Minecraft in Education Benefits Learning and Social Engagement

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ACCEPTED AUTHOR MANUSCRIPT

29th September 2021

To be published in

International Journal of Game-Based Learning

Please see the copy-edited version at

https://www.igi-global.com/gateway/article/full-text-html/287783&riu=true

Please cite as:

Alawajee, O., & Delafield-Butt, J. (2021). Minecraft in Education Benefits Learning and Social Engagement. *International Journal of Game-Based Learning (IJGBL), 11*(4), 19-56. http://doi.org/10.4018/IJGBL.2021100102

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Abstract

Empirical evidence suggests that Games-based Learning (GBL) as a potentially engaging form of contemporary learning. With the increase in the use of Minecraft, a sandbox computer game in open-world format, there has been a concurrent rise in the level of interest in investigating the role of Minecraft in social and academic learning. Minecraft is socially interactive, and its cooperative, rather than competitive, open-world gameplay suggests that it could be used for educational purposes. This paper presents a systematic review of all published peer-reviewed research and synthesises the evidence for and against Minecraft's use in education to better understand the applicability of Minecraft in educational and psychological interventions. Forty-two papers were identified. These revealed Minecraft to be beneficial in terms of increased motivation, language development, and academic learning in subjects such as science and history. Minecraft play also supported the development of social skills, including communication, sharing, collaboration, and leadership. Concerns about age-appropriateness, safety, technology use, and learning generalisation were raised, but on balance, the evidence favours an informed and guided employment of Minecraft for improved opportunities for learning and engagement in education.

Keywords: ***Minecraft, Serious Games, Digital Classrooms, Teaching and Learning, Games-based learning***

Introduction

The use of digital games in learning was first adopted in the 1970s, but its widespread use in mainstream classrooms only started in 2007 (Halverson, 2012). Children learn through active engagement with their environment (Baldwin, 1894, 1906; Piaget, 1953, 1962). They test its possibilities and explore its contingencies (Delafield-Butt & Trevarthen, 2013; Trevarthen & Delafield-Butt, 2014), self-creating what philosopher A.N. Whitehead (1933) called 'an adventure of ideas'. The engagement of children with other people, ideas or things requires skills that are sensitive to the social situation and the demands of the task, such as self-regulation, awareness, and attention that offer learning in how things proceed (Delafield-Butt, 2018; Trevarthen & Delafield-Butt, 2015; Tronick, 2007; Eisenberg, Valiente, and Eggum-Wilkens, 2010; Blair, 2002). They create stories or a narrative intelligence of how things are related to each other and highlight their social value. Each child who plays is socially engaged in the adventure of learning (Bruner 2003, Trevarthen & Delafield-Butt, 2013; Delafield-Butt & Adie, 2016; Whitehead 1929; Donaldson, 1978). These stories give meaning to life's projects and draw attention to understanding the nature of problems within contexts or worlds (Trevarthen & Delafield-Butt, 2013; Bruner, 1990). Within this view, a principal aim of education is to teach learners to think through 'self-directed activity' (Ozmon & Craver, 2008, p.26). Digital games, with their self-directed play, can help students to become independent thinkers. According to Gee (2013), the purpose of digital games in learning is "to make every learner a proactive, collaborative, reflective, critical, creative, and innovative problem solver; a producer with technology and not just a consumer; and a fully engaged participant and not just a spectator in civic life and the public sphere" (p.1).

Digital games can be used for learning and can be employed for different theoretical approaches, such as through increasing desired behaviours within a trial-and-error approach (behavioural); observing multiple models (social cognitive theory); the process and retrieval of

knowledge (information processing theory) and motivating social interaction (intersubjective and social cognition) (Felicia, 2009; Wardlow, 2014). Gee (2017) argues that a game is not limited to fun, but rather that digital games are a "set of well-designed problems to solve" (p.118). A large proportion of digital games are set up with multiple players engaged in the game environment at the same time, providing a form of socialisation where "all sorts of people, institutions, and interest groups get involved and help move meanings in different directions through their talk, arguments, actions, interactions…etc" (p.150). Play contributes to learning and cognitive development and "a child's greatest achievements are possible in play; achievements that will tomorrow become his basic level of real action and morality" (Vygotsky, 1978, p.100). Vygotsky (1986) recommended that learners interact with others, such as peers, teachers and other experts, to help make learning socially meaningful; a notion that stands in agreement with the social intersubjective psychology of learning (Trevarthen and Delafield-Butt, 2013). Learners may then implement what they have learned from one place to another, employing a social tool for problem-solving (Lutz & Huitt, 2004). Emphasis on social interaction in learning necessitates an enjoyable and fun method for improving social, as well as cognitive, development that gives an emotional and embodied foundation to learned facts because they are lived and shared (Delafied-Butt, 2018).

Learning through digital games may manifest in a similar way to traditional learning, but with more entertainment, enjoyment, and aesthetic appeal. Squire (2011) noted that using digital games in education goes beyond learning to involve a participatory culture and one that encourages systematic thinking and experimentation. Participation is not solely restricted to learning but can create an accessible and safe environment in which to explore and experiment. Three key attributes needs be considered when designing and choosing a game for learning: progression (achievements, levels, and points); feedback (bonuses, countdowns, and reward schedules); and behaviour (infinite gameplay, community collaboration, productivity, and

discovery) (Reese, 2011). These elements would provide better educational purposive outcomes, such as teamwork, critical reasoning, and empathy (Janine, 2018).

To conclude, many digital games attract the attention of students and stimulate learning (Kirriemuir & McFarlane, 2004). Feelings, such as being welcomed into an environment where learning can take place, are a core aspect of education where learners must feel safe and confident in the learning activity. Games that take place in such spaces not only enable students to work towards accomplishing their goals but allow for meaningful feedback and can act as a record to measure the level of learning achieved. Online computer games are mostly interactive; hence, they stimulate learning and motivate learners to challenge new knowledge or topics, and to share these new meanings with others (Felicia, 2011a). Digital games can help students build the skills they may require for living in a society of perpetual technological advancement.

Minecraft as a Creative Space for Playful Learning

Minecraft is a colourful sandbox game world rendered in a characteristic three-dimensional block-built environment. Its open, creative gameplay encourages exploration and learning, and indeed requires it (Elliott, 2014). A player moves through the world, interacts with the animals and objects, and can begin to build up his or her own constructed environment from the raw materials of the game (Quiring, 2015); for example, stones combined with wood can construct a hammer, a hammer can harvest harder stone, and harder stone can be used to make a strong house. Exploration, testing, and learning about the lawful properties of the unusual Minecraft world are at the heart of the gameplay.

Moreover, Minecraft is social. The lessons learned through trial and error and the creative tools and environments constructed in the Minecraft world can be shared with others in the game, or outside of it (Cipollone, Schifter, & Moffat, 2014). The Minecraft game is

played on a server online, and although one can choose to create a world with no others, it is typically played on servers in worlds with many other players' characters simultaneously exploring, learning, and creating. And within this setting houses can be built, entire cities developed, and empires constructed and shared. There are no restrictions or boundaries and players can play the game as they choose: hunting for animals, building structures, or exploring the landscape and discovering its lawful nature (Elliott, 2014). Clemenson, Henningfield, and Stark, (2019) stated that Minecraft can act as a form of environmental enrichment in humans. Indeed, despite its complexity and depth, Minecraft is recognised as an easy, engaging game with simple, basic rules of operation – move, interact, and combine objects to build new ones (Smolčec & Smolčec, 2014).

Gauquier and Schneider (2013) note that Minecraft engages considerable critical thinking potential. Players are affected by their choices: if they make 'bad' choices, their avatar's quality of life can be negatively impacted; if they make 'good' choices, the complexity and aesthetics of the game world increase, thereby driving creativity and forming a world shaped by the learner. This sense of creativity with consequences was a principle on which the game was first designed. On the other hand, the avatar aspect allows social interaction without real-world, physical consequence to the player's own vitality, allowing greater freedom from risk for creative exploration (Choo, Karamnejad, & May, 2013; Mavoa, Carter, & Gibbs, 2018). It is striking from the perspective of embodiment (Delafield-Butt, 2018; de Jaegher, Perakyla, & Stevanovic, 2016) that large game-world effects can be generated with simple, small movements of one's own real-world hands and fingers. This is a feature important for consideration for learners with physical disability or motor control issues. And its disembodied aspect can be helpful for those lacking confidence due to risk of social rejection. Further, Minecraft focuses on creativity rather than on winning and competitive gaming. Players are allowed to build whatever they wish using a variety of cubes and colours. For personal use,

the game is also affordable, costing approximately $26.95 (£17.95/ €23.95). Players pay once for ongoing online play with no subscription fees (Mojang Support, n.d.).

The user is free to choose the degree of sociability desired, from closed worlds that can only be accessed by special invitation (useful for classroom learning) to open worlds moderated by peers (such as Autcraft for individuals with autism that has specific rules of social engagement policed by others) to entirely open worlds with few rules of engagement.

The game was launched in 2010, developed by Markus Persson who became a popular legend within the game world known by his avatar, Notch. Minecraft can be played on a Windows PC or Apple computer and most modern smart mobile devices, namely Android or iOS tablets and phones. The game has been running continuously since its launch and has generated a userbase that now spans the entire globe. At the end of June 2019, more than 33 million people had bought the computer version of Minecraft (Minecraft, n.d.). There are also specialist versions of Minecraft that serve different user communities. For example, Autcraft is a particular platform of Minecraft for people with Autism Spectrum Disorder (ASD), founded in 2013 by Stuart Duncan who himself is on the autism spectrum and who has a child with ASD. Indeed, almost anyone can play the game, regardless of ability, gender, culture, or background, although it is officially categorised as suitable for children nine years old or over (iTunes, n.d.), the Pan-European Game Information (PEGI) system rated Minecraft as appropriate for seven years or older (PEGI, 2016), and younger children may also benefit from the game. Age considerations are highlighted in the discussion section below.

Players appear to like Minecraft because it allows them to modify the game (Tong, 2011). Newzoo.com (2014) analysed hundreds of the most popular computer games over multiple variables in six developed countries—the United States, the United Kingdom, France, Germany, Belgium and the Netherlands—and found that over 36 million of the players in these countries ranged between ten and fifty years old. Minecraft was ranked ninth in terms of

popularity. This research also reported that about 33% of Minecraft players were female and 81% of players played at home for more than half of their gaming time. Approximately 36% of the participants in this dataset had been playing the game for more than a year, and 24% had played the game for six months or more, but less than a year (Newzoo.com, 2014).

State of Knowledge on Minecraft and Education

However, despite its popularity, for educational purposes there is limited information about the effect of using Minecraft within learning (Sáez-López et al., 2015). Moreover, there are different opinions regarding the general use of computer games. Some fear that such games may render children more passive and isolated (Wernholm & Vigmo, 2015; Willett, 2015). These arguments are explored in the discussion section of this review. Minecraft was not explicitly designed for educational purposes (Willett, 2015), but as the game has no limits and allows users to construct a world and share it with others, it quickly found a place within some classrooms. Significantly, a specialist Minecraft Education Edition was launched in 2014 as a platform specifically tailored for its educational use. It is custom-built worlds makes it attractive for use in teaching topic such as Ecology, Biology, Chemistry, Physics, Geology, and Geography, as well as mathematical concepts and rules (Short, 2012). In fact, a group of pre-service training teachers found Minecraft to be useful for teaching any subject (McColgan, Colesante, & Andrade, 2018.)

Using new media to form an engaging curriculum provides students with a responsibility to direct their learning and achieve their own goals (Elliott, 2014), while also fostering their independent learning. It is essential to allow children to follow their interests in the classroom to benefit motivation for learning (Gunn & Delafield-Butt, 2016), and Minecraft can facilitate this in its open-world, child-led format. Minecraft Education Edition has many mods, curriculums and exercises to meet the Common Core State Standards and the Next Generation Science Standards, which are relevant to the US curriculum (Teaching with MinecraftEdu,

n.d.). Therefore, Minecraft seems to be a promising educational tool: it merges the conceptual ideas of collaborative learning with a serious game, especially in the multiplayer version (Wendel et al., 2013). Many studies have suggested the development of games for educational purposes and implementing the game-based learning concept to encourage student engagement (Boyle, Connolly, Hainey, & Boyle, 2012); this could be done by following their interests (Gunn & Delafield-Butt, 2016). Many researchers suggest Minecraft could be an advantageous educational tool in that it supports and encourages cooperative learning more than games that tend to focus on competitive learning (Al-Washmi et al., 2014; Quiring, 2015).

Research aims

Researchers, educators, and parents may debate what makes it so appealing and whether there is any intellectual or social value in such gameplay. There have been previous systematic reviews on computer games and serious games (Connolly et al., 2012; Grossard et al., 2017), Game-Based Learning (Abdul Jabbar & Felicia, 2015), and digital or computer games (Boyle et al., 2012; Clark et al., 2015; Tobias & Fletcher 2012; Mekler et al., 2014), but they did not focus on Minecraft. Hence, the question of this review paper is whether Minecraft has any impact on children's social and academic learning. We define social learning as learning social skills, such as cooperation, self-control, confidence, independence, curiosity, empathy, and communication. And we define academic learning as all learning that pertains to the educational curriculum, all subjects such as reading, writing, maths, history, biology, and so on. Therefore, this article aims to examine all contemporary research on the use of Minecraft in an educational setting in order to summarize and synthesise current literature with its available evidence to find whether Minecraft can be efficiently and beneficially utilised in the classroom, or not. Reviewing the use of Minecraft in an educational setting is significant in demonstrating its advantages and disadvantages for further classroom implementation and learning interventions. This review will develop researchers' current understanding of using

the game as an educational tool or an instructional psychology one and will summarize the reported benefits and limitations. The EBSCOHost research website produced a large number of results from newspapers and magazine articles, without a single systematic review of Minecraft, and there is currently no literature review that examines whether Minecraft is a useful teaching tool or what practical limitations might be avoided in future classroom execution. Thus, this review examined all available and identified research on Minecraft used as a method of teaching or developing students' skills in the classroom, and its benefits or drawbacks.

Method

This review was conducted on a broad literature search designed to identify and review all available peer-reviewed journal articles reporting on empirical studies on the use of Minecraft up to the 17th of September 2019. We have included all articles that encompassed primary data sources for the use of Minecraft/Autcraft, including psychological and sociological studies. Autcraft was included alongside Minecraft as a common platform important for specialist and inclusive educational contexts. This specific focus on peer-reviewed literature affords the most reliable data on the effects of Minecraft in teaching and learning with the acknowledgement of possible publication bias. However, since both the negative and positive effects of Minecraft are equally important and publishable, selection bias in one direction or the other is unlikely. Thus, this review provides the best possible presentation of both positive and negative effects of Minecraft in educational contexts.

This review went through five stages: identifying the research problems; screening relevant work; discussing inclusion criteria and negotiating eligibility; summarizing evidence from included studies and interpreting the findings. The eligibility process was conducted by the two authors and then compared, disagreements discussed, and an agreement achieved for

each paper based on meeting the inclusion criteria (stated below). The methodology of the review used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Moher, Tetzlaff, & Altman, 2009). PRISMA is an evidence-based set of checklists and procedures for conducting and reporting in systematic reviews and meta-analyses. The PRISMA framework was used initially for reporting reviews and evaluating randomised trials but has also been used for reporting systematic reviews of other types of research. In this review, we used the PRISMA checklist and PRISMA 2009 Flow Diagram to help develop appropriate review processes.

For this review, we conducted a literature search on 17th September 2019 using EBSCOHost research website, which carries a wide range of academic research databases. Our research term was only "*Minecraft*" or "*Autcraft*". EBSCOHost research website was used, producing a significant number of academic resources and journal articles. In relation to identifying related databases, eleven academic and psychological were selected, as following databases: *British Education Index, Child Development & Adolescent Studies, Education Abstracts (H.W. Wilson), ERIC, Library, Information Science & Technology Abstracts, PsycARTICLES, PsycBOOKS, PsycINFO, Communication & Mass Media Complete, OmniFile Full Text Select (H.W. Wilson),* and *Teacher Reference Center.*

We found 480 results, limited to 267 after removing exact duplicates between databases. We restricted this to 89 papers that were peer-reviewed for journals. This was further reduced to 85 papers written in English. After that, an examination and selection process was carried out following the PRISMA framework (Figure 1), which demonstrates the screening process. Papers were included if they met all the following criteria:

- The study had to have been published in scholarly (peer-reviewed) journals to meet a minimum standard of quality and reliability from other scholars' view (book

reviews, conference abstracts, proceedings papers, newspaper articles, magazine articles, and media reports were excluded).

- This review includes only studies that focused on the educational, psychological, and sociological use of Minecraft.
- The publications had to be empirical examinations of the use of Minecraft. Thus, all secondary sources were excluded.
- The articles needed to be in English.

The following PRISMA (2009) Flow Diagram explains how the criteria worked through the databases' websites.

[Insert Figure 1 about here]

The eligible papers (n= 42) were coded and analysed using a data extraction tables that included the research aspects and outcomes (Table 1 and Table 2). The characteristics correlated to the included papers were coded including (a) research aim or purpose, (b) research design (e.g., the intervention, research setting, etc.), (c) research sample (size of the sample and age), (d) data collection approach (e.g., survey, interviews, experiment, etc.), and the key findings. After that, the quality of the included paper was assessed and scored according to the Connolly, Boyle, MacArthur, Hainey, and Boyle (2012) scale (Figure 2). The Connolly et al. (2012) scale focuses on the following five criteria: the type of research, the study's appropriateness of the method and analysis, generalisability (size and representativeness of the sample), the study's importance to this review, and confidence in the presented results. Each one of the previous criteria received a rate as following (3 = high; 2 = medium; 1 = low) and a total score (maximum = 15). The key findings section (Table 1 and Table 2) presented in the results section of this review was conducted using thematic analysis and synthesis of qualitative research in systematic reviews. The thematic analysis was divided into six phases according to Marshall and Rossman (1999): organising the data, generating themes, coding the data, testing

understanding of the data, searching for alternative explanations of the data, and writing up the data analysis.

Results

Studies included in this review showed a variety of employed methods. Eight studies (19%) used quantitative approaches, 23 studies (55%) used qualitative methods, and 10 (26%) used a mixed-methods approach. Although 27 studies (64%) included an educational, psychological, or sociological intervention in the investigations, only 8 (19%) included a control group. The age of the samples was also different: eight studies (19%) included children aged 10 or less, 15 (36%) included teenagers aged 11–17, 14 studies (33%) included adults aged 18 and over, and five studies (12%) were indefinable due to poor clarity within the research designs presented. In terms of sample size, more than half of the studies used 1–16 participants (23 studies; 55%), whereas five (12%) and eight (19%) studies had a sample size of 17–64 and 65–205 participants, respectively. Three studies (7%) had a sample size of 322 and 394 participants, and another three studies (7%) did not use a sample. As shows in Figure 2, each of the included papers was given a quality score, the mean rating for the 42 papers was 9.2 on Connolly et al.'s (2012) scale. Since the number of included papers was small all papers were discussed regardless of the quality score, but emphasis was placed on papers rated 9 or above as they were considered to provide a stronger evidence base for or against the use of Minecraft in academic and social learning. Furthermore, Figure 3 shows an increasing number of publications over the years, showing the importance of this topic in social and academic learning. Figure 4 explains the methodological choices for the studies included, as explained previously.

[Insert Figure 3 about here]

[Insert Figure 4 about here]

Most of the included articles illustrate how Minecraft can be a useful tool for educational use, and social and communication learning if it was used effectively with well-designed lesson. These are presented in Table 1 and Table 2, respectively. Given that there are only a small number of eligible papers, all 42 are summarized in these tables and discussed. In the following sections, the articles are reviewed based on the skills that are impacted by the research.

Minecraft Can Increase Motivation for Learning

Minecraft is thought to be a useful tool for increasing students' motivation and interest in their learning environment. In fact, the game attitudes significantly predicted intrinsic motivation, which can be a significant predictor of game enjoyment, where players with a basic motivation experienced higher levels of enjoyment in the game (Baek & Touati, 2017); and for academic learning, games need to be enjoyable to be effective. Although the ability to enjoying was not defined in the reviewed studies, there is a tendency to be defined by having a positive attitude about the Minecraft experiment and the learned content. Nebel et al. (2017a) reported that student' reactions to Minecraft experiment were pleasant and researchers received only positive feedback from students about the experiment because using Minecraft allowed the transfer of educational principles to a new pedagogical medium, with Minecraft offering players more opportunities for creativity. A positive attitude is essential for learning; the goal was not only learning to read but to engage students and create a positive, inspiring environment (Nebel et al., 2017a).

Although having specific learning goals lowered extraneous and intrinsic cognitive load, players reported more fun and effective impacts of goal-setting and deeper motivational processes (Nebel, Schneider, Schledjewski, & Rey, 2017b). However, many participants working within a group with defined goals exhibited anger, impatience, or confusion when it was clear they would not be able to reach their goal, which may be deemed a disappointing

element of the game. In contrast, participants active in the goal-free environment started the game by reading the information and trying to solve the tasks (Nebel et al., 2017b). This is clearly a limitation to the implementation and preparation for the Minecraft study and not a limitation of Minecraft; having a specific learning goal with a defined task would contribute to the children's learning and reduce wasted classroom time.

Minecraft can also be considered a useful method for promoting student engagement in school and the community. Many researchers identified clear engagement advantages for students as a benefit of using Minecraft. For example, Cilauro's study (2015) reported that using Minecraft allowed disadvantaged young people to be socially included and involved in the online game, as well as to participate socially with others from different cultural backgrounds (Cilauro, 2015). Hollett & Ehret (2017) concluded that Minecraft helped teenagers to engage outside the school context through a shared interest in the game. Another example was reported by Elliott (2014) who reported that prior the Minecraft experiment, one student had poor school attendance and struggled within a formal learning space and tended to refuse to accomplish assignments and disengaged from his schoolwork. However, after the Minecraft intervention, the student displayed remarkable changes, with the teacher reporting that he had not only become more confident with his peers but that Minecraft had rekindled his interest in school and he had begun to attend class regularly, with a more positive attitude (Elliott, 2014). Furthermore, MacCormack & Freeman (2019) reported that although a low degree of motivation of youth with ASD to interact with others was observed during the free play in the early sessions, structured play increases the quality of social play and players were more engaged as they participate in shared goals as they had to make and respond to social bids, suggesting that Minecraft may be a useful modality for motivating youth with ASD to learn and practice social skills. Stone, Mills, and Saggers (2019) investigated whether Minecraft can be used for social interaction for three children with ASD and reported that

playing Minecraft with others provides opportunities for social and communication interactions in multimodal ways that are not available in face-to-face and offline contexts, which promote children's with ASD ability to initiate and sustain social interactions in inclusive educational settings.

Furthermore, Ellison (2017) reported that a participant from a minority group chose to create a digital story using Minecraft, illustrating the intended literacies and racial identities, inherent in digital participatory choice cultures. The decision to use Minecraft meant he was able to plan and map the story from beginning to end, creatively and independently, and felt comfortable operating within Minecraft. He reported that 'he was afforded opportunities to make decisions and became a problem solver and critical thinker while creating and exploring Minecraft worlds' (p.31). The study enabled researchers to understand how the race was essential to the participant, clearly evidenced in his digital story, where he was able to build on his knowledge and identity.

Although Minecraft could be considered as a great engaging tool because even those with no experience of the game can engage with it easily, Marcon and Faulkner (2016) stated that participants with no experience of the game had some difficulties. Cilauro (2015) reported similar issues when a number of young people were either not able to fully participate in the activity or were not able to be part of the group dialogue, which led to some isolation. Potentially, this is a disadvantage because all educational tools should engage all students in the activity. On the other hand, children in Petry's (2018) study emphasised that the freedom of being able to create whatever they wanted—the 'open space' idea—was the main reason to continue playing Minecraft. Likewise, Checa-Romero and Pascual Gómez, (2018) and Blanco-Herrera, Gentile and Rokkum, (2019) concluded that using Minecraft, with its high level of freedom, in an educational subject led to an increase in students' creativity and engagement with the classmates.

Academic Learning with Minecraft

Minecraft is a tool that can be used for educational purposes. McColgan, Colesante, and Andrade (2018) examine the pre-service teachers' skills, beliefs, and confidence using Minecraft to create lessons for teaching middle and high school students and reported that most of the participants decided to create lessons in STEM topics, "such as physics, math, earth science, anatomy, and others" (p. 20). . The experiment results show that the mean scores were higher at the post-test than the pre-test for perceptions of skill using technology and confidence with new technologies, with no gender differences. Participants reported three themes of positive changes in the classroom and their beliefs of using Minecraft emerged, which are the acquisition of knowledge/skills; engagement; and collaborative interaction. Therefore, teachers and parents have begun to adopt it as a tool to enhance and develop children's academic skills and facilitate learning. For example, Saito, Washizaki, and Fukazawa (2017) reported that participants' attitudes toward programming improved and participants' interest in programming increased (Saito et al., 2017). In addition, students in Callaghan's study (2016) reported that they felt that MinecraftEdu helped them attain their learning goals and played an important role in creating a specific task and accomplishing the desired outcomes; in fact, all students demonstrated a higher level of 'creative' and 'evaluative' skills (Bloom's Taxonomy). Being creative in learning is an important aspect of today's pedagogy (Ejsing-Duun & Skovbjerg, 2016; Mason, 2017). Checa-Romero and Pascual Gómez, (2018) examined empirical evidence of creativity development using Minecraft in the classroom and reported that a significant increase in creativity was founded, highlighting the needs to be used in classrooms to develop innovative educational contexts. Another study conducted by Moffat, Crombie, and Shabalina (2017) Moffat et al. (2017) testing the impact of three games (puzzle, sandbox, or a first-person shooter) on creativity using Torrance Tests of Creative Thinking, which measures divergent thinking. Researchers reported that sandbox games affected

creativity less than other types of games, such as a puzzle or first-person shooter game. Flexibility, as a form of creativity, was affected much more compared to fluency and originality where players exhibited little or no observable changes in their ideas; and with the limitation of this study's results, computer games could be used to engage students in a more creative state of mind, necessary for their learning (Moffat et al., 2017). Similarly, Blanco-Herrera, Gentile and Rokkum, (2019) reported that playing Minecraft in the undirected condition scored higher in the fluency category of AUT and performed better on the ADT than participants in the other conditions, suggesting that undirected Minecraft condition provided opportunities for creative thought and expression that is beneficial for the creativity effects (as they may had a lot of decisions and problems to solve). Therefore, both Blanco-Herrera et al. (2019) and Moffat et al. (2017) concluded that computer games seem to have a temporary effect on creativity, but this effect differs based on the game type.

Minecraft can be used to encourage students to become skilled in creating narrative scenarios by using language proficiency to optimise scenarios. Cipollone et al. (2014) used the game as a tool to explore literary concepts of scenarios created by one English teacher to explore the concepts of characterization, where "the desired outcome of this assignment was a video of the narrative, or machinima, developed by each group to demonstrate their understanding of the literary concepts" (p.5). The researchers reported that three groups out of five were able to create narratives using Minecraft and developed multiple characters with a range of personality traits, and Minecraft gave students access to a creative space, with less cost, to explore different narratives with a meaningful and useful interaction between students and the content. Marlatt (2018b), moreover, examined students' engagement in literary analysis of a novel and reported that the Minecraft motivated the participant to engage with the text and was a vehicle for his during-reading visualization and offered students with opportunities to cultivate multicultural perspectives. Marlatt (2018a) also reported that Minecraft help learners

to crafted well scenes that linked to the reading of the text, showing detailed and sustained engagement well with literature.

Furthermore, teaching first or second languages can be aided by using Minecraft as a mediator between players and the academic content with well-designed lesson, as it increases the learner's desire to engage. Marcon and Faulkner (2016) examines the use of "Minecraft" to motivate girls' literacy practices in a secondary English classroom through certain actions within the game to motivate students' discussion and collaboration of planning and building. Researchers reported that Minecraft was an attractive text for literacy learning and helped participants to work collaboratively and strategically in designing and immersing themselves in the game world, as well as allowing them to use problem-solving skills for distributed learning initiatives. However, playing Minecraft in the classroom was not confined to participants who had played before or had experience of the game, as reported previously, but offered players an opportunity for learning, allowing players to engage with others around them, and participants used expressive language to obtain assistance from other players and provided meaning for their actions, which resulted in an engaging, collaborative environment. They expressed their interest in gaming activities in their online social media platforms, indicating further learning beyond the classroom. They exhibited problem-solving skills and positive achievements during gameplay (Marcon & Faulkner, 2016). In addition, another study concluded that "playing the video game Minecraft can positively impact hippocampal function in the form of improved memory performance on tasks unrelated to activities in the game itself" (Clemenson, Henningfield, & Stark, 2019, p.11). Therefore, there was robust evidence that the games provided social and cognitive opportunities for creating and strategizing while playing.

Moreover, Minecraft was utilised as a tool to practice and engage with second language skills. Smolčec and Smolčec (2014) reported that Minecraft helped their son to learn and develop his English and speaking skills because he communicated with native speakers through

Minecraft and improved his listening skills by watching and listening to Minecraft videos on YouTube, resulted on becoming 'skilfully creative and speak English with an American accent' (p.13). Another study was undertaken to consider goal-orientated communicative tasks for virtual worlds adopting Minecraft (Swier, 2014). Researchers reported that Minecraft seemed to be a useful platform for developing tasks for language learners, and negotiation was clearly observable in the completion of the three tasks, meeting the intended goals. All participants indicated that they enjoyed the session and were able to manage the completion of assigned tasks in roughly the same amount of time. Participants reported that their communicative interaction during the tasks could improve their English, with the opportunity to speak English and work together (Swier, 2014). Furthermore, Minecraft was used in teaching English to international students by Egbert and Borysenko (2019) and they reported that Minecraft prompted discussion and speaking skills; indeed, about 73% of the pre- and in-service language teacher education students said that they would definitely use Minecraft in their future language teaching. Hence, Minecraft was able to improve their language skills through social interaction with other players. Sáez-López et al. (2015) found similar second language improvements in their study. Participants were asked to engage in Edmodo, a platform discussion where players, teachers, and parents interact and communicate with each other between the US and Spain. Researchers found that foreign students interacted with each other in English, although they were Spanish, which reflected the advantages of using Minecraft as a tool for practising communication and second language skills. Thus, despite Minecraft not being explicitly designed to improve language skills, it can assist players in practising in this field.

Minecraft might also be used for teaching history and architecture. Sáez-López et al.'s (2015) stated that the results illustrated that 97.1% of participants in the experimental group (who studied a historical event via an immersive environment in MinecraftEdu) believed that the game encouraged them to learn about historical content, although the results of the

academic unit testing did not show a significant difference between the control group and the experimental group. Furthermore, Craft (2016) reported that although some students were able to complete the task (given within the Minecraft world) before the deadline, many did not; nonetheless, the implication of this project was largely successful, with evidence of success presented in the pre- and post-written assessments on student understanding of Roman architecture. The growth of students' scores from pre- to post-assessment ranged from 20% to 38%; the average growth score was 29% (Craft 2016, p.360). Therefore, Minecraft can facilitate some students learning historical topics.

[Insert Table 1 about here]

Learning Social Skills in Minecraft

The previous section provided a presentation about the use of Minecraft for academic learning, with most studies highlighting that it was useful for academic and social learning if used effectively. Schneier and Taylor (2018) observed that players engaged with each other in the play sessions and healthy social and emotional interactions were observed. Minecraft, indeed, helped children with ASD to engage in reciprocal conversations, attracting others' attention, and engaging with others physical and in the virtual worlds, which is important to fulfil their needs (MacCormack & Freeman, 2019; Stone et al., 2019). Similarly, Through Minecraft, children demonstrated an understanding of literacy potential for impacting families and society, showing critical awareness of social inequality and prejudice in sociocultural interaction (Marlatt, 2018a). In addition, Hook, Baxter, and Kulczynski (2016) indicated that children with high evaluative social identities experienced positive feelings and emotions when they were able to interact with the brand-based social network and felt negative emotions when they were prevented from connecting with others.

Callaghan (2016), furthermore, stated that the teacher reported that the players of Minecraft in the study intervention were collaborative in sharing expertise, creating objects, solving problems, or completing a build; the more students vocalised, the more productive they became. The teacher also reported that her relationships with students had strengthened as a result of being online with them (Callaghan, 2016). Moreover, Nebel, Schneider, and Rey (2016) showed that lowered focused attention, significant higher cognitive load, extraneous and intrinsic cognitive load increased induced by social competition, and an increase in learning in the solo condition was observed. An extraneous cognitive load was reported by the players in the social competition because of the increased effort in working within a group environment. An increased intrinsic load for the classroom social competition was observed compared to solo play, which might be plausible due to given intrinsic load, as it is influenced by the interaction of the learning material (Nebel et al., 2016). However, no differences in satisfaction were observed, which might be because not every participant appeared to be challenged with an equally skilled competitor or the learning topic was not challenging (Nebel et al., 2016). Interestingly, the results of the group variation highlighted that monitoring other players caused adverse effects, and players in the competitive scenarios learned significantly less from their environment (Nebel et al., 2016). When the number of competitors is higher, some elements of engagement were decreased because they can distract each other, but higher challenges were positively related to a better level of engagement (Nebel et al., 2016).

Despite that improving social skills might not be the aim of researching Minecraft, their enhancement can be a positive outcome. For example, although players have reported that YouTube and books are the primary resources for obtaining ideas about how to play and be creative, all the participants indicated that Minecraft helped them to collaborate with others, engage in discussions, and share knowledge of the game with friends, contributing to developing social skills between players (Petry, 2018). Indeed, 37% of children watch

YouTube related to Minecraft (Mavoa et al., 2018). Sanz-Martos, Martínez-Martínez, and Creus (2018) studies the sense of online community and behaviour in online discussion platform. They reported that different behaviour depending on the communication space, but Minecraft community recognise each other and even inform others if one planned to be absent for a while, conversely to YouTube where participation follow any user, and it is not necessary to be subscribed to the channel. The study also found that members of the community tend to be grouped into teams of acquaintances, and they find the game's form is a place for exchanges of messages and information. The researchers (Sanz-Martos et al., 2018) concluded that although the number of viewers and the unorganized arrangement of the comments prevents the establishment of a community, there was enough evidence that users shared and exchanged knowledge, and they undoubtedly learn.

Furthermore, Niemeyer and Gerber (2015) found that sharing videos of play experiences via YouTube provided something to the viewer, such as how to complete a task, how to create a server, or how to build or craft something within the game. Some players expressed their own preference on how to build something, which allowed other players to enhance their gameplay, while others engaged in discussions about tasks, as well as exchanging feedback and ideas, with creators providing informative and entertaining comments (Niemeyer & Gerber, 2015). Similarly, Bebbington and Vellino (2015) reviewed and analysed online discussion platform and reported that five threads were posted as a request for technical information, twelve threads aimed to express strategic information and three endeavoured to learn about others' opinions. In addition, Hong-An (2016) undertook a similar project analysing twenty-five discussion threads. The researcher indicated that threads gave players opportunities to exchange news and legal and technical changes and to share a narrative, visual opinions, cultural and gaming experiences of Minecraft, and acted as self-directed learning, educational, and motivational support for others (Hong-An, 2016). Furthermore, Davis, Boss, and Meas, (2018) reported that

participants' communication and discussion during gameplay showed a number of factors that affecting their ability to achieve joint attention and successful collaboration, such as prior social ties, gaming experience, and responsiveness to other players. These actions of exchanging and sharing knowledge, as well as interaction, could help players expand their problem-solving skills and encourage collaborative group learning.

Fostering and maintaining the sharing feeling and providing opportunities for communication and collaboration with others presented an advantage in using Minecraft in the classroom. For example, according to Hill (2015), all players reported positive learning in the digital citizenship library game. Their feelings ranged from being nervous to excited, showing unique evidence of personal interest. Furthermore, Wernholm and Vigmo (2015) found that children expressed being annoyed when experiencing a technological problem, expressing and communicating this to each other during the game as meta-conversations, as the ability to manage feeling with others is a key in relationship skill. Playing Minecraft with others resulted in many forms of social and communication interaction in the class, such as discussing, sharing, arguing, and debating (Dezuanni et al., 2015). Although communication and collaboration with others might not constitute the main reason for playing Minecraft, it can be used to develop players' communication and relationship skills, which are necessary for developing children's life skills. Hill (2015) reported that Minecraft players were able to share and adapt their own skills through healthy team communications, and substantial evidence of engagement and collaboration within the team. Critical thinking in constructing the virtual works was observed from students who successfully embedded digital citizenship into an immersive learning environment (Hill, 2015). When enjoying an educational activity, learners can develop collaboration skills without aiming to do so (Quiring, 2015). Additionally, Smolčec and Smolčec (2014) stated that Minecraft helped participants to build friendship skills and develop team skills, aiding players to improve peer-tutoring techniques. Therefore, it could be

considered as being an instrument that brought players together to practice communication and collaboration skills in the pursuit of an activity.

Therefore, collaborative (not competitive) learning using Minecraft in the classroom is a key for a successful education system. The task performance of student groups increased when they were required to collaborate, with individual learning outcomes and interactions increasing, and collaboration was used to enable learning (Nebel et al., 2017a). Asking for collaboration or help was also observable in some Minecraft studies. Dezuanni et al. (2015) found that two of the girls participating in this study were perceived as technical experts and one of them moved around the class many times offering help to others. Asking for help and offering help appeared to be necessary for improving the communicative and collaborative skills taught to students in schools. However, using Minecraft as a tool to maintain learners' collaborative and communicative skills was not enough by itself. Dezuanni et al. (2015) highlighted that, although players started to show progress towards the learning levels, some children veered off-topic. This could count as one of the limitations, as Minecraft may present too many distractions for some players.

Leadership skills are important qualities that students need to develop to enhance their confidence and self-esteem; Minecraft is reported as a useful vehicle to this end. Elliott (2014) found that the participant's enthusiasm for school improved due to being involved with Minecraft, students were now seeking his help for guidance and instruction in the game (Elliott, 2014), where Minecraft changed the student's status among his peers as he became a leader and a significant person in this activity. Hollett and Ehret (2017) also reported that back-and-forth movements between one player and another were positive, where one assists them on their project before leaving them to take on the rest of the project independently. The player considered himself to be a teacher developing an initial pedagogy for newcomers and became self-reliant (Hollett & Ehret, 2017), where he viewed himself as a potential mentor in Minecraft

communities. Indeed, leadership skills might be tested and assessed through Minecraft. Therefore, Minecraft allows researchers to develop students' skills, such as their confidence and self-esteem.

[Insert Table 2 about here]

Discussion

Although this review demonstrates that Minecraft presents many significant educational advantages, a number of concerns has also arisen. McColgan et al. (2018) reported that pre-service mentioned five barriers, including the steep learning curve, time, and complexity for teachers, student distractibility, and complexity for students to learn the game; indeed, pre-service teachers were sceptical of using games for teaching in the classroom. This review summarized some of the limitations reported by previous studies, such as the generalizability of learning lessons to the environment outside the game, internet connectivity and suitability, possible side-effect of using games in schools, Minecraft age appropriateness, and the addiction and health concerns.

Generalisation of learning is a critical issue in teaching a skill through Minecraft. Some have debated whether students can apply what they learn through computer games to the real world. In fact, the concept of reality is another questionable issue in computer games. Quiring's study (2015) argued that "the video game world of Minecraft features physical and social places that, while digital, are no less real or meaningful than those outside the game" (p.14). This author supports that Minecraft is a depiction of real life with equal value, helping them to apply learned skills in real life (Quiring, 2015). More targeted studies are required to address whether the skills and knowledge learned in Minecraft is generalised, and to what degree.

Logistical issues such as internet connectivity and suitability presented one of the greatest concerns. For example, Cipollone et al. (2014) reported the teacher in his study was not a

technology supporter and was concerned about America's formal education perspective, which might not support tools like Minecraft. Furthermore, social familiarity was another issue in multiplayer games as one student reported that she did not enjoy playing Minecraft because there were some people on the server that she didn't know; however, other students in the study showed positive thoughts because of the social interaction, which was safely observed (Dezuanni et al., 2015); thus, although technology makes online social interaction more accessible, contact with unfamiliar people might be an issue. Craft (2016) stated that some students who used Minecraft felt overwhelmed; however, after making some iterations, such as including step-by-step instructions of the task to students, confidence in the use of Minecraft increased. The researcher stated, "I find that the best part of implementations of this sort is that we are educating our students about technology, a medium all too familiar to today's generation", (Craft 2016, p.362). However, because Minecraft is an open world, some players lost attention easily, which may have delayed the task's process (Nebel et al., 2017a). Therefore, making sure that the environment is safe and enjoyable for all students is a requirement in order to make learning more interactive and meaningful.

Digital games such as Minecraft, incorporate many distractions and users need to be aware of how to avoid them. Some players may get distracted by the features of the game and lose focus on what they have been asked to do. One player in Hill's study (2015) was distracted on so many occasions that he was removed from the team for two weeks until he promised to follow the team's desired goals, which he later achieved. Another example is when some of the participants mistakenly moved other people's blocks, which caused anger, but they apologised and worked well to fix the area. Therefore, some of the individual problems that arise in gaming can be easily solved; however, the issue becomes difficult when the problems affect the whole project or the whole class. Hill (2015) reported that after a month of working on a library project, the librarian's laptop crashed and the whole project was lost; the players

were disappointed because of the loss of the server, which meant they had to rebuild the virtual library again. After the end of the project, researchers reported that the feedback from all testers was positive. Teachers can help prevent distractions by properly introducing the game and using mods to exclude unrelated features.

Nevertheless, Minecraft might not be a suitable tool for all ages; therefore, researchers need to be aware of age appropriateness before implementing a study. Some research considers the age-appropriateness of Minecraft a limitation because it may display some violence (Mavoa, Carter, & Gibbs, 2017). The controversy is whether the game is child-friendly or contains violence. What is the definition of violence? Is killing a sheep to consume its meat considered violence? This is a grey area that researchers and parents might interpret differently. The ongoing debate concerning Minecraft and violence seems to be based on unproven cases. It should be noted that Minecraft can be used in a variety of modes, such as choose the creative mode, where the players do not need to eat meat; therefore, there is no need to kill animals. On the other hand, according to Willett (2015), the Entertainment Software Rating Board (ESRB) rates the game as suitable for children aged ten years and above, while the Pan European Game Information (PEGI) system rated Minecraft as appropriate for children aged seven years and older (PEGI, 2016). However, Mavoa et al., (2018) reported that children as young as three years old play Minecraft, but older children are more likely to play Minecraft than younger; indeed, 46% of parents reported that children start play Minecraft at age six or seven years old. Willett (2018) investigated the social aspects of ‘consuming media’ from six children aged eight to nine and reported that the children exhibited a general understanding of the gaming industry due to their investments in memberships, realms, and the merchandise of games. Furthermore, Sexual content has been discussed by Potts (2015), whose research analysed videos posted by Minecraft players on YouTube and reported that the number of sexual references or innuendos was very high; references to sex or gender relationships mostly

involved sexual innuendo, sexual activity, and nudity. Therefore, it is crucial to investigate the impact of the game on teenager players and their personal privacy and safety, and what measures could be taken to prevent inappropriate sexual content.

Addiction and health concerns were addressed in previous research, and parents and teachers seemed to be able to prevent these limitations by planning the activity. For example, Smolčec and Smolčec (2014) stated that they had a concern about addiction, where players may spend so much time playing the game that it could reduce time spent in developing their physical or social skills and improving their general knowledge. However, the researchers stated that they witnessed their son crafting and doing things that were useful in Minecraft, and this led to positive outcomes in language and collaboration skills. Furthermore, about a quarter of non-players in Callaghan's study (2016) were concerned about game addiction and time-wasting. However, the teacher and researcher did not see any time wasted during the lesson; in fact, the teacher reported that by using MinecraftEdu students became more productive, engaged, and willing to complete desired tasks. Players were interested in launching their work in MinecraftEdu immediately upon entering the classroom (Callaghan, 2016). Moreover, Schneier and Taylor (2018) reported that although players remained active within the game environment, their bodies positioning was mostly consistent through the play, same seated positions facing screens, which may raise a concern regarding their physical health. Further research is encouraged to investigate Minecraft addiction and whether it has an impact on physical or mental health.

In summary of the concern, Minecraft attracts the attention of students from different demographic backgrounds and stimulates learning. It allows them to work towards the accomplishment of their goals. However, it is impossible to state definitively whether Minecraft is a good or bad influence because its efficacy should be considered based on the context of where and how it is used. From one point of view, there is a level of risk in playing

Minecraft. However, risks exist everywhere, such as attendance at school, in online material, and in schoolbooks, so teaching children to be safe is always necessary, regardless of the educational methods teachers use. In general, Minecraft can facilitate communication and interaction between the learner players and learning content.

The reviewed studies have some limitations and weaknesses that are imperative to understand because it encourages further areas of research. This critique does not reduce the value of these articles, but it will highlight factors that teachers and school leaders need to be aware of because these might affect the generalisability of some of these articles. The most observable limitation is the lack of experimental studies, where in fact only eight of the reviewed studies include a control group. Studies with a control group are needed because they will allow readers to see the outcomes when these variables are eliminated and isolated. Furthermore, some articles lack detail on the research design. For example, Elliott (2014) used Minecraft in a classroom to develop a curriculum, but the research mentioned only one student. Readers might question the impact of the game on other students and whether the game changed the whole classroom environment or impacted only the reported student. Another example is where Blanco-Herrera et al. (2019) did not include details how long the intervention lasted, and details on what the participants were asked to do. Morover, some research lacks information about the participants (e.g., Bebbington & Vellino, 2015; Cilauro, 2015; Dezuanni et al., 2015; Schneier & Taylor, 2018) while other research has missing information about the project (e.g., Dezuanni et al., 2015). This missing information is vital for reusing the criteria in another setting. Furthermore, some research (e.g., Sáez-López et al., 2015) was conducted in two different countries. Although this might be counted as an advantage, researchers did not explain whether there was a difference between the performance of the two groups, as the game and the intervention might be understood differently due to cultural differences. It would be preferable for further research to examine the cultural value of using Minecraft for educational

purposes. Moreover, Cilauro (2015) did not state whether the participants that day had performed similarly to or differently from each other, nor what kind of libraries the participants had built by the end of that day. Another example would be the research conducted by Cipollone et al. (2014), where the authors did not clearly describe the results: researchers thought that full implementation of the intervention was prevented. Further research is encouraged to translate the observation notes to statements, helping readers to learn the outcomes of the intervention more easily. Overall, it is paramount that the results section is clear and covers all the mentioned elements, regardless of the outcomes. None of the articles in this review mentioned whether there was a difference between playing Minecraft as a multiplayer or a single-player game although previous systematic reviews of digital games, in general, reported that playing a multiplayer computer game had more of an effect on students' learning (Clark et al., 2015). There has been no study on whether it is different playing together in one place or playing together at a distance. This information might be helpful, especially for teaching online programs and offering online support for learners.

Some of the reviewed studies have issues related to sampling. For example, Wernholm and Vigmo (2015) had a sample of three children, but the researchers did not give a clear description of the participants, such as their gender, age, school grade, or level of expertise in the game. It is not clear whether the players were already friends. This information might be imperative because all the previously mentioned factors could affect the implementation of Minecraft. This could be an advantage because the participants' information matters for future researchers who want to apply the intervention in their classroom. Another issue was the number of participants in the research. Most of the research embraced either a very small number of participants (Elliott, 2014; Ellison, 2017; Potts, 2015; Marlatt, 2018a, 2018b, Smolčec & Smolčec, 2014; Swier, 2014; Wernholm & Vigmo, 2015; Willett, 2018), did not mention their age (Cilauro, 2015), or had a gender bias (Hollett & Ehret, 2017). For example,

Bebbington and Vellino (2015) interviewed eight participants, but only one was female. Overall, a sample issue does not signify an entirely negative aspect of the research, but it might affect its generalisation because the situation might be different when applying the game to a larger number of students in a classroom.

In summary of the reviewed papers' limitations, due to the previously mentioned weaknesses and limitations, further research is needed in order to provide parents, teachers, and school leaders with effective strategies to improve the use of Minecraft in the classroom. More research is needed to investigate parents' perspectives on the game and their possible involvement in further interventions. There is a need for further research to examine the short-term and long-term outcomes of Minecraft in the classroom for students' future life skills. An appropriate age is another critical area that teachers need to consider before implementing Minecraft in the classroom. Overall, a suitable environment is essential for the successful implementation of Minecraft, which is strongly suggested in order to improve the learning and knowledge of students.

Implications and Conclusions

Minecraft is a unique, open-world game that can be successfully implemented in classrooms for educational purposes. It offers opportunity for creating activities of interest that encourage learners to be creative with no restrictions or boundaries for its us, giving unlimited creative potential. Minecraft's advantage is that it is an accessible, creative game teachers can modify and adjust its use as they choose, and when done well can be very productive for learning. This review examined all of the available empirical data on Minecraft use for learning. These studies reviewed included application of the game in the classrooms or in design of a curriculum to be used in lessons or activities. Most of the studies reviewed found that Minecraft is useful for teaching and enhances students' social and academic skills.

Previous research was reviewed based on their primary target of social skills for educational use. Some studies aimed to improve students' knowledge of specific academic skills.

Based on the results of the papers reviewed here, teachers are encouraged to use Minecraft as an educational tool and to follow children's interests in its implementation to engage students' motivation for learning. This may be especially helpful for children with learning disabilities or with autism with restricted interests that can be accommodate in the game (Gunn & Delafield-Butt, 2016). To overcome unexpected events, educators are also advised to learn how to play the game before implementing it in the classroom to avoid unexpected problems. Further, teachers could ask students to collaborate in an academic activity, which would help them to develop social skills. Finally, teachers interested in implementing Minecraft in their school or learning environment could establish a private server and involve students to support their needs and interests. Children with particular or special needs may benefit from participating in the planning. This game could be implemented as an additional activity for students, which would make learning more enjoyable. It should be clear that it's not Minecraft that benefits academic learning and social engagement, but it how it has been designed and maintain to deliver lessons. Through the game, educators can walk students through various steps in social interaction and academic learning and can identify areas that need improvement. Nonetheless, although further research is necessary to clarify the issue, the studies reported here demonstrate overwhelmingly positive outcomes of using Minecraft in the classroom. Thus, teachers and parents are encouraged to play the game with their students or their children in informed and constructive ways, keeping the freedom of self-directed play in learning to the foreground. Positive outcomes include, but are not limited to, the motivation for engagement in learning and social and academic skill improvements. The Minecraft world enables learners' 'zest for learning' (Whitehead, 1929) with its open-world, creative and cooperative gameplay format, allowing the creation of projects and stories that enable learning,

and the co-creation or sharing of these with others – a cornerstone of education, whether in learning to work with each other socially or in the technical knowledge of facts and logical operations.

This systematic review has several limitations. First, it was limited to research published in English, which excluded unpublished studies or studies in other languages. Second, a large percentage of studies in the area were excluded because they were conference abstracts or proceedings papers. Thus, several relevant papers might have been excluded; selection and publication bias are acknowledged. Third, the review was limited to Minecraft and did not include other, similar digital games that might be relevant for children's academic and social performance; therefore, the outcomes are limited to Minecraft. Altogether, these limitations may have influenced the results, discussion, and recommendations made in this review. Despite these limitations, the benefits of Minecraft in education to enhance social skills and academic learning outweigh the potential disadvantages. All evidence in the studies reviewed here indicates that Minecraft's use in classrooms and public places were helpful in developing players' social skills: evidence of sharing, communication, monitoring, having a sense of social responsibility, collaborating and cooperating with others was explicitly noted. On the other hand, some limitations were reported, such as age-appropriateness, time management in using Minecraft in classrooms, and students' attraction to the desired goal. These limitations and disadvantages tended to arise as a result of inadequate preparation, unclear purpose, or a lack of knowledge of Minecraft. For future implementation, teachers are recommended to look closely at how Minecraft can be employed to fulfil their students' interests and age-appropriate level of learning. Researchers are encouraged to test the long-term impact of Minecraft on learning academic and social skills.

References

Abdul Jabbar, A. I., & Felicia, P. (2015). Gameplay engagement and learning in game-based learning: A systematic review. *Review of Educational Research*, *85*(4), 740-779.

Al-Washmi, R., Bana, J., Knight, I., Benson, E., Kerr, O. A. A., Blanchfield, P., & Hopkins, G. (2014, October). Design of a Math learning game using a Minecraft Mod. In *ECGBL2014-8th European Conference on Games Based Learning: ECGBL2014* (p. 10). Academic Conferences and Publishing International.

Baek, Y., & Touati, A. (2017). Exploring how individual traits influence enjoyment in a mobile learning game. *Computers in Human Behavior*, *69*, 347-357

Baldwin, J. (1894; 1906). *Mental development in the child and the race* (2nd ed.). New York: Macmillan Company.

Bebbington, S. s. g. c., & Vellino, A. a. u. c. (2015). Can playing Minecraft improve teenagers' information literacy? *Journal of Information Literacy, 9*(2), 6-26. doi:10.11645/9.2.2029

Blanco-Herrera, J. A., Gentile, D. A., & Rokkum, J. N. (2019). Video Games can Increase Creativity, but with Caveats. *Creativity Research Journal*, *31*(2), 119-131.

Boyle, E. A., Connolly, T. M., Hainey, T., & Boyle, J. M. (2012). Engagement in digital entertainment games: A systematic review. *Computers in human behavior*, *28*(3), 771-780.

Butler, J. O. (2017). Mindcrafting: The Semantic Characteristics of Spontaneous Names Generated as an Aid to Cognitive Mapping and Navigation of Simulated Environments. *Simulation & Gaming*, *48*(5), 588-602.

Callaghan, N. (2016). Investigating the role of Minecraft in educational learning environments. *Educational Media International*, *53*(4), 244-260.

Checa-Romero, M., & Pascual Gómez, I. (2018). Minecraft and machinima in action: development of creativity in the classroom. *Technology, Pedagogy & Education, 27*(5), 625-637. doi:10.1080/1475939X.2018.1537933

Choo, A., Karamnejad, M., & May, A. (2013). Maintaining long distance togetherness synchronous communication with Minecraft and Skype *2013 Ieee International Games Innovation Conference* (pp. 27-35).

Cilauro, R. (2015). Community building through a public library Minecraft Gaming Day. *Australian Library Journal, 64*(2), 87-93. doi:10.1080/00049670.2015.1015209

Cipollone, M., Schifter, C. C., & Moffat, R. A. (2014). Minecraft as a creative tool: A case study. *International Journal of Game-Based Learning, 4*(2), 1-14. doi:10.4018/ijgbl.2014040101

Clark, D. B., Tanner-Smith, E. E., & Killingsworth, S. S. (2015). Digital games, design, and learning a systematic review and meta-analysis. *Review of educational research*, 0034654315582065.

Clemenson, G. D., Henningfield, C. M., & Stark, C. (2019). Improving hippocampal memory through the experience of a rich Minecraft environment. *Frontiers in Behavioral Neuroscience*, *57*, 1-13.

Connolly, T. M., Boyle, E. A., MacArthur, E., Hainey, T., & Boyle, J. M. (2012). A systematic literature review of empirical evidence on computer games and serious games. *Computers & Education*, *59*(2), 661-686.

Craft, J. (2016). Rebuilding an empire with Minecraft: Bringing the classics into the digital space. *The Classical Journal*, *111*(3), 347-364

Davis, K., Boss, J. A., & Meas, P. (2018). Playing in the Virtual Sandbox: Students' Collaborative Practices in Minecraft. *International Journal of Game-Based Learning, 8*(3), 56-76.

De Jaegher, H., Perakyla, A., & Stevanovic, M. (2016). The co-creation of meaningful action: bridging enaction and interactional sociology. *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences, 371*(1693). doi:10.1098/rstb.2015.0378

Delafield-Butt, J. (2018). The Emotional and Embodied Nature of Human Understanding: Sharing narratives of meaning. In C. Trevarthen, J. Delafield-Butt, & A.-W. Dunlop (Eds.), *The Child's Curriculum: Working with the natural voices of young children*. Oxford: Oxford University Press.

Delafield-Butt, J., & Adie, J. (2016). The Embodied Narrative Nature of Learning: Nurture in school. *Mind Brain & Education,* 10(2), 14.

Delafield-Butt, J. T., & Gangopadhyay, N. (2013). Sensorimotor intentionality: The origins of intentionality in prospective agent action. *Developmental Review,* 33(4), 399-425.

Dezuanni, M., O'Mara, J., & Beavis, C. (2015). "Redstone is like electricity": Children's performative representations in and around "Minecraft". *E-Learning and Digital Media, 12*(2), 147-163.

Donaldson, M. (1978). *Children's Minds*. London: Harper Collins.

Education Scotland, (2016). *Curriculum for Excellence: Technologies principles and practice*. *educationscotland.gov.uk*. Retrieved 26 July 2018, from https://education.gov.scot/Documents/Technologies-es-os.pdf

Egbert, J., & Borysenko, N. (2019). Standards, engagement, and Minecraft: Optimizing experiences in language teacher education. *Teaching and Teacher Education*, *85*, 115-124.

Egenfeldt-Nielsen, S., Smith, J., & Tosca, S. (2013). *Understanding video games* (2nd ed.). New York: Routledge.

Ejsing-Duun, S., & Skovbjerg, H. M. (2016). Copycat or Creative Innovator? Reproduction as a Pedagogical Strategy in Schools. *Electronic Journal of E-learning*, *14*(2), 83-93.

Elliott, D. (2014). Levelling the playing field: Engaging disadvantaged students through game-based pedagogy. *Australian Journal of Language & Literacy, 37*(2), 34-40.

Ellison, T. (2017). Digital Participation, Agency, and Choice: An African American Youth's Digital Storytelling about Minecraft. *Journal of Adolescent & Adult Literacy*, *61*(1), 25-35

Felicia, P. (2009). *Digital games in schools a handbook for teachers*. Belgium: European Schoolnet. Retrieved 15 July 2016, from http://games.eun.org/upload/gis_handbook_en.pdf

Frönes, I. (2007). On theories of dialogue, self and society Redefining socialization and the acquisition. *On Being Moved: From Mirror Neurons to Empathy*, 201-217.

Gameplay. (n.d.). Retrieved January 08, 2016, from http://minecraft.gamepedia.com/Gameplay

Gauquier, E., & Schneider, J. (2013). Minecraft programs in the library. *Young Adult Library Services, 11*(2), 17-19.

Gee, J. (2013). *Good video games and good learning* (2nd ed.). New York: Peter Lang Publishing Inc.

Gee, J. P. (2017). *Teaching, learning, literacy in our high-risk high-tech world: A framework for becoming human*. Teachers College Press.

Grossard, C., Grynspan, O., Serrette, S., Jouen, A. L., Bailly, K., & Cohen, D. (2017). Serious games to teach social interactions and emotions to individuals with autism spectrum disorders (ASD). *Computers & Education*, *113*, 195-211.

Gtaking5. (2010, January 10). Minecraft. Retrieved January 28, 2016, from https://gamefaqs.gamespot.com/boards/995185-minecraft/56535079?page=1

Gunn, K. C., & Delafield-Butt, J. T. (2016). Teaching children with autism spectrum disorder with restricted interests: A review of evidence for best practice. *Review of Educational Research*, *86*(2), 408-430.

Halverson, R. (2012). Afterword: Games and the Future of Education Research. In Steinkuehler, C., Squire, K., & Barab, S. *Games, learning, and society: Learning and meaning in the digital age* (1st ed., pp. 433-446). Cambridge University Press.

Hill, V. (2015). Digital citizenship through game design in Minecraft. *New Library World*, *116*(7/8), 369-382.

Hollett, T., & Ehret, C. (2017). Civic rhythms in an informal, media-rich learning program. *Learning, Media and Technology*, *42*(4), 483-499.

Hong-An, W. (2016). Video game prosumers: Case study of a Minecraft affinity space. *Visual Arts Research*, *42*(1), 22-37.

Hook, M., Baxter, S., & Kulczynski, A. (2016). Children's participation in brand-based social networks: examining the role of evaluative social identity, self-esteem and anticipated emotions on commitment and desire to recommend. *International Journal of Consumer Studies*, *40*(5), 552-561.

iTunes. (n.d.). Minecraft: Pocket Edition. Retrieved January 27, 2016, from https://itunes.apple.com/gb/app/minecraft-pocket-edition/id479516143?mt=8

Janine, T. P. (2018). How gaming, artificial intelligence and big data is changing education. *Journal of Game, Game Art, and Gamification (JGGAG)*, *2*(2).

Lutz, S., & Huitt, W. (2004). Connecting cognitive development and constructivism: Implications from theory for instruction and assessment. *Constructivism in the Human Sciences*, *9*(1), 67-90.

MacCormack, J., & Freeman, J. (2019). Part 2: The virtual environment social program for youths with autism spectrum disorder. *International Journal of Play Therapy*, *28*(4), 218.

Marcon, N., & Faulkner, J. (2016). Exploring Minecraft as a pedagogy to motivate girls' literacy practices in the secondary English classroom. *English in Australia*, *51*(1), 63.

Marlatt, R. (2018a). Literary analysis using Minecraft: An Asian American youth crafts her literacy identity. *Journal of Adolescent & Adult Literacy, 62*(1), 55-66.

Marshall, C., & Rossman, G. B. (1999). The "what" of the study: Building the conceptual framework. *Designing qualitative research*, *3*, 21-54.Mavoa, J., Carter, M., & Gibbs, M. (2017, October). Beyond addiction: positive and negative parent perceptions of Minecraft play. In *Proceedings of the Annual Symposium on Computer-Human Interaction in Play* (pp. 171-181). ACM.

Mason, J. H. (2017). *The value of creativity: The origins and emergence of a modern belief.* Routledge. London.

Mavoa, J., Carter, M., & Gibbs, M. (2017). Children and Minecraft: A survey of children's digital play. *New Media & Society*, *20*(9), 3283-3303. doi:10.1177/1461444817745320.

McColgan, M., Colesante, R., & Andrade, A. (2018). Pre-Service Teachers Learn to Teach with Serious Games. *Journal of STEM Education*, *19*(2), 19-25.

Mekler, E. D., Bopp, J. A., Tuch, A. N., & Opwis, K. (2014, April). A systematic review of quantitative studies on the enjoyment of digital entertainment games. In *Proceedings of the 32nd annual ACM conference on Human factors in computing systems* (pp. 927-936). ACM.

Minecraft. (n.d.). Retrieved July 03, 2019, from https://www.minecraft.net/en-us/store/

Moffat, D. C., Crombie, W., & Shabalina, O. (2017). Some video games can increase the player's creativity. *International Journal of Game-Based Learning (IJGBL)*, *7*(2), 35-46.

Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Annals of internal medicine*, *151*(4), 264-269

Mojang Support. (n.d.). Where can I buy Minecraft? Retrieved January 08, 2016, from https://help.mojang.com/customer/en/portal/articles/325947-where-can-i-buy-minecraft-

Nebel, S., Schneider, S., & Rey, G. D. (2016). From duels to classroom competition: Social competition and learning in educational videogames within different group sizes. *Computers in Human Behavior*, *55*, 384-398.

Nebel, S., Schneider, S., Beege, M., Kolda, F., Mackiewicz, V., & Rey, G. D. (2017a). You cannot do this alone! Increasing task interdependence in cooperative educational videogames to encourage collaboration. *Educational Technology Research and Development*, *65*(4), 993-1014.

Nebel, S., Schneider, S., Schledjewski, J., & Rey, G. D. (2017b). Goal-Setting in educational video Games: Comparing goal-setting theory and the goal-free effect. *Simulation & Gaming*, *48*(1), 98-130.

Newzoo.com. (2014, March 25). Analyzing game franchises: Why gamers love Minecraft. Retrieved January 08, 2016, from https://newzoo.com/insights/articles/analyzing-game-franchises-gamers-love-minecraft/

Niemeyer, D. J., & Gerber, H. R. (2015). Maker culture and Minecraft: implications for the future of learning. *Educational Media International, 52*(3), 216-226. doi:10.1080/09523987.2015.1075103

Ozmon, H. & Craver, S. (2008). *Philosophical foundations of education*. Upper Saddle River, N.J.: Pearson/Merrill Prentice Hall.

PEGI. (2016). *Pan European Game Information - Advanced Search. Pegi.info*. Retrieved 26 September 2016, from https://pegi.info/search-pegi?q=Minecraft&op=Search&filter-age%5B%5D=&filter-descriptor%5B%5D=&filter-publisher=&filter-platform%5B%5D=&filter-release-year%5B%5D=&page=1&form_build_id=form-LtU7hP1FqtKKrjmtuJm4-BAqHZO1FxcO2ESS2x4xoGg&form_id=pegi_search_form

Petry, A. (2018). Playing in Minecraft: an exploratory study 1. *Revista FAMECOS*, *25*(1), 1-18. doi:10.15448/1980-3729.2018.1.27156

Piaget, J. (1953). The Origin of Intelligence in the Child. London: Routledge & Paul.

Piaget, J. (1962). *Play, dreams and imitation in childhood*. Routledge & Kegan Paul.

Potts, A. (2015). 'Love you guys (no homo)' How gamers and fans play with sexuality, gender, and Minecraft on YouTube. *Critical Discourse Studies, 12*(2), 163-186. doi:10.1080/17405904.2014.974635

Quiring, T. (2015). From voxel vistas: Place-making in Minecraft. *Journal of Virtual Worlds Research, 8*(1), 1-17.

Reese, H. W. (2011). The learning-by-doing principle. *Behavioral Development Bulletin*, *17*(1), 1.

Sáez-López, J. M., Miller, J., Vázquez-Cano, E., & Domínguez-Garrido, M. C. (2015). Exploring application, attitudes and integration of video games: MinecraftEdu in middle school. *Journal of Educational Technology & Society*, *18*(3), 114-128.

Saito, D., Washizaki, H., & Fukazawa, Y. (2017). Comparison of Text-Based and Visual-Based Programming Input Methods for First-Time Learners. *Journal of Information Technology Education-Research*, *16*, 209-226.

Sanz-Martos, S., Martínez-Martínez, S., & Creus, A. (2018). Talking about games: Gamers' digital communication spaces as the object of study. *Catalan Journal of Communication & Cultural Studies*, *10*(2), 231-245. doi:10.1386/cjcs.10.2.231_1

Schneier, J., & Taylor, N. (2018). Handcrafted gameworlds: Space-time biases in mobile Minecraft play. *New Media & Society,* 20(9), 3420-3436. doi:10.1177/1461444817749517.

Short, D. (2012). Teaching scientific concepts using a virtual world —Minecraft. *Teaching Science, 58*(3), 55-58.

Smolčec, M. & Smolčec, F. (2014). Using Minecraft for learning English. *TESL-EJ, 18*(2), 1-15.

Squire, K. (2011). *Video Games and Learning: Teaching and Participatory Culture in the Digital Age. Technology, Education--Connections (the TEC Series)*. Teachers College Press. New York.

Stone, B. G., Mills, K. A., & Saggers, B. (2019). Online multiplayer games for the social interactions of children with autism spectrum disorder: a resource for inclusive education. *International Journal of Inclusive Education*, *23*(2), 209-228.

Swier, R. (2014). Tasks for Easily Modifiable Virtual Environments. *JALT CALL Journal*, *10*(3), 203-219.

Teaching with MinecraftEdu. (n.d.). Retrieved January 28, 2016, from http://services.minecraftedu.com/wiki/Teaching_with_MinecraftEdu

Tobias, S., & Fletcher, D. (2012). Learning from computer games: A research review. In *Serious games: The challenge*(pp. 6-17). Springer, Berlin, Heidelberg.

Tong, S. (2011, August 28). Mining data from Minecraft. Retrieved January 08, 2016, from https://www.gamespot.com/articles/mining-data-from-minecraft/1100-6331569/

Trevarthen, C., & Delafield-Butt, J. (2013). Biology of shared experience and language development: regulations for the inter-subjective life of narratives. *The infant mind: Origins of the social brain*, 167-199.

Trevarthen, C., & Delafield-Butt, J. (2014). The Infant's Creative Vitality, In Projects of Self-Discovery and Shared Meaning: How They Anticipate School, and Make It Fruitful. In: Robson S, Quinn SF (eds.) *The Routledge International Handbook of Young Children's Thinking and Understanding*, 3-18. Abingdon, UK: Routledge.

Vygotsky, L. (1978). The Role of Play in Development (pp. 92-104). In *Mind in society: The development of higher mental process*. Cambridge, MA: Harvard University Press.

Vygotsky, L. (1986). *Thought and Language*, (A. Kozulin, Trans.). Cambridge, MA: Harvard University Press.

Wardlow, L. (2014). *The Philosophies of Learning Behind Improving Access to Learning Resources*. *Pearson Research and Innovation Network*. Retrieved 20 July 2016, from https://www.pearsoned.com/wp-content/uploads/DigitalAge_AccessReport_021714.pdf

Wendel, V., Gutjahr, M., Battenberg, P., Ness, R., Fahnenschreiber, S., Goebel, S., & Steinmetz, R. (2013). Designing a collaborative serious game for team building using Minecraft. In P. Escudeiro & C. V. DeCarvalho (Eds.), *Proceedings of the 7th European Conference on Games Based Learning, Vols 1 and 2* (pp. 569-578).

Wernholm, M., & Vigmo, S. (2015). Capturing children's knowledge-making dialogues in Minecraft. *International Journal of Research & Method in Education*, *38*(3), 230-246.

Whitehead, A. N. (1929). *The Aims of Education and Other Essays*. New York: Macmillan Company.

Whitehead, A. N. (1933). *Adventures of Ideas*: Macmillan.

Willett, R. (2018). 'Microsoft bought Minecraft… who knows what's going to happen?!': a sociocultural analysis of 8–9-year-olds' understanding of commercial online gaming industries. *Learning, Media and Technology*, *43*(1), 101-116.

Willett, R. J. (2015). The discursive construction of "good parenting' and digital media - the case of children's virtual world games. *Media Culture & Society, 37*(7), 1060-1075. doi:10.1177/0163443715591666

Appendices

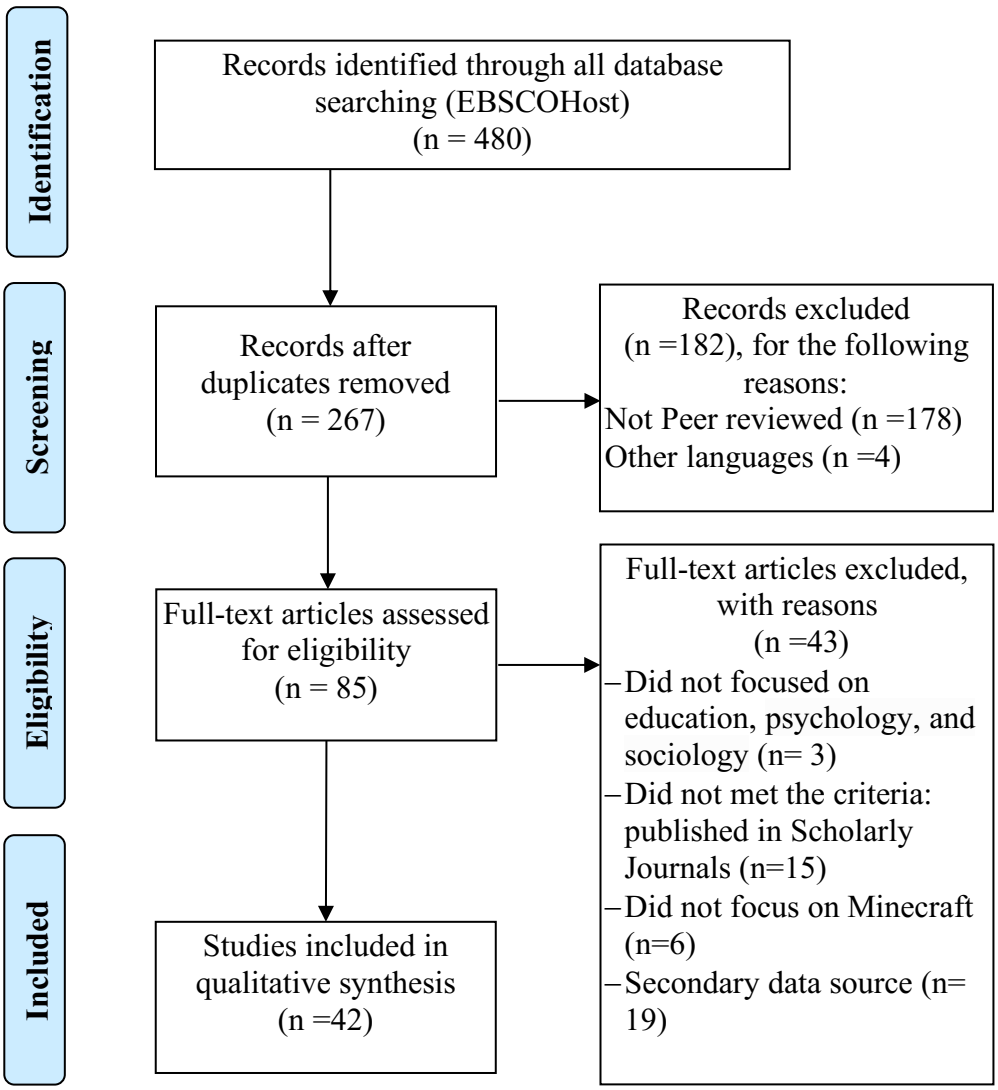

Figure 1. Flow diagram of the screening and selection process employed to search and select the articles reviewed.

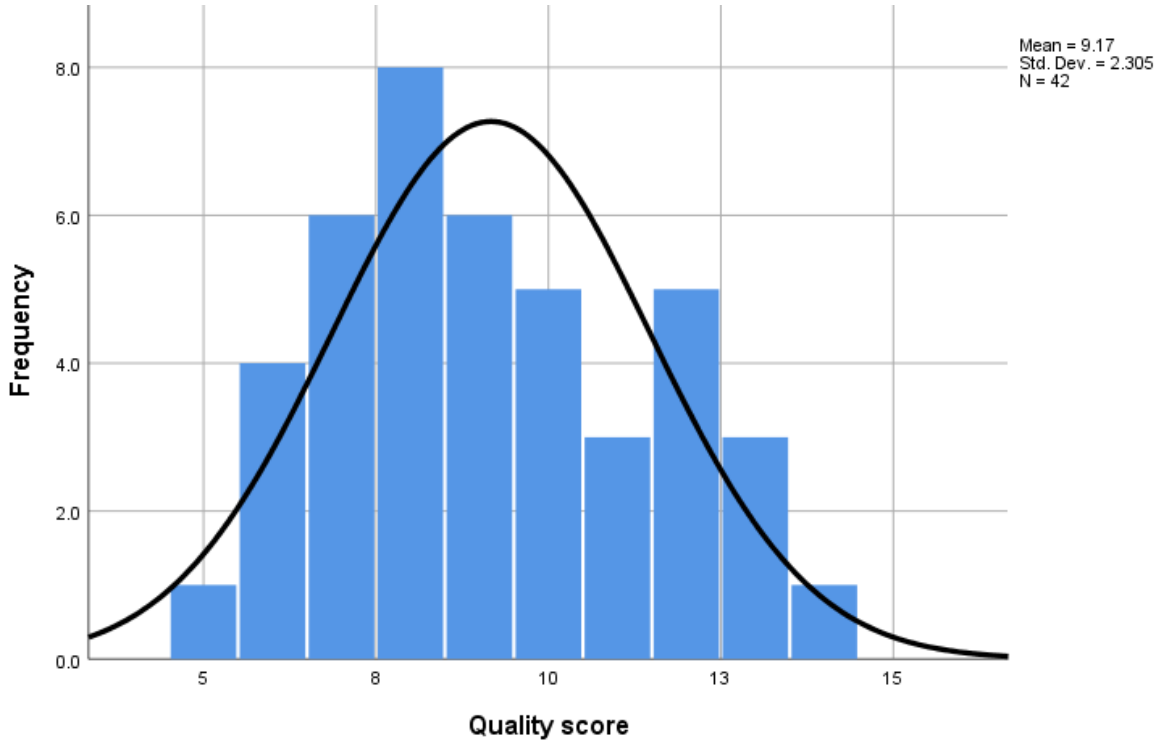

Figure 2. Histogram of the weight of evidence quality score for all included papers.

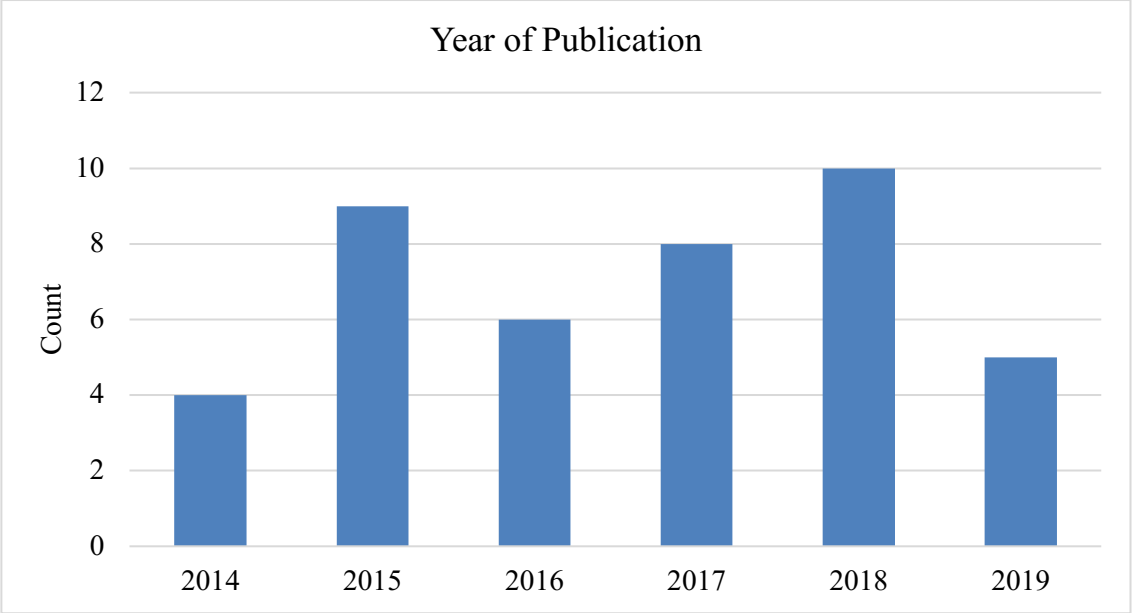

Figure 3. Number of publications selected for review according to the year of publication.

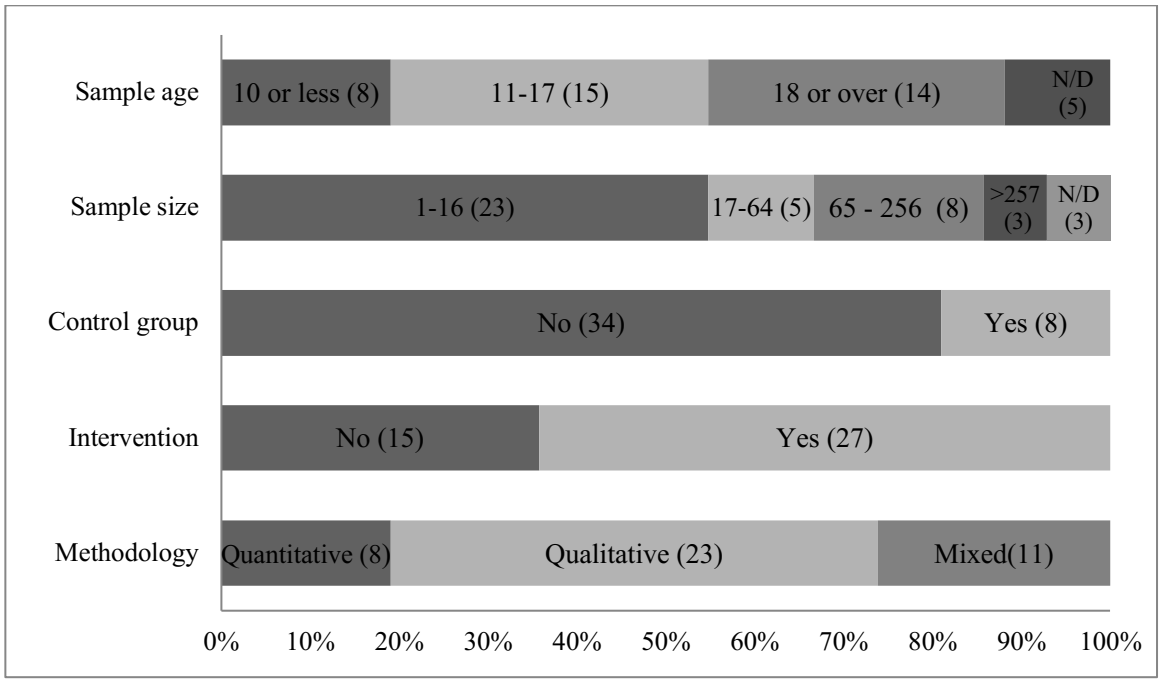

Figure 4. Methodological choices for studies reviewed, including participant group characteristics.

Table 1 Summary of all included studies about Minecraft (MC) focuses on academic and motivation to learning outcomes

Author/ citation	Study aim	Research design (intervention)	Sample N (Age)	Data collection approach	Key findings	Connolly et al. scale
Baek and Touati (2017)	Testing relationships between enjoyment & learning styles, collaboration skills, intrinsic motivation, game attitude, &achievement.	Participants were given two tasks for their gameplay: 1) choosing and replicating a maze in MC from three levels of difficulty; 2) building the main school building and playground in MC.	164 (11-12)	Students were given: the Computer Game Attitude Scale, Enjoyment Test, Learning Style Inventory, Computer Game Attitude Scale, Collaboration Attitude Test, & Intrinsic Motivation Inventory.	• Players with more intrinsic motivation experienced higher levels of enjoyment that significantly correlated with achievement. • MC as an educational tool can motivate students intrinsically, regardless of extrinsic roles in driving students' behaviours. • Players with a more positive attitude toward the game were intrinsically motivated to play it. • Students exhibiting more positive collaboration skills were more able to perform in gaming achievements.	11
Blanco-Herrera, Gentile & Rokkum, (2019)	To find whether playing Minecraft can benefit players' performance on creativity measures	Participants were randomly assigned to one of four groups for approximately 45 min: undirected play on MC; directed MC (participants were directed to 'play as creatively as they could'; NASCAR (a car racing game), and TV (watched an episode, called Crocodile Hunter).	352 (Avg. 19.33)	Researchers used the video game history questionnaire (VGHQ) and four measures of creativity: the Divergent thinking: alternative uses task (AUT), Convergent thinking: remote association test (RAT), imaginative capability scale (ICS), and Creative production: alien drawing task (ADT).	• In the VGHQ, 89.8% of the participants reported playing a video game in the last 6 months. • The grades were associated with most measures of creativity, but no significant association between parental income, age, or gender and any of the creativity measures. • Game-playing habits associated negatively with school performance (GPA) but correlated positively with trait creativity. A positive correlation was observed between self-reported gameplay exposure and trait creativity • Participants in the undirected Minecraft condition scored higher in the fluency category of AUT than the NASCAR condition, and performed better on the ADT than participants in the other conditions, suggesting that undirected Minecraft condition provided opportunities for creative thought and expression that is beneficial for the creativity effects (as they may had a lot of decisions and problems to solve) rather than being directed to specific tasks which may limit being creative.	14

Butler (2017)	Examining the semantic properties of spontaneous naming systems and potential influence.	Participants explored a closed environment in MC to locate an assigned goal, verbalizing their ongoing thoughts.	12 (16-26)	Data were collected through observing participants for considered proper nouns while the task was carried out for the twelve runs.	• Names do serve a functional role in providing cognitive navigational assistance. Functional identificatory semantics was consistent although the nature of the participatory group was limited. A significant strong negative correlation (−0.88) between numbers of names generated and speed of task completion, so cognitive mapping is highly impacted by the name development.	7
Checa-Romero and Pascual Gómez (2018)	Examining empirical evidence of creativity development using MC in the classroom	Students were enrolled in eight-weeks MC workshop and asked to build 'the house of their dreams'	85 (11-12)	Pre-test/post-test through the CREA Creative Intelligence Test	• MC and the audio-visual productions allowed students to creatively express their conceptions of the house of their dreams. • Using games in the classroom is a challenge for educational institutions and teachers and students. • Results show a significant increase in creativity highlighting the needs to be used in classrooms to develop innovative educational contexts. Using MC, with its high level of freedom, in an educational subject led to an increase in students' creativity.	12
Cipollone et al. (2014)	Discussing the use of MC as an educational tool in a formal educational setting in an English class.	Participants were divided into 5 groups. MC and the assignment's introduced in two options - using MC to create their video or using a camera to video their story.	20 (13-16)	Researchers observed the participants' film and provided a shared server. Teachers were interviewed during and after the project.	• Students were able to create narratives using MC, developing multiple personalities with a range of character traits. • MC gave students access to a creative space with less cost. • Researchers observed meaningful, useful interaction between students and the content through MC. • Limitations of the study: The teacher was not a technology supporter, thought negatively about the use of MC; some students were unsuccessful in the project due to unfamiliarity with the game.	9
Clemenson, Henningfield, and Stark (2019)	To test whether the spatial exploration of a virtual video game environment,	Participants were divided into four groups, each playing on custom servers and focusing on different aspects of	82 (Avg. 19.83)	Data were collected through pre and post-tests and Principal Components Analysis using: Mnemonic Similarity Task (MST)	• Three groups (Directed Building, Free Exploration, and Explore and Build groups) show reliable changes in the LDI score, greater improvements than the Free Building group; however, no change was observed in general recognition memory measure in the MST, indicating a specific	11

	can impact the hippocampus and lead to an improvement in hippocampal-dependent memory.	Minecraft over the course of 2 weeks.		and Roaming Entropy (RE) measures.	improvement in the highly hippocampal dependent lure discrimination metric. • Researchers observed improvements in a hippocampal-dependent memory task, indicating that both the kind of enrichment activity and the degree of engagement in the activity were correlated with the amount of improvement. • Researchers concluded that "playing the video game Minecraft can positively impact hippocampal function in the form of improved memory performance on tasks unrelated to activities in the game itself" (p.11).	
Craft (2016)	Reporting the use of MC to supplement history and foreign language classes.	Server with a simple Roman temple was created to reproduce the temple.	49 (13-18)	The researcher observes and check progress and lending assistance and comparing pre- and post-assessments.	• The project was overall successful; some evidence being in the pre- and a post-written assessment on student understanding of Roman architecture. Performance increased from 13% (answers correct) in the pre-test to 60% in the post-test. • Some students completed the tasks before the deadline. Some reported it was overwhelming for them to find information about their temple or were distracted, but after including a step by step instruction, confidence in the use of MC increased.	8
(Egbert & Borysenko, 2019)	To test whether the use of the TESOL Technology Standards (TTS) and engagement principles as a foundation for language tasks in Minecraft facilitate teacher	Students were placed in 12-weeks of a course focusing on an introduction to computer-assisted language learning (CALL) for pre- and in-service language teacher education students using Minecraft.	15 (≤ 19)	Three data sources were analysed: students' tasks documents (they participated in presentations, discussions, and completed reflection about the task as well as completing a speaking and listening task for the topic of knowledge/skills acquisition), Minecraft tasks (weekly 90 min.	• Students reported that they had learned the basics of technology knowledge and skills and are able to teach some of these basics to others. They made positive comments about their experiences with Minecraft and that it is developed their communicative skills and facilitate group collaboration. • The course helped students to engage with each other (Minecraft prompted discussion because it was used with language learners, which were planned to help students to learn about the effectiveness of CALL based on learning principles) and allow them to focus on the knowledge they most wanted/needed to gain.	10

	classroom learning.			task), and students end course evaluations.	• Students were observed exhibiting and perceiving constant involvement in working on their Minecraft task or on their houses/stores after class and/or before the next class session. About 73% of the students said that they would definitely use Minecraft in their future teaching.	
Elliott (2014)*	Finding ways to develop curriculum in English and Humanities class using "non-linear new media text".	Purpose of using MC was to explore ways to develop curriculum and engage students who have major reading, writing and behavioural issues.	N/D (Avg. 14)	The researcher interviewed students, teachers; used formative surveys; collected Snapshots, text record, video game levels, pictures and classroom audio.	• Some students engaged deeply with the games and reported highly desirable schoolwork. • The study focused on a case study of a teenager who had poor school attendance and difficulties with learning space. After introducing MC, the student became more confident to share his expertise of MC; his social interaction increased; His attitude toward school become more positive; he began to engage in traditional activities and more interested talking to teachers. • Limitations of the study: limited to one case study, and the number, age, and gender of students were missing.	9
Hill (2015)*	Describing a library project exploring innovative options for embedding information literacy skills by utilizing MC.	The MC club met in the school library. Students choose to lead a role in building a virtual world library, with all its facilities with digital citizenship.	8 (10-11)	Observations for children's activity in the virtual library from October 2013 through April 2014; interviews about their experience during the last month of the project; and mixed reality videos, both in the physical school library and in the virtual world.	• Students allowed adapting their own expertise skills, e.g., one student showing strong leading skills took the role of the game designer; another became computer technician …etc. • The researcher reported a strong observation of engagement in programming and developing MC. Collaboration, critical thinking and constructing the virtual works were observed, embedded in digital citizenship. Students reported positive learning. • Limitations: after a month the librarian's laptop crashed, and the whole project was lost.	8
Marcon and Faulkner (2016)	Examining the use of MC as an academic tool to motivate girls' literacy	The study lasted two weeks of 9 meetings. The unit of MC was added to bridge the gap between formal	14 (12–13)	Data collected through observations, interviewing two girls, a survey and screenshots; and students' MC	• Girls reported that MC was an attractive text for literacy learning and helped them collaboratively and strategically in designing and immersing themselves in the game world purposefully as well as allowing them to use problem-	9

	practices in the English classroom.	and informal learning.		posts/comments on Instagram and Facebooks.	solving skills and negotiations for distributed learning initiatives. • Girls used expressive language to pursue assistance from other players and provide the meaning of their actions and expressed their interest and gaming activities within their online social tools, indicate more engaging learning beyond the classroom.	
Marlatt (2018a)	Exploring the use of digital literacies to support student-centred literary analysis	Students read a novel together, then conduct a literary analysis with MC in three 90-minute gaming sessions.	1 (18)	Observation how one student, Stella, engaged with the novel and the literary analysis in MC; and interviewed her for 3 times to understand concepts behind what she produced via MC and how those activities are related to the text.	• Stella's crafted well scenes that linked to the reading of the text, showing detailed and sustained engagement well with literature. • She demonstrated an understanding of literacy potential for impacting families and society, showing critical awareness of social inequality and prejudice in sociocultural interaction. • Players showed strategy and problem solving, and her analysis offers her new lenses to examine her identity.	6
Marlatt (2018b)	To describes students' engagement in the literary analysis of a novel using MC.	The novel was read with the students, and they asked to re-create two scenes of their choice from each chapter using MC instead of daily comprehension quizzes or vocabulary worksheets.	1 (20)	Data collected through observations of player' moves on the screens and observing their social and textual interaction. The observed player is from a minority and had experienced failure in literacy.	• Through MC players were excited about literature. • Yem (the observed player) was creative and enjoyed gaming and reported that it is the first time he was given a choice on what and how to read in high school. MC motivated him to engage with the text and was a vehicle for his during-reading visualization. • MC offered the students with the opportunities to cultivate multicultural perspectives. • Offering interesting readings and numerous entry points into those readings for students is important for social justice which highlighted students' diverse literacy practices	6
McColgan, Colesante, and Andrade (2018)	To find if a game-based experience had an impact on pre-service	Students were enrolled in issues in Contemporary Education class that includes using MC	55 (18-23)	Pre-posttest Likert-scale survey designed by the instructor and align with the objectives of the course to evaluate	• Most groups decided to create lessons in STEM topics regardless of their own major. Mean scores were higher at the post-test than the pre-test for perceptions of skill using technology and confidence with new technologies, with no gender differences.	11

	teachers' skills, beliefs, and confidence using games for teaching.	to create lessons for middle and high school students.		the effectiveness of the project, and "included questions about students' attitudes, time using social media, time spent on games and gaming with technology, and skill with technology."; and reflection essays.	• Three themes of positive changes in the classroom and their beliefs of using MC emerged, which are the acquisition of knowledge/ skills; engagement; and collaborative interaction. • They mentioned five barriers, including the steep learning curve, time, and complexity for teachers, student distractibility, and complexity for students to learn the game. Pre-service teachers were sceptical of using games for teaching in the classroom.	
Moffat et al. (2017)	Testing three games' impact on creativity.	Participants asked to play one of three games for 30 minutes: puzzle, sandbox, or a first-person shooter.	21 (18-30)	Participants completed a survey afterwards. Creativity was measured by the Torrance Tests of Creative Thinking (TTCT).	• Sandbox game affected creativity the least of the three types of games. Flexibility, as a form of creativity, was affected much more than fluency and originality, which had not been impacted much in this experiment - players had little or unobservable change in the fluency or originality in their ideas. • Video games engage students creatively; this temporary effect on creativity was differs based on the game type.	10
Nebel, Schneider, Schledjewsk, et al. (2017)	Presenting a comparison of different goal types within an educational video game, using MC as a content creation tool.	Three groups of students (specific performance goal, specific learning goal, goal-free condition) did 5 tasks to learn about the basic elements of computer science and electrical engineering.	87 (17-31)	Some observations and surveys were used to measure outcomes: The survey was on Current Motivation; Cognitive Load Measurement; Survey for retention, transfer and far transfer; and participants rated the fun they had.	• Having specific learning goals lowered extraneous and intrinsic cognitive load; players reported more fun and effective impacts of goal-setting and deeper motivational processes. • In the goal groups, participants showed anger, impatience or confusion after not being able to reach their goal. Participants in the goal-free condition started by reading the task information and then tried to solve the tasks, whereas the specific performance group read a minimum of texts to understand the requirements to solve the tasks. However, no significant change in learning performance was found.	13
Petry (2018)*	Examining children's conception of the relationship	No intervention reported. The researcher observed	5 (6-12)	Semi-structured interviews and 5 play sessions recorded of children who identified	• YouTube and books stated as the main resources for learning about how to play and be creative. Children indicated some aspect of learning from the game. MC	7

	between work/labour and leisure in game playing.	some playing sessions.		themselves to be MC fans.	helped them to collaborate with others, engage, discuss, and share knowledge. • However, most children had never heard the word 'labour' in playing; instead, they use 'work'. • The play involved much work, requiring a state of mind and fun; when players lose the fun, they lose the game.	
Quiring (2015)	Bridging gaps between the literature and research on virtual worlds.	No intervention was reported.	1 (N/D)	MC analysed through the researcher's own experience and analysis of gameplay videos uploaded to YouTube.	• MC discussion was based on the themes of Alteration/Change - players' ability to alter their virtual environment; Proximity - MC space to participate in shared projects and events; Conflict/Cooperation -the multiplayer servers where players centre on specific projects and negotiate conflicts. MC is no less real or meaningful than human interaction outside the game.	5
Sáez-López et al. (2015)	Evaluating the use and outcomes of MCEdu and discussing attitudes of the educational community.	MCEdu was used, where teachers developed a unit to evaluate the outcome of using this game for the experimental group.	Stage A) 181 (11-14) Stage B) 205 (N/D) Stage C) 131 (11-14)	A) Learning, of 131 students in the experimental group (MC group), and 50 in the control group assessed through formal tests. B) Surveys to analysis the attitude of parents, teachers and students regarding the use of MCEdu. C) Qualitative analysis of an online discussion platform.	• Test results of the academic unit did not show a significant difference between the experimental and the control groups. • 98.5 % of participants thought MCEdu was fun; enables discovery (96.6%), encourages learning (97.1%), enables rich interactions (96.6%), and enhances creativity (96.1%) and learning (83.4%). • Students interacted with each other in English although there were some from Spain and the USA. • Limitations of the game: 24 people thought the school lost time applying it and 36 people thought it should be used outside the classroom. Parents were the most negative regarding these two points, with 79.1% and 75% of the frequencies, respectively.	13
Saito et al. (2017)	Examining whether a visual-based input method induces a	Participants attended a lecture, which taught the basic concepts of	72 (6-15)	Pre- and post-questionnaires given to participants before and after the lecture, assessing: Interest,	• Participants' attitudes for interest, difficulty, and fun towards programming improved and became positive. The results included that the Visual Group had a larger positive change in the attitude toward programming than the Text Group.	10

	different attitude or outcomes of programming .	programming environments.		Difficulty, Usefulness, Fun, and Willingness with five Likert scales.	• The visual input increases positive attitudes towards programming more than the text input method and seems to be great for an introduction to programming and in a programming implementation environment for first learners. • Limitations of the study: groups were unbalanced.	
Smolčec and Smolčec (2014)	Reporting on how MC has helped their son with developing language skills.	No intervention was reported.	1 (10)	Observation for their son's monitoring their work online playing MC and the impact on his linguistics skills of listening, speaking and writing.	• MC helped the child to learn collaboration and build friendships. They learned vocabulary, which helped them to be more confident as a speaker and as a writer. Different English skills were learnt by watching YouTube videos. • Limitations of the game/study: the child learnt inappropriate language through interacting with others, such as swearing, and developed an addiction, some spent too much time playing rather than doing other activities.	7
Swier (2014)	Considering goal-orientated communicative tasks for virtual worlds, adopting MC as a platform of choice.	Three goal-orientated tasks that involve some exploration and modification of the environment were designed by the participants.	6 (19-29)	Pre- and post- Likert questionnaires using a five-point scale to explore the attitudes of the participants towards completing goal-orientated tasks in MC; and a semi-interview about completing the task.	• MC is a useful platform for developing communication skills for language learners; negotiation was clearly observable; linguistic interaction between players decreased during periods where players were not faced with an immediate goal, such as solving a problem or making a decision. Participants completed the tasks in the same amount of time; stating that their communicative interaction improved their English. • Limitations of the study: the sample is small.	9
Wernholm and Vigmo (2015)*	Attempt to find how online technologies could influence data collection chances and process.	Children played as one community on the same server. Their playing was recorded using FRAPS software.	3 (> 15)	FRAPS - an online tool, allowing players to video record their play was used and then the dialogues were transcribed and analysed in regarding: Which of all these dialogues can be	• FRAPS helps researchers get closer to children, and not distribute children's participation. Participants' interactions were in the Swedish language and English concepts. Analysis of the video recordings showed players gained and shared knowledge and became better through collaboration with the language use. • Limitations of the study - children, expressed annoyance when having technical problems.	8

		characterized as knowledge-making dialogues.

* *Social and communication learning is a secondary outcome for these studies*.

Table 2 Summary of all included studies about Minecraft (MC) focuses on social and communication learning outcomes

Author/ citation	Study aim	Research design (intervention)	Sample N (Age)	Data collection approach	Key findings	Connolly et al. scale score
Bebbington and Vellino (2015)	Defining how information literacy is used through MC and how these skills were demonstrated in informal online spaces.	No intervention - researchers analysed online discussion threads, August 2011 - June 2013, located from MCforum.net, and interviewed MC players.	8 (15-16)	Stage A) analysed online interaction of 20 threads with 510 participants in a public dissection forum. Stage B) semi-structured 30-minute interviews with eight MC players.	• Stage A - 5 threads were requesting for technical information, 12 were expressing strategic information, and 3 endeavoured to share opinions. 98.75 days were the average duration of threads. • Stage B - 5 of interviewees reported they get information from MC -focus resources, used the trial and error process to learn, reporting a different way of evaluating information.	8
Callaghan (2016)	Investigating the role of MC Edu in collaborative educational learning environments	Two separate worlds created on MCEdu. One created for learning for the Technology Applied Studies (TAS) class and the other for socialization for an MC club (after school club).	168 (12-16)	Observations using a framework to record classroom information data observed all online activity in real time and using video recording software. An online questionnaire was given for students, with Likert scales and open-ended questions.	• MCEdu used as part of the teaching and learning by 62% of participants. 72% of students reported the educational benefits of using MCEdu in class. The more students vocalized, the more they became productive in building structures collaboratively. • Teacher and researcher reported that players were generous in sharing expertise, communicating, creating objects, problem-solving, and working collaboratively. • All students demonstrated higher order skills of “create” and “evaluate” (Bloom’s Taxonomy).	12
Cilauro (2015)*	To attract youth, to have a role in library programming, creating social interaction opportunities	Participants engaged in planning for the MC Gaming Day, and they were given a chance to critically review the library space and employ	5 (N/D)	Staff evaluation of designed library and focus groups about their experience in participation in the library gaming program.	• Parents were involved indirectly and understood the online behaviour of their young people. • Participants were able to socially interact with others from other ethnicities and cultures, including disadvantaged young people to be socially included in this online game. This became a socially engaged tool in the library. But, Some of them could not fully take part due to lack of access	8

	within the community.	their rules in the virtual library program.			to MC or being unable to be part of the group dialogues, leading to some isolation. • Limitations of the study: - the age of participants not reported.	
Davis, Boss, and Meas (2018)	Exploring collaboration in MC and factors support a high quality of collaboration.	Three groups of 2-4 students were invited to build a summer camp together in Mc for one hour.	10 (11-13)	Observation, field notes, and transcripts of reordered video of the playing and participants' utterances using an in-depth thematic analysis.	• Most of the players' discussion with each other included talking about gameplay and asking and answering questions. • Participants' communication and discussion during gameplay showed a number of factors that affecting their ability to achieve joint attention and successful collaboration, such as prior social ties, gaming experience, and responsiveness to other players.	9
Dezuanni et al. (2015)	Exploring how girls undertake practices of curatorship to display their MC knowledge.	Year 3 students and the teacher played MCEdu, in the class, and explore how girls manage curatorship in the playing and discussion of MC.	16 (8-9)	Interviews and focus groups lasted between 15-30 minutes about the girls' use of use the MCEdu version and their home and school gameplay.	• Year 3 students showed positive thoughts about the school MC server because of the social interaction, occurred by seeing each other's screens and by sharing ideas or solving problems. • Playing the game showed many forms of social interaction in the class, such as discussing, sharing, arguing, ignoring and debating. One student, she did not enjoy the game socially due to not knowing some people on the server.	8
Ellison (2017)*	Examining how the participant (Zack) chose a topic and created a digital story; and the influence of his racial identities.	Digital storytelling workshop held after school, one hour a week for seven weeks as part of a PTA enrichment club program for students at Zack's school.	1 (13)	The researcher observed Zack seven times, for one hour each week, creating audio- recorded transcripts from three 30-minute semi-structured and unstructured interviews.	• The child chose to create his digital story using MC, being a sign of how MC is essential to him; was able to plan and map the story from the beginning to end creatively and independently, feeling comfortable operating in MC space. He reported being afforded opportunities make decisions, problem solve and be a critical thinker within MC worlds. • The study helped researchers understand how race is an important part of the participant, as evidently presented in his digital story, allowing him to build on his literacies, agency, funds of knowledge and identity.	7

Hollett and Ehret (2017)	How civic youth can engage in a youth-driven program - Metro: Building Blocks (MBB), provided within a digital media learning lab in an urban public library.	Participants played together on the same server and location (the learning lab) where the budding city planners built components of Metro, sometimes joining from home if unable to physically attend.	3 (12-16)	The analysis was illustrated upon observation, and video recordings of nearly 90 hours of gameplay as well as field notes and interviews with participants.	• Collaboration and engagement were observed. The engagement was desire-driven toward collaborative transit station, more than interest-driven. • Back-and-forth movements between one player and the others took place, assisting them then leaving them to work independently. • The analytical interest of this paper focused on three rhythmic elements: pulsation; reciprocation; and oscillation. • This study is useful for considering how to program designers, mentors and educators can encourage productive participation. • Limitations of the game/study - all participants were male.	7
Hong-An (2016)	Exploring the use of values generated by prosumers through their production in affinity spaces.	No intervention reported, as researchers aimed at analysing 25 discussion threads.	N/D (N/D)	Content analysing methods was used to investigate the descriptions, discussions, and artefacts produced on MC affinity space regarding MC.	• Threads gave players opportunities to exchange news, legal and technical changes to be able to access the game; sharing a narrative or visual experience of MC and giving opinions and suggestions that can offer the game cultural and social gaming exchanges. These threads can be used as self-directed learning and as educational and motivational support for others, as well as an entry point for socialization.	6
Hook et al. (2016)	Examining the influence of evaluative social identity on brand-based social network commitment.	No intervention was reported.	394 (6-14)	Measurements were: Evaluative Social Identity; Negative Anticipated Emotions; Positive Anticipated Emotions; Community Commitment and Recommendations; Personal Self-esteem; Perceived Behavioural Control.	• Evaluative social identity and network recommendations are positively associated, where a higher level of evaluative social identity leads to a higher level of network commitment. • Children with high evaluative social identity showed positive feelings and emotions when they were able to interact with the brand-based social network, leading children to network commitment and network recommendations. They felt negative emotions when they were prevented from connecting to the brand-based social network.	12

(MacCormack & Freeman, 2019)	To describes a pilot study for a play-based intervention designed to support the development of social competence of youths with ASD using Minecraft.	Youth with ASD participated 8 1-hr sessions in free (no roles or objectives) and structured (role-based objective) play in MC during 8 1-hr sessions with a typically developing peer and two adults with video modelling, adult facilitation, and mediation.	4 ASD + 1 TD (11-13) & 2 Adults	Researchers use video recordings of in-person and in-game play to score the quality of social play, measured by rates of initiations and level of engagement and affect.	• Although a low degree of motivation of youth with ASD to interact with others was observed during the free play in the early sessions, structured play increases the quality of social play and players were more engaged as they participate in shared goals as they had to make and respond to social bids. • Players' social play through the early sessions was identified to be more parallel and associative, but the play became often cooperative during the later sessions. • The result of this intervention suggests that as the players practiced making social initiations during structured play, they transferred the skills to free play. • 'The present study suggests that videogame play may be a useful modality for programs by which youth with ASD can learn and practice social skills through play' (p. 234).	10
Mavoa, Carter, and Gibbs (2018)	Examining engagement with MC for children aged 3-12 living in Melbourne.	No intervention was reported.	753 (children= 3-12; parents= 36-45)	A questionnaire filled by parents to collect data about the children's demographic information, general digital gameplay, Minecraft gameplay, YouTube use, general 'screen time' and finally basic parents' demographic questions.	• Almost 50% of children had played MC in the month prior to filling the survey. Older children are more likely to play MC than younger; boys in the youngest group 3-5 play MC 3 to 5 time more than girls; but older group 9-12, girls play MC more than boys (they drop off from 72% of all boys at 9-11 years old to 54% of boys aged 11-12 years old); 46% of parents reported that children start play MC at age 6 or 7 years old; a lot of children play less than one hour a day; children play MC in single player mode play more often; most children play in creative mode; and 37% of children watch YouTube related to MC.	13
Nebel et al. (2016a)	Finding out if social competition increases cognitive load, engagement, interest, and	Researchers built one world for each of the four groups. They created a learning task, tested the environment and gave participants a tutorial for the task.	115 (18-42)	A pre-survey and post-survey for cognitive load measurement, revised the User Engagement Scale, the Situational Interest, and completed the Game	• The extraneous load was reported by players in the social competition due to the increase in effort in working with the group, but no differences in satisfaction could be observed. • A higher number of competitors decreased some engagement because distracting each other, but higher challenges were positively related to the better level of engagement.	12

	subsequently learning.			Experience Questionnaire.	• Players in the competitive scenarios learned significantly less.	
Nebel, Schneider, Beege, et al. (2017)*	To evaluate the level of cooperation on learning, play, cognitive load, efficiency, and play experience.	Participants were divided randomly into two groups: voluntary cooperation (VC) and increased task interdependence (ITI) where collaboration was necessary to solve the task.	56 (15-20)	A survey about the experience and pattern of playing of MC. Texts were analysed according to the task criteria and speaking time. Cognitive Load was used, and standardized learning measurements were used as learning performance indicators.	• MC offers players more opportunities for creativity, and they were pleasant, and only positive feedback was yielded. • Students' group task performance increased as they were required to collaborate, so individual learning outcomes increased as their interaction increased. Cognitive load was not affected by the collaboration requirement, but collaboration was used to enable learning, and more mental effort was invested by the ITI group due to the cooperative requirement. • Limitations of the game - some players lose their attention easily and do their own gaming, delaying the process of the given task.	12
Niemeyer and Gerber (2015)	Exploring the phenomena of digital maker culture by examining five MC channels on YouTube.	No intervention was reported.	1 (N/D)	Researchers interviewed an avid player about best channels for MC maker culture, subscribed to 5, reviewed 10 videos from each channel, and then analysed comments.	• All videos provided something to the viewer, such as how to complete a task or build something; some players expressed their own experience of creating something. • Creators and viewers engaged in lengthy discussions. • Creators showed a high quality of MC knowledge and video production. • Limitations - lack of information about the reviewed channels.	8
Potts (2015)	Exploring the impact of MC popular players on the language and interactions of the fan community.	No intervention was reported.	1 (30)	Three data collection sources used: 63 YouTube videos, comments on these videos, and an interview with one of the famous	• Sexual innuendo was the most frequent themes using a different linguistic tactic. References to romantic acts and feelings in a relationship were also observed, at male gaming partners. • Highest frequent sexual themes in comments were whether they were gay or straight, masculine or feminine. • The anonymity offered by MC allows players to blur and utilize their characters, which can be used to promote social	7

				YouTube channels producer in the UK.	justice and offer a transgressive engagement in the digital world.	
Sanz-Martos, Martínez-Martínez, and Creus (2018)	To analyse users' behaviour, the amount and content of messages and compare the structures and workings of MC and League of Legends (LOL)	No intervention was reported.	N/D (N/D)	Content analysing methods used of messages of two famous YouTube channels	• There is different behaviour depending on the communication space. Mundo-MC community recognise each other and even inform others if one planned to be absent for a while; conversely to YouTube where participation follow any user, and it is not necessary to be subscribed to the channel. • The interest in the topic remains as it is. Members of the community tend to be grouped into teams of acquaintances. They find the game's form is a place for exchanges of messages and information. • Although the number of viewers and the unorganized arrangement of the comments prevents the establishment of a community, there was enough evidence that users shared and exchanged knowledge, and they undoubtedly learn.	6
Schneier and Taylor (2018)	To examine the collaborative engagement of MC players.	Participants were divided into groups and allowed to play MC Pocket Edition for 30-60 minutes.	10 (Avg. 16, *SD*= 10.88)	participatory observation of both on- and off-screen activity for participants playing MC to discuss players' engagements with MC.	• Players remained active in the game, but their bodies positioning was largely consistent through the play, same seated positions facing screens. • All players engaged with each other in the play sessions with MC PE and social and emotional interactions were observed.	9
Stone, Mills, and Saggers (2019).	To report on the support for social interactions received by three students with ASD through Minecraft	No intervention was reported.	3 (9-10)	Data collected through screen observations of children playing Minecraft and semi-structured interviews	• MC provide platforms for students to engage in reciprocal conversations. Attracting others' attention, communicate and engage with others physical and in the virtual worlds was observed. • Playing MC with others provides opportunities for social interactions in multimodal ways that are not available in face-to-face and offline contexts. The game could be used to promote children's with ASD ability to initiate and sustain social interactions in inclusive educational settings.	10

Willett (2018)	Understanding the ways social aspects of consuming media contribute to meaning-making practices.	No intervention was reported.	6 (8-9)	Semi-structured interviews with children, and one with parents about participants' understandings of online games and gaming resources and sociocultural influences of online games.	• Children showed a general understanding of the gaming industry, due to their investments in membership, Realms, merchandise of games. They were aware of numerous revenue-generating mechanisms and learn about financial aspects including critical evaluation of the games' income through social resources, such as older siblings, friends and parents. Socio-economic and cultural contexts of families and parental interests affect online gaming's influence on children's media literacy skills. • Limitations of the study: the sample size is small.	8

* *Academic and motivation for learning is a secondary outcome for these studies*.