures and calculate area, volume, and perimeter (Mathematics)<br>Measure surface area and volume of unusual shapes (Mathematics)<br>Manipulate formulas while building and creating (Mathematics) |
| | Examine and build historical entities (Social Science)<br>Navigate through the virtual historical space (Social Science)<br>Observe the scenes that simulate real-life situations (Social Science)<br>Plan the details and refinements of building with accuracy (Social Science)<br>Collaborate with others in large-scale construction (Social Science) |
| | Use time spent in-game as impetus and content for writing compositions (Language Arts)<br>Write in-game books and loan them to one another inside Minecraft (Language Arts)<br>Design characters and landscapes in-game and use them as content for expository writing (Language Arts)<br>Develop storylines about characters' adventures (Language Arts)<br>Explain the building process (Language Arts)<br>Participate in ongoing tasks that require collaboration and conversation (Language Arts) |
| | Link in-game interactions to musical compositions (Music)<br>Create musical compositions inside of Minecraft (Music) |
| | Engage in social gaming to increase communication among language learners (Language Acquisition)<br>Exchange in-game messages (Language Acquisition)<br>Develop maps to interact with the study of language and culture (Language Acquisition) |

English language acquisition. Xu et al. (2019) studied articles published from 2000 to 2018 with the intent of putting together a cohesive summary that would help propel further specific research diving deep into commercially made games as immersive environments to engage students in new ways of imagining the classroom. Their findings indicate that nearly 80% of the 59 studies "reported a positive impact on English language acquisition" while also acknowledging that about 75% of the 59 studies contained a small sample size of under 100 human subjects.

The call for more large-scale, large sample size research on using Minecraft as an immersive gameplay educational environment is clearly needed and also suggested in the review by Xu et al. (2019). A noteworthy additional aspect from their work asks for game designers to involve more educators and educational researchers in the development of their commercial game products. They also added a complex suggestion that classrooms using game-based play approaches implement "more standardized tests that align with commercial games, because this may improve the reliability and validity of research results." (Xu et al., 2019) While a sound suggestion to vertically align these inputs and outputs, it also demonstrates a philosophical underpinning in favor of traditional measurement. This could be interpreted as working against the aims of immersive constructivist and constructionist gameplay; however, it could also be interpreted as an attempt to pull together disparate strands of education and gameplay to unify and advance a shared vision for enhancing student learning environments.

Similar to the discussion of incorporating makerspaces into schools as standalone spaces with their own curriculum, the discussion of incorporating Minecraft receives a treatment that presents it more as a place to go instead of a way to think. This cognitive split in the research presents itself as the conflict worth addressing head-on and directly studying in both the classroom and research experiments that next emerge. A thorough exposition of how to play and what to do in Minecraft resides in a thoughtful chapter by H. Chad Lane and Sherry Yi (2017) which also makes clear the philosophical connection to Papert's constructionism (Papert, 1980). It is worth noting that this remains the most frequently discussed stance that educators raise in their anecdotes and articles: "Constructionism challenges the idea that 'verbally expressed formal knowledge' is a sufficient end point for education. It suggests that knowledge can be constructed by learners rather than simply being told, and that this learning should occur in the context of creation, invention, and exploration." (Lane & Yi, 2017) This flies in the face of traditional schooling and assessments. It is where private schools may have an advantage due to their freedom to create learning sequences free of standardized tests and textbook guidance that are required in public schools. This is also an issue of equity, then, as public school students may lack experiences that are provided to families with means. In their book, *Invent to Learn*, about inventing and making with games, computers, robotics, and crafts in the classroom, Dr. Gary Stager and Sylvia Martinez write that "quality work takes time, disobeys bell schedules, doesn't result in neat projects that work with canned rubrics, and might not have any impact on test scores" (Stager & Martinez, 2019). Again, the knowledge created by students when they *do things* that are constructive toward their own interests and goals overshadows their coerced

focus on worksheets and examinations. There exists a large historical body of work supporting learning by doing, and while there are limitations and controversies within the more recent studies and musings in game-based learning, it still is early in its own timeline as an approach to school that merits attention. Alternatively, as short as 5 years ago, the current hardware and software capabilities combined with the current interest from adults shows us that something new is rapidly emerging and captivating both students and teachers alike.

## 17.3 Children, Computers, and Powerful Ideas

A tradition of working with computers in classrooms with students is highly reliant on the work of Dr. Seymour Papert and his contemporaries. It was true then as it is now that classroom work with computers requires time dedicated to exploration, and this sits at odds with many school dictums for graduation outcomes and requirements. Students are asked to make sense of the world by making things when they engage in games, projects, and inquiries with a computer. This is the opposite of a planned curriculum and a battery of examinations that have been written years prior.

Of further interest in the study of working with computers is that the work people do with computers creates microworlds of the world outside of the computer. This alone is an engaging enterprise for it pushes on both the logic and the creativity of the individual to enter into an almost allegorical relationship with reality. This then dovetails into the microworld joining back into the world outside when one shares the "thing" that was made. The microworld expands via commentary, critique, and user interaction and then returns to the laboratory table where the creator debugs, augments, and improves the project. This feedback cycle has a further impact on how students view both their work and the larger world.

This experience briefly described earlier resembles to most people as a hobby or a business but not necessarily a classroom activity, learning experience, or pedagogical approach, let alone a school philosophy. Far more common is to segment off the computer class time from the rest of the week of academic work or to make it an elective or afterschool club. Programming, robotics, and web design courses are the most frequently separated components of students' experience in school, if there at all.

The sense that more could be done with the time spent in schools with students and computers is not one that is shared by all. In part, the dilemma stems from a history of the behaviorist method where computers were put to work as a delivery machine. The earliest teaching machines created by Dr. Sidney Pressey were rote learning devices designed for ensuring students had essentially memorized the content presented. A student would receive an initial output from the machine, and then the machine would receive input from the student in reply. Next, the machine would deliver a result indicating whether the student had the correct answer. From its inception, this worked well for technical knowledge such as operating heavy machinery or knowing the order of wires in a complicated electrical circuit. But

when applied to the classroom, there is far more to do than ask students to answer questions.

Applying a constructivist approach to using computers in schools would likely commit a significant amount of available classroom minutes so that students could freely explore the potential. It would no doubt take away from other things students are required to complete. This begs the question about the value of those subjects and tasks, as well as the value of computers, computing, and technology-based learning environments—or even using the computer as an object-to-think-with. The recent research cited above on using Minecraft as a game-based learning environment demonstrates some reluctance of schools to push past using it for much more than a substitution of previously planned lessons and activities. However, the long view of meaningful change in school recognizes the unique potential of each student and strives to design a learning environment suited specifically for each of their powerful, creative, and inventive minds. Students need engagement in experiences that keep them curious. And for some, Minecraft could very well be where students reject the worksheet and instead take control of their own minds, thinking, and creations.

## 17.4 What Could We Do If Minecraft Were a School?

The limits don't have to exist. Minecraft only has the limitations of one's imagination and access to reliable equipment. If one were to situate a school inside of Minecraft, it would acknowledge that educators often hold hostage the most engaging and transformative projects in their planned curricula. It would demonstrate that quarantining student-led work in specialty courses reserves the best practices for only a small percentage of students. It would perhaps prove that the common approach to experiential learning occurs when students behave in a manner consistent with the authority's wishes.

If Minecraft were a school, many long-held assumptions about how schools are organized would crumble. Instead of competing goals, there would be more cooperation of goals. Many have already questioned the need and value of ranking and ordering students in school. The goal of constructivist education places an emphasis on students finding their voices and purpose through learn-by-doing experiences. Grades and scores are by-products of a system that enforces compliance. That compliance is powerful and permeates so much of how a school asks students and teachers alike to operate. The sheer volume of tasks that students and teachers complete out of compliance is astonishing. In this submissive process, they all slowly abandon some portion of their autonomy, creativity, and thought production.

But in Minecraft, all players are immersed in a newly imagined multiplayer present that consumes their thinking and imagination in a longitudinal collaborative effort. With an infinite number of blocks with which to build, and the possibility to modify those blocks with infinite permutation, never before have students and teachers alike had the ability to move around and make things together inside of a

simulated environment. And as with any endeavor that has no specific goals predetermined by an outside agency, work and play in Minecraft can span over years and grow as its inhabitants bring to bear their inspiration, diligence, thinking, and creativity.

What will this experience of school in Minecraft look like? Done well, it ought to begin through exploratory play from the start. There is no better way to ruin a game or a project with students than to teach them every step or move or reaction of a newly encountered set of playthings. Let them find their way and mimic each other. No teacher would explain every rock, twig, or animal in the forest before going on a hike. Likewise, the act of discovery in Minecraft, and there is so much to discover and uncover, remains essential. Furthermore, it would behoove teachers to know how to play Minecraft, but they need not be experts.

As the work and play unfold, the dialogue and questions naturally occurring among students will create a curriculum of ideas to pursue. While some will certainly be about the mechanics of the game itself, many more will display the students' thinking processes and value systems. Most students enter a Minecraft world, see how big it is, and want to first work on creating a house to call their own. This instinct is one that might have in another lesson plan been a writing prompt about basic needs and the role of safety and comfort in creating a just society. Perhaps a debate or seminar would follow based on a text that discusses the balance of individual freedom and coexisting within a civilization. Those texts and discussions can and should still happen, although they can be ordered differently now that educators are asking students to immerse themselves in a game as the classroom. The texts can be scattered throughout the game world. The conversations can happen as a natural consequence of the power struggles that will emerge from the mostly harmless decision to build a house a little too close for comfort near a classmate.

No collaborative effort ever happened without conflict. Gameplay actually thrives on that conflict, though, for it creates an interactive visual of the conflict and also allows for rapid rebuilding or expansion. With an analog experience of physical materials manipulated with hands, conflict over the design or purpose of a structure leads to just as much strife as with digital, but with little room for the rebuilding. This element of computer-based collaboration could actually provide a healthy environment to explore and reinforce social skills that oftentimes are questionably taught by punishment in school. Restorative practices in communication and community building might have more success, particularly in the younger ages, when working in a digital project or game-based environment.

Educators also have an opportunity to engage deeply with students over long periods inside of Minecraft. Furthermore, educators can meet each other in the game to develop ideas together and prepare challenges or curricular materials to bring to their students. Even further, students and teachers from different physical classrooms in different subject matters but meeting at the same clock hour can all gather in a Minecraft world to work, innovate, and explore together. This potential speaks to what some researchers are hoping happens in a school that allows them to study such a project, for it will push the boundaries and the goals of game-based learning. Interestingly, this concept feels right at home inside of a summer camp or

a pilot program, but when regular school is in session it is difficult to obtain consensus.

Confusion surrounds using computers and computing in the classroom. Books, paper, pencils, blocks, scissors, glue, rulers, markers, pipe cleaners? The storeroom is stocked. Tablet, laptop, software program, mouse, camera, robotics kit? The storeroom is not only locked, but it might also be empty. The child's most powerful tool in school is either inaccessible or controlled by adults. There are no research journals putting out calls today for studies about the benefits of worksheets and predetermined outcomes. Nobody seems to be asking for educators and researchers to spend their time justifying why student voice and inquiry should be suppressed.

Minecraft is currently the most powerful learning environment available for creating and collaborating together both in synchronous and asynchronous time. Working in a Minecraft world, students can informally learn specific subject matter at rates that might not be possible to document. A worksheet or test might reinforce knowledge of a few mathematical concepts. What documented value can be placed on an immersive play experience where the student interacts with those very same mathematical concepts? It seems odd to compare a worksheet against standing inside of a virtual three-dimensional coordinate geometry system. The two are vastly different learning experiences.

Using Minecraft as the playground for these student thoughts to coexist and commingle will provide rich opportunities where innovations will undoubtedly emerge, and educators can both join and observe to provide useful guidance. Instead of the once-a-week "one and done" Minecraft computer class, we need to revise our expectations. One hour in Minecraft per week goes so quickly it will not be a terribly productive or meaningful experience. But if classes played there on a daily basis and tracked their ideas and questions, they would find new focal points to explore outside of the game. And that work outside of the game would dovetail back into what happened when logged in again.

It would not fit the purpose or philosophy of computers in education to take the child's most powerful tool, and have any educator or researcher dictate or predetermine exactly what lessons or actions should happen when kids play in Minecraft together as part of the school. The same goes for anything that students might create with a computer. They will figure things out that teachers never thought of doing. Would any educator tell students to mimic their every move with cotton balls, glue, paper, and crayons?

It just so happens that Minecraft is the most powerful real-time collaborative virtual learning environment for making things. Maybe there will be something else better in the future, but we have not yet fully explored this one. Ask your principal if you can stop turning in lesson plans for approval and instead conduct a self-study of your students working together in a Minecraft world. Unleash the power of your students' minds. They are interesting people and we should listen to them. They live in the world, too, and will naturally encounter and explore through game-based play all of the ideas we have for decades split up into artificially disparate classes and curricula. Let's put it all back together.

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