1-2020

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Publication Information

Baek, Youngkyun; Min, Ellen; and Yun, Seongchul. (2020). "Mining Educational Implications of Minecraft". *Computers in the Schools, 37*(1), 1-16. https://dx.doi.org/10.1080/07380569.2020.1719802

This is an Accepted Manuscript of an Article published in *Computers in the Schools*, 2020, available online at doi: 10.1080/07380569.2020.1719802

Mining Educational Implications of Minecraft

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Abstract

This study aims to explore the educational potential of Minecraft which has been widely used since its first release in 2009. Articles about Minecraft were searched for in ProQuest. Data was gathered from twenty-six articles which were indicative of three categories: Integration into curriculum; Student engagement, interest and enthusiasm; and Knowledge and skills acquisition. By using Minecraft, students acquire knowledge and skills, and are also engaged, interested and enthusiastic when Minecraft is employed in science, math, social sciences, language arts and composition classes. Challenges with using Minecraft in the classroom include the lack of focused learning objectives, inflexible curriculum, and no previous gaming skills. Nevertheless, Minecraft holds potential for game-based teaching and learning. Successful integration of Minecraft into the teaching and learning environments require teacher- versus learned-centeredness.

Keywords: Minecraft, curriculum integration, engagement, knowledge acquisition

Introduction

Technology has become ubiquitous in education. Teaching and learning in digital spaces have also increased dramatically in modern educational settings. One such digital space is Minecraft, which is a game that shows promise as a digital learning environment. For example, Microsoft's MinecraftEdu has been sold to over 6,500 educational facilities ranging from schools and libraries to museums (Herold, 2015). Both adults who play Minecraft and educators who are interested in integrating technology into classrooms largely approve of the game (Cózar-Gutiérrez & Sáez-López, 2016; Mail, 2015). Minecraft Education Edition is rebranded from Minecraft EDU and officially released at Summer, 2016. Since then, it has been used to engage students across subjects as an open open-world game that promotes creativity, collaboration, and problem-solving in an immersive environment (Hobbs, Stevens, Hartley, & Hartley, 2019; Mørch, Mifsud, & Eie, 2019; Steinbeiß, 2017). In 2017, Minecraft Education Edition became available in 115 countries around the world with more than two million users (Giret, 2017).

An online survey found that the majority of respondents (60 %) familiar with Minecraft believe that Minecraft has the potential for useful applications in the classroom (Mail, 2015). In a separate survey, over 90% of 89 university students pursuing their degrees in primary education agreed that a game-based approach makes subject matter classes more interesting, and a similar proportion agreed that game-based learning approaches result in more active and engaged students (Cózar-Gutiérrez & Sáez-López, 2016).

Minecraft satisfies an important principle of effective learning: a connection to reality. Bers, Ponte, Juelich, Viera, and Schenker (2002) identified that "learning by doing", or engaging primarily in a world of application rather than of theory, as an efficient technique in education. Perrotta, Featherstone, Aston, and Houghton (2013) noted that 'Experiential learning' is one of five learning principles that should be included in game-based learning, along with 'Intrinsic motivation', 'Learning through intense enjoyment', 'Authenticity', 'Self-reliance and autonomy'. This is because games model real-life experiences rather than simply providing written or visual descriptions such scenarios,

enabling students to learn through a more hands-on, immersive approach than when using tools commonly found in traditional classroom settings such as textbooks and worksheets (Bogost, 2011; Nguyen, 2016). Furthermore, unlike traditional classroom tools, Minecraft is customizable by teachers and students.

Minecraft's gameplay can be adapted to a wide variety of classroom needs. Minecraft has two creative modes of play: creative and survival. The creative mode provides players with a wide variety of materials and there is no danger of dying during gameplay. By contrast, the survival mode requires players to gather materials and defend themselves against possible threats in the game. Teachers have the option of choosing which mode best fits in the curricula. In addition, mods, or add-ons to the standard version of Minecraft can modify the game's rules, content, or design (Steinbeiß, 2017). Through the use of mods, teachers can make subtle changes without having to restructure the entire game. For more technical changes, Minecraft's entire source code is available for open source. This allows researchers and educators to develop any custom components such as new items or map locations, as well as to tweak the finer aspects of the game's design, resulting in an ideal learning environment (Al-Washmi et al., 2014). Moreover, Minecraft's multiplayer modes and servers simplify user collaboration and content sharing between teachers who have developed any modifications (Nebel, Schneider, & Rey, 2016). One example of such user created content are "worlds".

There are a variety of pre-built worlds, such as the Ming Dynasty and the Jamestown settlement, which are suitable for a large range of classroom subjects and objectives (Lorence, 2015). Within each world, blocks can be arranged and structured to build virtually any physical object or representation (Nebel, Schneider, & Rey, 2016). This flexibility can stimulate creativity and promote individualization. Because of the endless possibilities within Minecraft, students can engage with the game in their own unique ways, leading to distinct outcomes for each person (Marcon, 2013). The flexibility similarly allows students to have fun with the game, which is an important aspect that teachers should consider when deciding to use games in the classrooms since enjoyment maximizes the effectiveness of learning outcomes (Karsenti, Bugmann, & Gros, 2017). As students express their creativity while building structures in Minecraft, they can also search for additional information because building objects efficiently requires a detailed understanding of the resources available in the game (Bebbington, 2014). These features in Minecraft are beneficial since they not only promote communication between students, but also can improve information literacy skills (Bebbington, 2014; Uusi-Mäkelä, 2015).

Furthermore, Minecraft can minimize exposure to the negative effects of violent and profanity-laden communication generally associated with popular multiplayer video games (Bebbington, 2014). Further, teachers can grant and/or restrict student access to certain blocks or teleport students during gameplay as needed (Short, 2012). They can regulate the game environment by tracking students' progress as students play the game (Lorence, 2015). In short, Minecraft incorporates many necessary regulatory tools, as well as environmental principles for proper learning: relevance to real-life, ease of classroom control, and social skills and creativity. This makes Minecraft a game apt for use in education. In the academic literature, there are variety of studies which have examined the potential of Minecraft's use in classroom environments. This paper reviews both theoretical and empirical studies that discuss the applications of Minecraft in educational environments. The research questions which this study seeks to answer are:

1. How is Minecraft integrated into curricula of different subject areas?

2. How does Minecraft affect student engagement levels and interest?

3. How does Minecraft affect student learning and knowledge acquisition?

4. What are the challenges and issues in using Minecraft as a tool for teaching and learning?

To answer these questions, we examine Minecraft integration strategies in classrooms, as well as student benefits in terms of engagement, interest, academic achievement, and knowledge acquisition. We also investigate challenges and implications involved in implementing Minecraft.

Research Method

The authors synthesized the literature review research methods of Levy and Ellis (2006), Hamari, Koivisto, and Sarsa (2014), Ramdhani, Ramdhani, and Amin (2014), and Nakano and Muniz Jr. (2018) to create a procedure for this study. The procedure is presented below in Figure 1.

Insert Figure 1 about here

Proquest was used to identify the studies incorporated into this literature review. As the goal was to find theoretical and practical connections between Minecraft and education, the initial search was conducted using the keywords "*Minecraft*" and "*education*" which yielded 5,713 results. The total number of articles was refined by applying the following additional keywords: "*gamification*," "*technology*," "*classroom*," and "*learning*". This decreased the number of articles to 1,934. The number of articles was further narrowed down through various factors such as 'but' and/or 'not', and limited to reviews of abstracts, publication dates, language, and sub-topic information.

Papers published within the last ten years were typically preferred with the exception of a few papers that presented theoretical backgrounds on technology in the classroom. This guideline was applied in order to reflect and acknowledge changes in the ever-expanding world of technology. Papers not written in English, due to limited resources for translation, were also removed. The source of publication was not a deciding factor for inclusion/exclusion. As a result, a total of twenty-six articles are included in the analysis.

After initial reviews by the authors, the articles were classified into three categories. The first category included papers that described integrating Minecraft into subject areas *and* which proposed ways of integrating Minecraft in the classroom. Reviewing this category would tell us how and for what Minecraft has been used for in various subject areas. The second category included papers that focused and reported on students' engagement, interest, and enthusiasm while playing. The third category included papers which had knowledge and skills acquisition as research objectives. These articles are categorized as follows.

Insert Figure 2 about here

As shown in Figure 2, the twenty-six articles show Minecraft usage being popular in the subject area of language arts, Minecraft research being performed at the elementary school level, and the main Minecraft activity being playing. Nevertheless, there are several limitations of this study that these authors acknowledge early in this paper. There are few well-established theoretical frameworks or unified discourses at present. As a result, few studies test theoretical frameworks. Instead many studies have merely hypothesized that Minecraft may be useful for teaching and learning. 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.

Results

Reviews of the collected articles were divided into four sections and are presented in the discussion section in four parts, however a brief summary of the discussion is outlined here. In the first section, we examined how Minecraft was integrated into different subject matters, as well as how researchers have developed and proposed methods of implementation in these areas, the latter of which are science, math, social sciences, writing and arts, and second language learning. In the second section, we investigated the psychological and academic benefits of Minecraft, and then knowledge and skills acquisition in the third. Various challenges and issues extracted from the collected studies were reflected upon in the fourth section.

Integration of Minecraft into the Curriculum

We examined how Minecraft might be integrated into curricula in a variety of subject areas. The studies reviewed explore science, math, social science, and language arts applications.

In Science, Minecraft's depictions of nature integrate well in science learning. Nguyen (2016) pointed out that students can "experiment with and simulate a range of socioeconomic and environmental conditions" while playing Minecraft (p. 471). This aligns well with the hands-on, immersive learning which is necessary for using video games effectively

in education. To learn ecology, for example, students can generate different biomes, with topography, temperatures, humidity levels, or foliage which can all be depicted on the maps, and students can explore various types of rocks and minerals (Short, 2012). Moreover, organisms can differ within each biome, demonstrating principles of biodiversity.

In one paper, a hands-on approach was implemented in a biology class where students created models of biological structures within Minecraft, such as animal cells after learning about the topic with more traditional materials (Pusey & Pusey, 2015). The classroom teacher controlled the game server from a remote location in addition to monitoring active gameplay. In this case, students had prior knowledge of the topic. The students used Minecraft to connect with the material in an engaging, meaningful, and constructive way which ultimately enhanced the understanding of the topics they had previously studied. A similar approach can be seen with chemistry.

Conventional ways of teaching chemistry often involve printed periodic tables and textbooks which summarize the properties of various elements. One chemistry teacher, however, developed a system that illustrated the nature of different phases of matter through simulations. Another teacher created a three-dimensional periodic table of elements using signposts to inform students about the characteristics of different elements (Short, 2012). Instead of simply reading or listening to lectures about subject content, students can take an active role in learning by playing, exploring, and expanding their understanding in a game environment. The end result is that building and creating objects in Minecraft holds promise for learning by simulating biological, physical and environmental phenomena in science. Theoretical and socio-economic aspects of the real world are abstracted and represented by the virtual properties of Minecraft. As Short (2012) indicated, educational activity maps in lesson plans employing Minecraft demonstrations are only increasing; “Minecraft is a game-changer in the field of science education” (Short, 2012, p. 58).

In Math, building various structures within the game is a relatively easy way to reinforce the mathematical concepts of area, volume, and perimeter. In one elementary school, students built houses and calculated the respective floor areas, the volumes of stories, and fence perimeters (Herold, 2015). This kind of application enabled students to be independent and engage in building, which is Minecraft’s original and intended purpose. Thus even when used out of the box with default settings and environments, teachers can easily use Minecraft in the classroom since it does not require downloading multiple mods or worlds and instead simply uses the default state of the game. While this approach is practical for less experienced teachers, Minecraft is not limited to game defaults. If teachers so choose, they can employ complex methods of incorporating Minecraft.

Researchers have developed multiple mods, including Numbers, Operator Benches, and Calculator Benches that can be used to facilitate calculations within the game (Al-Washmi et al., 2014). Two teachers from Louisville, Kentucky, created a world in Minecraft that includes pressure-sensitive plates, wherein students could create graphs by stepping on certain squares and placing blocks within a coordinate system (Lorence, 2015). While these intricate systems require more time and effort from coordinators, the mods allow students to interact with the game in novel ways, potentially stimulating curiosity and creativity in students already familiar with Minecraft, as well as those just beginning to gain proficiency in the game.

In Moore’s (2018) mathematics class, Minecraft was used to build the characters Steve and Double Steve. While measuring the surface area and volume of the Steve built in Minecraft, students followed lessons in which a teacher simultaneously motivated, engaged, explored, explained, elaborated, and evaluated students’ learning of calculations of area and volume. She found that “students see [that] formulas are not just something to arbitrarily memorize, but are connected to concrete objects and experiences” (p. 21).

In Social Sciences, building extends student creations and worlds in Minecraft and is an appropriate environment for examining and building historical entities. Some parts of Minecraft are directly related to historical sites modeled after places like the American South in the Civil War. Such maps can even include realistic imagery such as plantations and 19th-century houses (Lorence, 2015). Detailed depictions of history in a game that models real-life historical and present conditions are an appealing alternative to static pictures and descriptions used in traditional materials. Students can navigate through the virtual game space and observe the scenes that simulate real-life situations, promoting student interest and engagement.

The building of historical virtual environments integrates Minecraft into teaching social sciences and liberal arts. for example, as part of a lesson on historical preservation, various groups of students built replicas of Colorado’s significant architectural sites and medieval villages (Herold, 2015). Because building these virtual places requires reasoned and detailed planning and prior knowledge, it leads to deeper understandings of the details and refinements

of the structures and civilizations that students are studying. For example, some students built a model of an ancient Chinese city and learned about the impacts that culture had on architecture (Lorence, 2015). Moreover, large-scale constructions in Minecraft often require coordination among students, stimulating not only collaborative environments but also extensive discussions about the topic at hand. 'World building' in Minecraft and exploring them promotes students' global participation and intercultural competencies (Balnaves, 2018). Students from different countries participated in this global project. Students shared what they had in common with one another because they were able to communicate using common languages, landscapes, tools and artefacts in Minecraft.

In Language Arts, one way to integrate Minecraft to improve students' writing skills is to encourage students to write about gaming experiences. In one case, twenty-one students worked together to survive a hostile environment, similar to a lone survivor scenario. They wrote journal entries throughout the game play which were embedded into maps and could be saved as text files (Uusi-Mäkelä, 2014). In another study, teachers created items in Minecraft that enabled students to write in-game books that could be loaned out to one another (Lorence, 2015). These approaches prompted students to use their writing abilities in engaging and entertaining ways that they had already been familiar with from traditional modes of study. Minecraft can act not only as a supplement and incentive for writing, but also as a vehicle for facilitating writing.

Minecraft can also be integrated indirectly into writing-centered lesson plans to stimulate creativity, imagination, and other important composition skills. Minecraft can develop literacy by allowing students to design characters and landscapes (Marcon, 2013). By describing unique characters in writing, they practice literacy and composition. By using the knowledge of the types of clothing and other tools available in Minecraft to modify characters' appearances, students can further develop their digital gaming skills. Students can even develop storylines or blogs about characters' actions or create videos explaining the building process (Marcon, 2013). The connection between a dynamic game and writing can be helpful for students to develop composition skills and make their experiences more enjoyable and productive. Kuhn and Stevens (2017) observed that experiential learning of this nature meshes well with the "open and fluid nature of language learning" (page number). In fact, Minecraft seems to be an "ideal fit for language learning" (p.754).

In an Indonesian international school, Elementary-aged English Language Learner (ELL) students were given the task of escaping from a mountain by collaborating with each other and employing problem solving and critical thinking skills (Rich, 2016). The environment was conducive to learning English, as collaboration required the use of English. In another study that was designed in part to determine what components of language learning are trained in Minecraft, Finnish students in an elective English class were asked to write blog entries about their experiences with Minecraft (Uusi-Mäkelä, 2015). Continuous participation in tasks requiring collaboration and conversation within and between groups was effective; the design and implementation of the programs required a constant exchange of written messages in the target language.

Student Engagement, Interest and Enthusiasm

Studies have demonstrated that Minecraft can lead to increased motivation and creativity, improved abilities in information technology and communication, and effective collaboration skills (Al-Washmi et al., 2014; Karsenti, Bugmann, & Gros, 2017; Lorence, 2015; Petrov, 2014; Pusey & Pusey, 2015; Uusi-Mäkelä, 2015). Students commented that Minecraft stimulated their imaginations and motivation (Herold, 2015). Many students expressed an excitement when attending class since Minecraft was treated as a special activity. Students were enthusiastic about it and supported the return of the program the next year (Karsenti et al., 2017; Pusey & Pusey, 2015). Minecraft, as implemented in classrooms in these papers, appears to effectively boost students' interest and drive to learn, all while participating in regular classroom activities. This has even been seen in primary school music classrooms where students' engagement with Minecraft has promoted and stimulated critical thinking, collaboration and creativity since Minecraft world building is a new and unique way linking students' experiences playing video games with learning music composition (Abrahams, 2018). In short, students can be engaged by Minecraft-based activities in unexpected ways.

Not only are there increased rates of assignment completion, but students who normally did not actively take leading roles in class were able to act as leaders within the game (Hultstrand, 2015). Additionally, Minecraft also reduced students' perceived barriers to learning. For example, a fifth-grade student in Singapore, whose teacher had implemented Minecraft in the classroom, was asked to present his final exam using Minecraft where he used Minecraft to convey his ideas in his second language of English (Lorence, 2015). In another study, students used the target

language with decreased apprehension, corroborating previous assertions that social gaming can lower inhibition barriers to language production (Rich, 2016). This suggests that Minecraft can be used as a unifying and connecting force when certain factors, such as language, prevent unobstructed communication amongst students and teachers. Moreover, in a study from Cipollone, Schifter, and Moffat (2014), students used Minecraft to collaborate outside of the classroom for learning about characterization and plot, as well as for developing and capturing stories created in Minecraft inside of the classroom. This shows support for Minecraft's potential for use in flipped learning environments.

Knowledge and Skills Acquisition

Language learning activities centred around Minecraft hold significant potential for engagement and skills development. Success in the game is contingent upon a productive sharing of knowledge and resources. Accomplishing learning objectives often requires searching for information online in English or extensive communication between players, both of which encourage the use of a common target language, namely English (Uusi-Mäkelä, 2015). In one study, researchers noted blending and code-switching between Swedish, the students' native language, and English, the language they learn in school. The students, while exchanging messages in Swedish, also used English language words for concepts to communicate their ideas (Wernholm & Vigmo, 2015). Casual communication among Minecraft players also appears to promote informal learning processes, as ideas, understandings, and linguistic skills develop through collaboration and information searches. The benefits of locating and sharing information are not limited to language learning, however.

Bebbington (2014) noted that Minecraft game play enhances teenagers' information literacy skills. Likewise, students in Lorence's (2015) study responded that they were "pulling information from the game" to answer questions (p. 30), and Israelsen, a teacher who pioneered an educational Minecraft application in a Colorado elementary school, commented that Minecraft was excellent for building skills geared toward digital literacy standards outlined by the State (Herold, 2015). In a structured program intended to enhance digital skills, students improved skills in information technology, communication, reading, and writing, as well as effective collaboration and creativity (Karsenti et al., 2017). Educational authorities promoting digital literacy skill development could employ Minecraft to achieve their goals. In the same context, Minecraft could be a digital tool fostering the maker movement of creating new designs, cultural environments, and common design standards (Neimeyer & Gerber, 2015).

Challenges and Issues

One of the challenges involved in employing Minecraft in education is the focus, or lack thereof, that is often associated with video game play. Full immersion into the game creates an ideal environment for learning, as the players can maintain their motivation and become more receptive to learning and less receptive to distractions (Karsenti et al., 2017). Furthermore, one study noted that difficulties with time management or possible distractions were not issues, as students completed the objectives and tasks on time (Callaghan, 2016; Pusey & Pusey, 2015). This, of course, may be dependent upon the levels of teacher regulation, students' ages, and methods of implementation. For example, a highly structured curriculum involving older students may require less supervision than a program with younger students. This is an area that is open to further study.

Another challenge is the fact that many educators are reluctant to use Minecraft in the curriculum. This may stem from the gap between students' and teachers' video game literacies (Kuhn & Steven, 2017). The learning curve for teachers, who have to learn new technological systems and the associated digital skills, can appear steep when starting to learn such programs (Nebel, Schneider, & Rey, 2016; Pusey & Pusey, 2015), however teachers and researchers are developing educational applications to help bridge this gap. For example, a group of teachers made an online space called a TESOL EVO (Electronic Village Online) session, and another group developed a 5-week MOOC (Massive Online Open Course) to help teachers become familiar with Minecraft (Kuhn & Steven, 2017). Teachers have noted that subsequent lessons are increasingly easier to orchestrate after overcoming the initial difficulties; they had even felt that the process of editing and making Minecraft worlds was similar to creating student worksheets (Pusey & Pusey, 2015). The expansion of programs available to teachers employing video games in education may be necessary to drive further progress in the field.

A notable point of contention is the discrepancies in digital literacy skills among students. In many situations, students who may not have had much previous interaction with a particular game may initially feel challenged to keep up with more experienced peers (Al-Washmi et. al, 2014; Hewett, 2016; Pusey & Pusey, 2015). With guided instruction,

however, beginner students are able to keep pace with the prescribed activities (Callaghan, 2016). To reduce the severity of this challenge, teachers may modify their curriculum. For example, in one study, students could choose the complexity of the houses they build in the program (Herold, 2015). This may decrease apprehension and challenge for inexperienced students participating in an activity. If this is not possible, more experienced gamers can use their skills to mentor less experienced peers and enable a smoother integration of the game into the learning activities. In these cases, peer-to-peer collaboration would be a crucial part of the program.

Another related issue is that experienced players may employ their previous skills to skip past the intended lessons (Nebel, Schneider, & Rey, 2016). Notably in one study, some experienced players displayed tendencies of reverting to familiar game play methods to progress through the game rather than by going through the new paths set out by the designers which were intended to promote mathematical learning (Al-Washmi et al., 2014). To remedy this, researchers proposed that the game should be played in adventure mode as opposed to the creative mode which allows for unrestricted game play (Al-Washmi et al., 2014). The creative mode often allows students to venture off on their own and find shortcuts, whereas the adventure mode can create more regulated environments.

The cost of integrating Minecraft, in money and in time, is another issue, especially when compared to more easily accessible resources like textbooks and worksheets. To integrate MinecraftEdu for a class of 25 students, the cost would be about $400 for licenses and the server (Lorence, 2015). Unfortunately, the increasingly popular budget educational computers such as Google's Chromebook are not compatible with Minecraft; however, cheaper alternatives to the game and the program, such as an independent handheld version, are available (Petrov, 2014). Once the classroom is functioning and integrated, MinecraftEdu resources such as lesson plans and tutorials are available for free (Lorence, 2015). The initial costs, however, are a hurdle that may deter some schools from implementing such programs.

Conclusion and Suggestions

As games continue to increase in cultural relevance, attempts to use them in teaching and learning are becoming ever more popular. Minecraft is no exception to this trend, partly due to its widespread popularity in the gaming world. As a result, many educators are adopting it as a tool for students' learning. In contrast to its educational implications, studies have not been yet performed systematically or scientifically. Thus, it is premature to assert its effectiveness in terms of educational outcomes. Nevertheless, it is clear that it has a great deal of potential based on this review of Minecraft educational applications.

The reviewed studies demonstrate that Minecraft can be successfully integrated into various school subject matter. In science, building and creating activities were carried out by simulating biological, physical and environmental phenomena. Experimental and socio-economic aspects of the real world were abstracted and represented by the virtual properties of Minecraft. These types of educational Minecraft applications are possible for Math and Social Sciences, as well. In addition to these activities, engaging collaborations were stimulated as another impetus for students' language learning in Minecraft. Students' engagement with Minecraft appears to result in high levels of motivation and persistence to complete assigned activities, while encouraging critical thinking, collaboration, and creativity. Thus, playing Minecraft can promote knowledge and skills acquisition. It allows students agency, which provides motivation for success while setting clear boundaries and allowing exploration and creative thinking (Callaghan, 2016). Despite the educational potential, there were several challenges noted that are involved in integrating Minecraft into classroom teaching. One of them is a lack of focus on learning due to a potential student lack of focus, as well as a potential lack of teacher preparedness (Thorsteinsson & Niculescu, 2016). Curriculum inflexibility also offers resistance to the incorporation of digital game play. The literature review revealed that Minecraft has a positive effect on levels of student interest, motivation and learning; however, there are several caveats that must be addressed in order to successfully use games in educational settings.

As Steinbeiß (2017) indicated, limiting target learning content may be advisable when using Minecraft for educational applications. Too much information can be overwhelming, so it may be more effective to present a narrow range of topics in order to delve into material more deeply. Likewise, in the case of simulating the real world in Minecraft, simulation activities in are appealing, attractive, enjoyable and motivating. Moreover, they encourage student interest and engagement. However, excessive simulation fidelity to the real world may distract students from learning. It can also be challenging to integrate Minecraft into regular classrooms due to its incompatibility with formal curricula. Elliot (2018) concluded that "informal practices that are introduced to the formal learning environment are interpreted as unwelcome or unnecessarily diluted by the formal demands of pedagogy and assessment" (p. 22). Balancing a

formal learning environment with the informal learning which games permit can challenge teachers who are interested in designing a game-based curriculum for their students. Especially with Minecraft activities, construction, even on a small scale, requires time, effort and coordination among players. Construction also often involves collaboration which in Minecraft frequently stimulates thorough and extensive discussions about gameplay and the learning objectives at hand as well.

Minecraft has the salient feature of flexible goal orientation, simple graphics, and endless opportunities for construction (Smeaton, 2012). To be successful in integrating the features of Minecraft into teaching and learning, teachers' roles are significant in such environments. Teachers should be the guiding figures in integrating Minecraft into students' learning (Callaghan, 2016). The literature reviewed and presented here has revealed that educational research on Minecraft is increasingly impactful and effective in student academic achievement. Minecraft is an invaluable space for teachers and students by reducing the tension between knowledge production characteristic of the game and the culture of the formal education system (Cipollone, Schifter, & Moffat, 2014). As McColgan, Colesante and Andrade (2018) noted, the reduction of this tension is possible as teachers and learning environments evolve.

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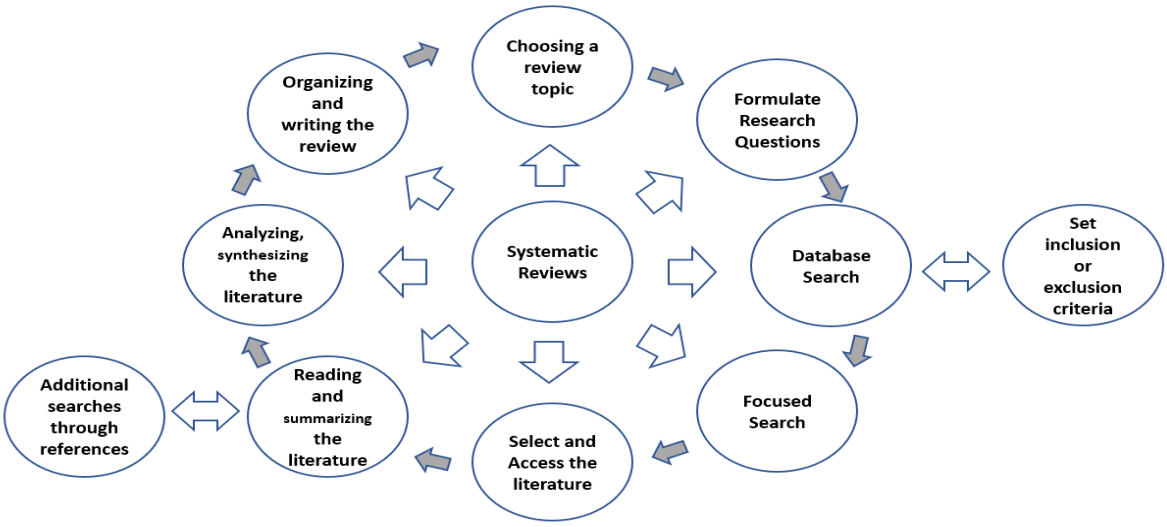

Figure 1. Procedure of the study

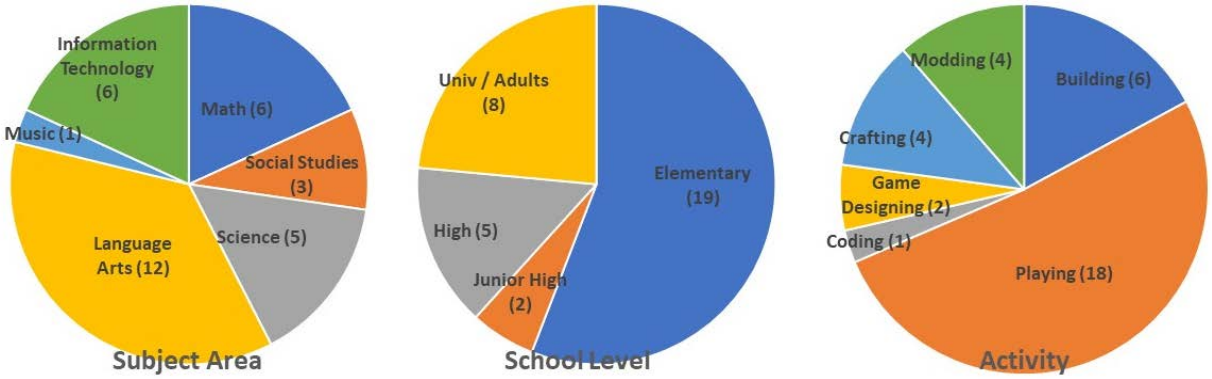

Figure 2. Articles classification