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Teaching with a Digital Sandbox Game: Teachers' Experiences with Minecraft Education Edition

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Abstract

We are witnessing an excitement about digital games and related immersive media as these become ever more prevalent in the world. Governments, private companies, and research institutes are investing in these technologies in hopes of transforming education. However, while scholarship on digital game-based learning has been steadily growing over the last few decades, we still know little about how teachers experience, design curricula for, and use digital games as teaching tools. This knowledge gap stems from researchers focusing on the design of educational games and game-intervention effects on student outcomes. This dissertation aims to address this gap by examining how K-12 teachers integrate Minecraft Education Edition as a teaching tool into formal instruction. The most successful video game to date, Minecraft, is a digital sandbox game that allows players to build and explore virtual worlds made of blocks. Through three studies, I seek to understand better the experiences of teachers who integrate the sandbox game into their teaching practice.

In the first study, I analyze a publicly available repository of lesson plans from the Minecraft Education Edition website. Using descriptive statistics, I report the lessons' target students' ages, subjects, and skills. Then, using qualitative methods, I identify a taxonomy of seven design dimensions and four lesson types based on different combinations of these dimensions. These findings provide a lens to describe what lessons with Minecraft look like and what variations teachers make when designing learning activities with the sandbox game. In the second study, 92 K-12 teachers sampled from the Minecraft Education Edition community responded to an online survey. The findings showed that most teachers used the game weekly and across subject areas. The results also revealed that almost all the teachers faced multiple

challenges in their game integration. A thematic analysis of open-ended questions surfaced five challenge themes. Two themes specifically, content and pedagogy, contribute to the literature by highlighting difficulties teachers face in sourcing curricular materials and managing classroom activities with the sandbox game. In the third study, I use a case study methodology to examine how three experienced Minecraft-using teachers think about, design curricular materials with, and use Minecraft Education Edition in their teaching practice. Results showed that all three teachers viewed the game as a powerful teaching tool that increased student motivation, engagement, and collaboration. However, they shared qualitatively different learning activities and approaches to curricular design with the game. One key variation hinged on whether teachers viewed Minecraft as a blank canvass with which students could represent their learning or as a tool for the teacher to create a curated virtual world with prescribed student activities to follow. Moreover, the findings revealed that curricular design with a commercial sandbox game could involve collaborations between diverse stakeholders: teachers, students, content experts, and game publishers.

Collectively, this dissertation contributes to our theoretical and applied knowledge of what teaching with commercial digital sandbox games entails. In particular, it sheds light on how teachers design curricula with Minecraft Education Edition. Moreover, the findings carry practical implications for teachers, policymakers, and game publishers.

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Chapter 1. Introduction

Digital game-based learning - the use of digital games for educational ends – has gained worldwide attention over the last decades as a technological innovation with the potential to improve educational outcomes (Honey & Hilton, 2011; Sandford et al., 2006; Wastiau, P., Kearney, C., & Van den Berghe, 2009). Private entities have been investing in the design and research of game-based learning platforms (Kuhn, 2018; Lunden, 2020). In fact, market forecasts predict the growth of this industry from $4.7 billion in 2019 to a $17 billion market size in 2026 (Knowledge Sourcing Intelligence LLP, 2021). A growing body of research on game-based interventions buttresses this excitement by demonstrating that digital games can lead to gains in student engagement, motivation, and learning outcomes (Clark et al., 2016, 2018; Wouters et al., 2013). Advocates of game-based learning frame digital games as powerful learning tools in several ways. Games are environments that immerse students in disciplinary content (S. Barab & Dede, 2007; de Freitas, 2006) and invite learners to engage in multiple literacies both inside the game and with para-game texts (Gee, 2003; Steinkuehler et al., 2010). Digital game designers have developed games for topics across the curriculum with titles supporting learning in STEM, Social Studies, and Social Emotional Learning (Clark et al., 2018; Esper et al., 2014; Khalili et al., 2011). In line with the proliferation of games for learning and the availability of computers in schools, recent surveys indicate that teachers in many nations are increasingly open to using digital games (Jesmin & Ley, 2020; Millstone, 2012; Ruggiero & Loe, 2013; Takeuchi & Vaala, 2014; Wastiau, P., Kearney, C., & Van den Berghe, 2009).

However, while surveys indicate an increase in teachers' openness and digital game use, we still know relatively little about teaching with digital games. This gap stems from researchers

in the game-based learning field primarily focusing on the design of educational games and the effects of game interventions on student learning processes and outcomes (Egenfeldt-nielsen, 2007; Hwang & Wu, 2012). These foci have resulted in very few studies examining how teachers integrate digital games into real-world formal classrooms (Egenfeldt-nielsen, 2001; Marklund & Taylor, 2016). Research has established that the availability of technologies alone is not enough to change teaching and learning (Cuban, 2009; Penuel, 2006). Bringing this skeptical view to the context of digital games means that we should carefully examine how teachers use digital gaming technology in their teaching practice and identify areas for support and improvement such as through policy. A 2011 National Research Council committee on science learning with computer games and simulations recognized this need. They called for future research to focus on best practices for integrating digital games into formal learning contexts, the challenges of integrating digital games, and solutions to scaling up the use of digital games in education (Honey & Hilton, 2011).

Viewing teachers as agents of integration in game-based learning, several researchers have examined how teachers use digital games in formal K-12 classroom instruction. Their studies inform us that teaching with digital games is complicated, time-consuming, and requires teachers to deal with many barriers (Klopfer et al., 2009; Marklund, 2014; Marklund & Taylor, 2016). In addition, by paying close attention to teachers' roles and pedagogical activities in game-based learning, several studies have begun to describe and model game-based pedagogy – what teaching with games entails and requires of teachers (Thorkild Hanghøj, 2013; Nousiainen et al., 2018; Taylor et al., 2012). These studies establish a basis from which our understanding of teaching with games is constructed. Nonetheless, many questions remain about teaching with

digital games. How do teachers prepare learning activities and curricular materials with digital games? How do teachers integrate digital games into their yearlong teaching practice? Making matters more complicated, digital games differ from title to title, across genres, subject matter and context. This makes it difficult to draw generalizations about teaching with digital games beyond the particular genre or game in question (Plass et al., 2019). With this in mind, research is especially wanting on teaching with immersive interactive digital games and commercial digital games (Eck, 2009; Stieler-hunt & Jones, 2019), classes of games that may require teachers to develop curricula and that lend themselves to prolonged gameplay activities (Becker, 2017).

To address these gaps in the literature, I examine how teachers integrate a digital game as a teaching tool. Specifically, I explore how K-12 teachers design and implement learning activities with an immersive interactive and a commercial digital game, Minecraft Education Edition. Building on foundational works on teaching with digital games (Egenfeldt-nielsen, 2007; Thorkild Hanghøj, 2013; Marklund, 2014; Sandford et al., 2006; Taylor et al., 2012), I report on three studies on teachers' real-world use of Minecraft Education Edition, an exemplar of the sandbox game genre (Lyngstad, 2017).

The Current Dissertation

In this dissertation, I build upon prior work and aim to advance our understanding of how teachers integrate digital games into formal K-12 classroom instruction. Specifically, I focus on the case of Minecraft Education Edition, a popular digital sandbox game in practice, and the game-based learning literature. My driving research questions were:

"When K-12 teachers integrate a commercial digital sandbox game as a teaching tool

1. What does their teaching look like?

2. What challenges do they face?

3. How do they design their lesson plans?"

Through three separate studies, I sought to answer these questions and subsets of questions that guided my analysis.

Study 1 - Crafting Game-Based Learning: Teacher-Designed Lessons with Minecraft Education Edition

Starting this dissertation, I asked, "What do learning activities with Minecraft Education Edition look like?" To answer this question and begin investigating the real-world use of Minecraft by teachers, study 1 drew on a large corpus of publicly available lesson plans from the Minecraft Education Edition website. I first produced descriptive statistics to understand who the teachers were and what subjects, skills, and students they taught with the game. After identifying a subset of the sixteen most prolific uploaders of lesson plans, I conducted a qualitative analysis of their 159 lesson plans. Namely, I coded the textual descriptions of the lesson plans and supplemental curricular materials.

This analysis led to a taxonomy of seven design dimensions along which the lesson plans varied. World builder - whether teachers build a dedicated world for the lesson. NPCs – whether teachers embed their worlds with non-playable characters. Single or multiplayer – whether students play individually or together in a shared virtual space. Students as builders – Whether

students build in the Minecraft world as part of the lesson. External media - whether the learning activity is contained entirely in-game or are across other digital or physical media. Documentation - whether students are to document and share their activities. Game world to real world connection – whether the teachers ask students to make explicit comparisons and connections between the real world and the game world. Moreover, I describe four categories of lesson types based on teachers' combinations of these seven dimensions. In this way, I illustrate how teachers arrange the socio-technical environment and set up a range of learning activities with the game. Taken together, this work provides a lens to describe what lessons with Minecraft look like and what design variations teachers make when planning learning activities with the Sandbox game.

Study 2 - Teaching with a Sandbox Game: Teachers' Use and Challenges with Minecraft Education Edition

Study two moves from examining lesson plans to surveying the experiences of teachers who teach with Minecraft in their own words rather than through secondary data. 92 K-12 teachers responded to an online questionnaire about their use of Minecraft Education Edition as a teaching tool. Close-ended and open-ended items queried teachers' demographics, experiences with digital games, and use of Minecraft Education Edition. The teachers used the game frequently in their teaching across subject areas. Moreover, though the teachers had been using Minecraft for several years, they still faced multiple challenges when integrating the game into formal classroom practice. Qualitatively analyzing open-ended responses, I narrowed these challenges into five themes: Technical, Content, Time, Pedagogy, and Lack of expertise.

These themes echoed and expanded on prior literature regarding challenges and barriers to teaching with digital games. The technical theme replicated prior work showing that gaming technologies, especially for multiplayer gameplay may not always work smoothly and requires technical support. The content theme highlights that teachers need to find or create suitable curricular materials for the use of a commercial sandbox game. Prior research has stated that teachers often lack time, especially when integrating novel technologies like games. The current study echoes these findings while stressing a particular challenge in the case of teaching with a sandbox game like Minecraft, the time needed to create virtual worlds. The pedagogy theme reveals that many of the proposed benefits of game-based learning may also be things to contend with pedagogically. Specifically, that students' engagement sometime strays off task, that collaboration requires teacher scaffolding, that behavioral issues like destroying each other's virtual creations may occur, and that the diversity of student experiences and interest in the game requires attention as well. Finally, the lack of expertise theme shows that teachers who are adopters of Minecraft Education Edition, may nonetheless feel like they do not possess certain skills like programming with the game or like building virtual worlds.

Study 2 - Curricular Design and Implementation Practices in Game-Based Learning: A Case Study of Three Experienced Minecraft Teachers

In study three, I examine closely the design and implementation practices, thinking, and experiences of Minecraft using teachers. After conducting in-depth qualitative interviews with seven teachers who use Minecraft regularly in their teaching practice, I constructed case studies around three focal teachers. To do so, I triangulated primary video and audio interview data with secondary data from curricular materials, teacher blogs, teacher websites, and teachers' prior

appearances in conferences and interviews. For each teacher, I chronicled their: views of the affordances of the game, use of the game as a teaching tool, and curricular design process and output. While the three teachers integrated Minecraft regularly into their teaching practices, the analysis revealed qualitative differences across the three points of comparison. These findings expand on the lesson variations from study 1 and explain how teachers situate their Minecraft activities within the school year. Moreover, the expertise displayed in the teachers' design and integration helps to identify what novices should learn to become knowledge teachers with Minecraft Education Edition.

Organization of the Dissertation

Chapter 2 lays the theoretical background motivating and framing this work. I summarize pertinent scholarship on digital game-based learning and teachers' integration of digital games. I also clarify what we know about this problem space and identifying gaps in the literature. Chapter 3 outlines the research strategy I took and my methodological approach and rationale across the three studies. Chapters 4, 5, and 6 each present one of the studies at the heart of this dissertation. Each of these chapters is a fully contained article, following a three-article dissertation structure, complete with literature review, methods, results, and discussion. In chapter 7, I reflect back to the three studies, synthesizing their joint findings in relation to prior work and implications. Specifically, I articulate contributions to theory on how teachers integrate digital games into their instructional practice. I also suggest directions for future research in this domain. Finally, with an intention to inform practice, I propose ways in which this work can inform practitioners – teachers, game developers, and policy makers- toward the scalable and successful use of digital sandbox games in formal K-12 classroom practice.

Chapter 2. Literature Review

Overview of the Literatures Reviewed

Put succinctly, the three studies of this dissertation examine the following questions: What learning activities do teachers design with Minecraft, a commercial digital sandbox game? How do teachers use Minecraft in their teaching practice, and what challenges do they face? How do expert Minecraft teachers view, design, and implement learning activities with the game?

The above driving research questions contain specialized language from the domain of game-based learning that requires unpacking. To engage in the research detailed in this dissertation, I familiarized myself with bodies of work from a range of disciplines, themselves often interdisciplinary. Examples include Game Studies, Psychology, Human-Computer Interaction, Communication, Teacher Education, and Learning Sciences. In the following sections, I provide a foundational background that sets the stage and motivates my research endeavors. I divide this background into four sections. The first section covers games; how to define a game and the different categories of games. The second section serves as a primer on game-based learning. Following the broad field of game-based learning, the third section more closely articulates the focus on teaching with games in formal classroom practice. Closing this literature review, the fourth section provides relevant context for the dissertation, literature on Minecraft, and its role in teaching and learning. By covering these four areas, I hope that readers shall have sufficient background to comprehend and appreciate the motivation, structure, and contribution of this dissertation.

Games

A Definition of Play

As we start to investigate the use of digital games as a teaching tool, it is critical to establish what games are. We need to establish how we understand them in the literature. First, we should address the concept of play, as games are forms of play. Play is found throughout the animal kingdom, especially among mammals as a form of social regulation, interaction, and learning (Bekoff, 1972). Play is central to human culture and society (Huizinga, 2014). Several theoreticians have defined play in their own ways. Perhaps most notable is Dutch historian John Huizinga who established five characteristics that define playing as:

1. Play is a voluntary/free activity.

2. Play is not 'ordinary' or beholden to real life.

3. Play is distinctly separate from the 'ordinary' in terms of locality and duration.

4. Play is an activity that demands and instils absolute order.

5. Play is disconnected from material interest and no profit can be gained from it.

Building on Huizinga's work, Caillois (1961) explained play as running along a continuum with one pole being Ludus, goal-oriented play and the other pole being Paidia, player-led play. Let us consider two games that many play as children, Hide and Seek and Make-Believe. These two games do not require physical objects other than the body and imagination. In Hide and Seek, there are clear rules, such as the seeker needing to count to a certain number and then trying to find the players who are hiding. Moreover, there is a clear win and lose state

for both the seeker and the hider. Hide and Seek is an example of a game that falls squarely on the Ludus end of the continuum. Make-believe is player-led, and often the main goal is to create a narrative while embodying characters and a narrator. This goal may lead to sub-goals - like dressing up - that are emergent and player-led, not a rule. Finally, make-believe does not have a point system or win-and-lose states. If it did, it probably would not be as fun and popular. Therefore, Make-believe is on the Paidia end of the continuum.

Definitions of Games and Digital Games

Although games and play are closely related concepts, the two do not always reflect the same activities (Salen & Zimmerman, 2003). If we take two examples, a child playfully dropping their food on the ground and two teenagers playing chess. Only the latter would likely fall under what we would categorize as a game. Nonetheless, the distinction between play and game and the definitions of a game has sparked a debate, with most definitions of a game emphasizing the Ludus end of the play continuum. For example, Salen and Zimmerman (2003) combined several definitions to arrive at the following: "*A game is a system in which players engage in an artificial conflict, defined by rules, that results in a quantifiable outcome.*" (P.11). Scholars have been more open in their definitions, positing that games (including digital games) structure player behavior towards entertainment (Aarseth, 2011) either by rule and objective game-play or by interactive fiction (Tavinor, 2015). In a later section of this literature review, I describe Minecraft in further detail as a title that fits these more liberal definitions of games.

Digital games run on a digitized medium such as a computer or a gaming console. Several characteristics, which stem from code and the power of computing technology define digital games: interactivity between player actions and in-game outcomes, dynamic feedback in

response to player actions, levels of challenge, multimodal information manipulation, complex systems, and networked communication, to name a few (Plass et al., 2019; Salen & Zimmerman, 2003). Play and games seem to have always been a part of human culture. However, it is only in recent decades that digital games have become ubiquitous. Everywhere we turn, adults and children play digital games on their mobile devices or at home on their personal computers or gaming consoles (Lenhart et al., 2008; Perrin, 2018). Digital games are often motivating and enjoyable media by design (Plass et al., 2015; Ryan et al., 2006).

Game-Based Learning

The properties that make digital games so attractive a medium to a global audience have led educators, researchers, and game developers to advocate for games as learning contexts. Game-based learning or digital game-based learning is the application of digital games for learning purposes. Advocates of game-based learning have articulated multiple assertions and arguments about the power of digital games as contexts for learning: Motivation - Games are motivating and engaging to learners, especially in comparison to more traditional modes of learning (Plass et al., 2015; Ryan et al., 2006). Situated learning - Games afford situated learning opportunities and a way to work towards clearly defined goals (S. A. Barab et al., 2009; Dawley & Dede, 2014). Collaboration - Games are exceptionally well designed for collaborative learning, allowing learners to take up different roles, communicate, and work towards shared goals (Garneli et al., 2021; Musa, 2017). Complex systems – Like computer simulations, digital games allow learners to manipulate, visualize and interact with complex social and natural phenomena (David et al., 2005). Empirical studies support this advocacy, showing that game-

based learning yields gains in engagement, motivation and learning (Clark et al., 2016; Wouters et al., 2013).

The game-based learning field is broad, encapsulating several different activities and game types (Egenfeldt-nielsen, 2006). In terms of activities, learning with games includes informal learning at home or in after school clubs (Ito et al., 2010; Stevens et al., 2008) and more deliberate classroom interventions with digital games (Sandford et al., 2006; Wilson et al., 2018). On top of differences in contexts, the games themselves that are developed and studies as part of game-based learning vary as well. As with the definition of games, there are several ways to categorize games for learning (Becker, 2017; Govender & Arnedo-moreno, 2021; Nadolny et al., 2020). One level of distinction is the initially intended utility of games; that is between games for entertainment and games for learning. Educational games (also called serious games) are games that are designed by game companies or by researchers for the purposes of teaching or enabling learners to learn something (Becker, 2017; Wouters et al., 2013). In contrast, commercial-off-the-shelf games are designed by game publishers for entertainment (Eck, 2009; Govender & Arnedo-moreno, 2021). A second level of distinction is the genre of a game – categories of games that carry with them sets of design elements which players learn to expect and that shape gameplay and learning (Nadolny et al., 2020; Plass et al., 2019).

As stated in the introduction, much of the research on game-based learning has focused on the design of educational games and on outcomes from game-interventions (Clark et al., 2016; Plass et al., 2019; Wouters et al., 2013). Thus, the field has backgrounded the role that teachers play as agents who integrate digital games into formal school practice (Egenfeldt-nielsen, 2007; Foster & Shah, 2015; Hwang & Wu, 2012; Marklund, 2014). For example, Hwang

and Wu (2012) reviewed 137 papers on game-based learning published from 2001 to 2010. Of these papers, only three had sampled teachers as participants. I share the view of researchers who believe that supporting game-based learning requires that we focus on teachers as users of digital games and the real-world ways they integrate this technology into formal classroom practice. In the following section, I elaborate on the literature review to summarize what prior work states on teachers as enactors of game-based learning, or, in other words teaching with games.

Teaching with Digital Games

"Integrating digital games into schools is not simply a matter of making the tools available... How and when games are used in relation to other instruction, the role that teachers take as they are playing the game, and how the game is integrated into the overall classroom ecology all play a role in whether and what students ultimately learn."

(Bell & Gresalfi, 2017)

This dissertation aims to expand our knowledge of how teachers integrate digital games as a teaching tool. I build on prior work that believes that digital games alone cannot engender the positive educational impact that some might see in this technology (Bell & Gresalfi, 2017; Egenfeldt-nielsen, 2007; Marklund & Taylor, 2016). Digital games must indeed be present to enact digital game-based learning. However, I think that without teachers using digital games successfully to enhance their teaching practice, digital games will likely end up in the annals of technological innovations that failed to permeate educational practice (Marklund, 2014; Pivec, 2009). Moreover, there are dangers in marketing digital games as a silver bullet solution to the ills and challenges of education in ways that take agency away from teachers and instead play

into the whims of the gaming industry's financial interests (Arnseth, 2006; Marklund et al., 2021).

While representing a small share of the literature on game-based learning, a slowly growing number of publications over the last two decades have explored teaching with digital games. In the following paragraphs, I attempt to summarize this literature in prose, organizing it thematically and synthesizing what we know about teachers in game-based learning. Table 1 provides an overview of the seven research themes, including example publications, methods, and findings. My goal in this literature summary is twofold. First, I aim to allow readers of this dissertation to orient themselves to the literature in such a way that allows for an understanding of the three studies and their contribution to knowledge. Second, I hope that this summary in and of itself would contribute to a primer on teaching digital games for both researchers and practitioners in the field.

Teachers' Perceptions and Attitudes towards Game-Based Learning

The largest body of scholarship on teachers and digital games comprises studies on teachers' perceptions and attitudes towards digital game-based learning. This work reflects international interest in the degree to which teachers accept digital games as a teaching tool (Bourgonjon et al., 2013; Hayak & Avidov-ungar, 2020; Millstone, 2012; Proctor & Marks, 2013). The overarching goal of this work is to identify factors that may explain the likelihood of teachers adopting gaming technology into their teaching practice. Studies examine many factors such as the role of value perception of games (Huizenga et al., 2017; Pastore & Falvo, 2010) , gender (James & Wright, 2009), career stage (Hayak & Avidov-ungar, 2020), gaming experience (James & Wright, 2009; Takeuchi & Vaala, 2014), and school context (Grove et al., 2012).

Earlier in this conversation, scholars argued that the low rates of game use in formal instruction stems from teachers' negative views of digital games (Marklund, 2014). However, surveys from recent years indicate that teachers increasingly view digital games as legitimate teaching tools (Fishman, Riconscente, Snider, Tsai & Plass, 2014; Millstone, 2012; Takeuchi & Vaala, 2014; Wastiau, P., Kearney, C., & Van den Berghe, 2009). Therefore, questions regarding teachers' use of digital games or lack thereof must turn to other explanations outside teachers' aversion towards games or to technological innovation broadly.

Teachers' Use and Barriers to in the Use of Digital Games

The second area of work is studies on teachers' use of digital games and the barriers to adopting this technology. Several of these explore how frequently different teacher populations integrate digital games into their teaching practices. Surveys of K-12 teachers in the US found that an overwhelming majority used digital games in their teaching practice and often every week (Fishman, Riconscente, Snider, Tsai & Plass, 2014; Millstone, 2012; Takeuchi & Vaala, 2014). The games reported on were primarily educational games intended for short drill & practice activities. These games stand in contrast to immersive interactive digital games or commercial-off-the-shelf (COTS) games, gaming titles not originally designed for educational use and afford long-form gameplay activities. Similar to studies in the US, surveys of European teachers report high levels of game use among school teachers (Jesmin & Ley, 2020; Wastiau, Kearney & Van den Berghe, 2009). Studies of game use will often also explore teachers' reported barriers to integrating digital games. This work seeks to understand and mitigate the factors that hinder teachers from teaching with digital games. Studies have identified numerous barriers, the most common being: insufficient time, costs, lack of tech resources, difficulty

finding quality games, uncertainty about integrating games, unfamiliarity with technology, difficulty finding games that fit the curriculum, and lack of stakeholder support (Baek, 2008; Klopfer et al., 2009; Millstone, 2012; Takeuchi & Vaala, 2014).

The Effect of Teacher Implementation on Game-Based Learning

The third area of research focuses on how teachers' implementation and activities shape and affect student learning with digital games. Wilson and colleagues (2018) compared a science curriculum with and without a digital game on genetics. Findings showed that the game intervention yielded statistically significant improvements compared to the non-game condition. Moreover, teachers who implemented the game-based learning curriculum more effectively saw significantly better student results than teachers who were less effective at teaching with the game. This echoes earlier findings that teacher activities supplement a game's educational properties (Jaipal & Figg, 2009). Teachers can also implement instructional strategies that support non-gamer students' learning with digital games (Jong et al., 2017). Finally, as teachers gain experience in teaching with digital games, their comfort level rises, and they interact more frequently with students during gameplay. These changes lead to increased learning outcomes (Bell & Gresalfi, 2017; Hodges et al., 2021).

Teachers' Self-Reported Knowledge about Teaching with Games

The fourth area of research is teachers' self-reported knowledge of teaching with games. This area deals with what teachers know or should know to teach with digital games. An interview study of two teachers showed that defining game literacy for teachers is complicated (Bourgonjon & Hanghoi, 2011). The researchers reported that a teacher, who expressed low levels of knowledge in games, nonetheless integrated digital games into his practice and felt

confident about his ability to teach with games. This contrasted with the second teacher, who perceived himself as a gamer and expert in games, but did not feel confident in his knowledge or ability to integrate digital games in his classroom. Other studies have tried to develop a psychometric instrument to measure teachers' knowledge of teaching with games (Liang, 2015). This work draws on the TPACK framework (Kohler & Mishra, 2009) , which breaks down into components and their overlapping areas of the knowledge of teachers. The researchers propose TPACK-G (games), a survey instrument aiming to measure knowledge pertinent to teaching with games (Hsu et al., 2017; Liang, 2015). The instrument has been tested with preschool, elementary and junior high school teachers (Hsu et al., 2020). However, the TPACK-G carries the weaknesses of the TPACK framework and its many measures (Graham, 2011). While it may measure teachers' change in self-perceived knowledge about teaching with games (i.e. before and after), the instrument measures the confidence level of teachers in their games knowledge rather than the knowledge itself. In other words, TPACK-G does not inform the field about what it is that teachers who are knowledgeable about teaching with games know.

Reviews of Teacher Practice

The fifth area of research attempts to shed light on what teaching with games looks like, which may inform us about teacher knowledge as seen in practice. An overwhelming percentage of game-based intervention studies did not focus on teachers in their reports (Hwang & Wu, 2012). Nonetheless, these studies will often include descriptions of the interventions and what teachers or researchers did in their implementation. A few papers have exploited these descriptions to produce reviews of teacher practice in the literature (Bado, 2019; Kangas et al., 2016; Sun et al., 2020). A qualitative review of the game-based learning literature identified four

main pedagogical activities (or processes) teachers exhibit when teaching with games. Planning – the teacher prepares gaming sessions and traditional instruction activities for the selected learning objectives. Orientation - the teacher introduces the gaming session, setting goals and expectations for the classroom. Playing – the teacher directs student attention to important aspects of the game and facilitates discussions about the game and real-world content. Elaboration – following a gaming session, the teacher debriefs and leads discussions with students. A 2019 review of 45 articles described and quantified the prevalence of teachers' instructional activities when teaching with games (Bado, 2019). The author coded instructional activities under three categories, pre-game, game, and post-game as found in prior research (Taylor et al., 2012) and noted specific activities within these three categories. Findings showed that in 87% of studies, teachers used some forms of pre-game instructional activities such as demonstrating the game or giving a content lecture before learning content. 60.9% of studies reported teachers' activities during gameplay, technical support being chief, followed by classroom management and scaffolding. Finally, post-game activities were only present in 28% of the studies, reflecting either a blind spot on the part of researchers or a missed opportunity by teachers to debrief and further connect gameplay activities to students' discussions and sense making.

Teacher Handbooks on Game-Based Learning

The sixth area of scholarship is handbooks and guidelines published primarily to inform practitioners – teachers and teacher educators - about teaching with digital games (Becker, 2017; Felicia, 2020; Sandford & Williamson, 2005; Torrente et al., 2011; Ulicsak & Williamson, 2006). These documents summarize the theoretical underpinnings of game-based learning and

then provide practical advice on several issues. Some provide templates and examples for lesson planning with digital games (Becker, 2017; Torrente et al., 2011), while others discuss the management of gameplay in the classroom (Felicia, 2020) or the encouragement of gameplay at home (Ulicsak & Williamson, 2006). These documents draw to one extent or another on case studies, thus providing concrete examples of teaching with games. Overall, teacher handbooks are resources that summarize up-to-date literature and present applied information catered to a practitioner audience.

Case Studies Unpacking Game-Based Teaching and its Practicalities

The seventh and final area is case studies of game-based teaching. These case studies are well suited to capture and articulate the phenomenon of integrating digital games in formal K-12 classrooms (Yin, 2018). The aims of this area of research are twofold. First, most of these case studies aim to uncover what teaching with digital games looks like (Thorkild Hanghøj, 2013; Hébert & Jenson, 2019; Nousiainen et al., 2018; Taylor et al., 2012). Second, to contrast naïve descriptions of game-based learning as an easy and magical innovation, many case studies report the challenges and practicalities of teaching with digital games (Barab et al., 2010; Egenfeldt-nielsen, 2001; Marklund, 2014; Marklund & Taylor, 2016).

Several case studies have looked at pedagogical roles, practices, and competencies teachers exhibit when teaching with games. One set of studies identified four roles that teachers shift during game-based learning sessions: instructor, playmaker, guide, and evaluator (Thorkild Hanghøj, 2013; Thorkild Hanghøj & Brund, 2018). A case study conducted in Finland triangulated documents, interviews, and questionnaires of elementary and middle school teachers who teach with games. They identified ten teacher competencies within four areas of game-based

teaching: pedagogical, technological, collaborative, and creative (Nousiainen et al., 2018). Another found nine pedagogical strategies within three categories: gameplay, lesson planning, delivery, and framing technology and the game (Hébert & Jenson, 2019). Other studies document how teachers orchestrate learning with digital games (Arnseth & Silseth, 2018; T Hanghøj et al., 2014; Peddycord-liu et al., 2019; Sousa et al., 2018). Several explore how teachers combine gameplay, whole classroom discussions, and other instructional activities to drive dialogic learning with commercial digital games (Arnseth & Silseth, 2018; Sousa et al., 2018).

Studies have noted the many challenges that teachers face when teaching with games. When using commercial games, teachers spend a lot of time and effort designing learning environments within the game (Marklund & Taylor, 2016; Tüzün, 2007). Teachers also need to perform many tasks to technically set up and maintain the gaming infrastructure (Egenfeldt-nielsen, 2001; Marklund & Taylor, 2016; Tüzün, 2007). While games drive student motivation and engagement (Clark et al., 2016; Wouters et al., 2013), case studies reveal that teachers often need to direct students attention toward learning tasks during gameplay (Hébert & Jenson, 2019; Marklund & Taylor, 2016). Finally, contrary to framings of learners today as “digital natives” (Prensky, 2001), there are gaps in students’ experiences, interest in, and abilities with computing technologies including digital games (Helsper & Eynon, 2010; Marklund & Taylor, 2016). Case studies reveal that teachers must contend with this diversity and support the learning processes and pace of experienced and less experienced gamers in the classroom (Egenfeldt-nielsen, 2001; Marklund & Taylor, 2016).

Summarizing the Literature on Teaching with Games

In this section, I summarized the existing areas of scholarship on teachers within the game-based learning field. I aimed to provide readers with a foundation of knowledge on teaching with games in a way that situates the design and findings of this dissertation in the literature. This summary has shown a trend over time of teachers increasingly seeing games as legitimate teaching tools and using digital games. Additionally, teachers face many barriers to the integration of digital games and many practicalities when enacting game-based teaching in formal classrooms. The literature is not very clear about the knowledge teachers possess about teaching with games. However, reviews and case studies provide accounts of teacher practices, roles, and competencies, which may inform us about knowledge in action. Several handbooks have been published that support practitioners who want to teach with digital games. However, this literature generally still have many open questions regarding teachers' use, practices, lesson planning, and challenges with commercial and immersive interactive digital games.

Table 1. Selected publications from the seven literature areas on teaching with digital games.

Research Type	**Example Publications**	**Findings**	**Methods**
Teachers' perceptions and attitudes towards game-based learning	(Bourgonjon et al., 2013)	Teachers differ in perceptions of games. Factors such as demographics, social support, and prior experience may affect teacher's willingness to use games.	Surveys Focus Groups

Teachers' use and barriers in the use of digital games	(Millstone, 2012) Allsop & Jessel. (2015) (Fishman, Riconscente, Snider, Tsai & Plass, 2014) (Takeuchi & Vaala, 2014) (Ruggiero & Loe, 2013)	Teachers in the US and Europe are increasingly open to and are teaching with games. Teachers face a number of barriers both internally and contextually.	Surveys Interviews
The effect of teacher implementation on game-based learning	(Wilson et al., 2018) (Jong et al., 2017) (Hodges et al., 2021) (Bell & Gresalfi, 2017)	The way teachers implement game-based curricula affected student learning. Teachers' use of strategies to scaffold non-gamer learners improves overall student learning. As teachers become comfortable teaching with digital games, they interact more with students around the games, which engenders improved learning outcomes. After a year of teaching with a digital game for math learning, a teacher is more confident and productive in facilitating	Quasi-experiment Observations Interviews Surveys Student tests

		problem solving during gameplay.	
Teachers' self-reported knowledge about teaching with games	(Hsu et al., 2015) (Y. Hsu et al., 2017)	Teachers' knowledge of teaching with games can be measured with the TPACK-G instrument. The order in which teachers are taught about different aspects of teaching with games yields differences in their TPACK-G scores.	Surveys
Reviews of Teacher Practice	(Kangas et al., 2016) (Bado, 2019)	Teacher perform a range of instructional activities in game-based learning across four phases: planning, orientation, during game play, and after game play. Pedagogical activities before and after gameplay are less salient than during gameplay in the literature.	Qualitative Literature Review Quantitative Literature Review
Teacher handbooks on game-based learning	(Becker, 2017) (Felicia, 2020) (Torrente et al., 2011)	Guidelines on how to choose appropriate games for learning. Guidelines on how to conduct game-based learning. Lesson plan templates for teaching with digital games.	Summaries How-to guides
Case Studies unpacking game-based teaching	(Nousiainen et al., 2018) (Marklund & Taylor, 2016)	Teachers exhibit four game-based pedagogy competencies: *pedagogical, technological, collaborative,* and *creativity.*	Documents Surveys Observations

and its practicalities	(Taylor et al., 2012)	Game-based trainers follow a three phase iterative coaching cycle that includes scenario preparation, gameplay, and debriefing. Teaching with Minecraft required teachers to perform many tasks and responsibilities. These include technical activities as well as planning and supporting student learning.	Recordings Interviews

Minecraft

Minecraft is an open-world video game developed by Mojang in 2009 (Kuhn, 2018). Minecraft does not have defined goals or objectives, leaving players to explore and create. Upon starting the game, players appear in a computer-generated world. The game environment comprises blocks leading many to describe Minecraft as being like Lego (Mørch & Thomassen, 2016; Slovak et al., 2018). The player can interact with the world by moving their avatar, breaking blocks, picking up materials, crafting them into objects, and building things by placing said blocks and objects. The game is played primarily in one of two game modes, Survival and Creative (O'Hanlon & Whale, 2014). In survival mode, the player begins empty-handed and should collect resources, craft, and build a shelter to survive the night when monsters (mobs) appear. To do so, players must collect food and avoid dangers, such as falling from high places or being killed by mobs. In Creative mode, hunger and health are not a concern, and while Mobs can appear (when turned on in the settings), they do not attack the player. Additionally, in Creative mode, the player has access to all blocks and items in the game, can break blocks

quicker, and fly. With these affordances, Creative lets players construct and explore worlds efficiently, whereas, Survival mode requires players to contend with the environment and work harder to get resources and build.

From the first years of Minecraft's development, the game garnered attention and interest as an educational platform. Innovative teachers such as Joel Levin's "The Minecraft Teacher"[1] and communities of teachers such as Massively Minecraft[2] and Minecraft Teachers[3] started to discuss and share experiences and resources for using Minecraft in the classroom. Around the same time, games and learning researchers began to study and write about the potential of Minecraft for learning, creativity, and community (Duncan, 2011; Gauquier & Schneider, 2013). In 2011, TeacherGaming and E-Line Media, games-based learning companies, developed and published an educational mod of Minecraft, MinecraftEdu. In 2014, Microsoft purchased Mojang and the Minecraft intellectual property (Stuart & Hern, 2014). In 2016, Mojang purchased MinecraftEdu, and shortly afterward, released a new version of Minecraft, Minecraft Education Edition.

Minecraft Education Edition is a classroom-dedicated version of Minecraft. It includes features such as in-game documentation items and a classroom management tool that allows teachers to monitor the students, teleport them around the game world, and toggle game settings (Kuhn, 2018). Schools purchase the game on an annual license and can then run it on iPad, laptops, PC, or Chromebook. According to Microsoft, millions of learners use Minecraft

[1] http://minecraftteacher.net/
[2] https://deangroom.wordpress.com/2011/06/20/welcome-to-massively-minecraft/
[3] https://groups.google.com/g/minecraft-teachers

Education Edition every month (personal correspondence). The Minecraft teacher community has remained active since 2009. In recent years, Minecraft Education Edition has facilitated forums and platforms for teachers to connect and support one another in their game use. As of April 2022, the official Minecraft Education Edition community had 10,000 members[4], including 914 global mentors and Minecraft certified teachers who volunteer to support others in their adoption of the game into classroom practice (Farber & Williams, 2019).

[4] https://education.minecraft.net/en-us/connect

Chapter 3. Research Methodology

As stated in the introduction and literature review chapters, this dissertation explores several research questions about K-12 teachers' curricular design, use, and implementation experiences with commercial digital sandbox games. To answer these questions, I focused on the international community of Minecraft Education Edition teachers. Taking an iterative process, I designed and conducted three separate studies while aiming to compile a more comprehensive understanding of the phenomenon in question. For transparency, replicability, and credibility (O'leary, 2017; Whittemore et al., 2001) , I detail the methodological considerations for this dissertation.

First, I note the context of the Covid-19 pandemic as a context present throughout the dissertation, from research design, through data collection, to the writing of this document. Second, in light of the pandemic and the geographic diversity of participants in this study, I justify using remote research methods and explain pertinent considerations. Third, I articulate how the three studies' worked in concert and the logic behind their methodologies to uncover a richer picture of the studied phenomenon. Finally, since I employed mix-methods research methods (Creswell & Clark, 2018) and focused on a particular case of teachers who use one focal digital game, I address issues of generalizing and transfer (Firestone, 1993; Tsang, 2014) from the findings of this dissertation.

COVID-19

I started to work on this dissertation in January 2020. Two months later, on March 11, 2020, the World Health Organization (WHO) declared the coronavirus disease (COVID-19) a pandemic. As part of a spread mitigation strategy, 107 countries implemented national school

closures (Viner et al., 2020). Learning in these countries transitioned to remote models - teachers and students communicated via online tools (Serhan, 2020; Squire, 2021). The effects of the pandemic also led to challenges in social science research, particularly education research. First, in terms of ecological validity, the pandemic acts as a "social event that is disrupting our social order" (Teti et al., 2020), thus creating a potentially unique context in which social phenomena take place. Second, methodologically, many social researchers responded to lockdowns and other social-distancing measures by adapting to remote research methods (Lobe et al., 2020).

Remote Research

Responding to the above constraints, I followed other researchers and utilized remote research methods (Gray et al., 2020; Lobe et al., 2020). Here, the researcher uses online technologies to gather data without being physically co-located with participants. The benefits of remote research include lower costs, geographical diversity, time flexibility, and streamlined ways to record and store data (Bolt & Tulathimutte, 2010; Gray et al., 2020; Lobe et al., 2020). However, remote research has several potential weaknesses. These include losses of non-verbal cues, requirements for technological infrastructure, and a need for participants to feel comfortable with such technologies (Bolt & Tulathimutte, 2010; James & Busher, 2016).

Specifically, in the case of my three studies, remote methods provided substantial benefits and minimal weaknesses. My research concerns the designs and experiences of Minecraft using teachers, a population that is globally diverse and relatively tech-savvy. Moreover, for study 3, I interviewed teachers when most of their communication was via online video conferencing tools. Therefore, remote research methods allowed me to connect with and

collect data from this unique community. The characteristics and circumstances of participants across the studies helped mitigate the weaknesses of remote research.

Methods across the Three Studies

Although all examined the same phenomenon - teaching with Minecraft Education Edition - each of the three studies differed in their methods. Table 2 provides an overview of the differences across the three studies in terms of their methods and research output. In studies one and two, I conducted mixed methods research, combining quantitative and qualitative data analysis, whereas in study three, I conducted strictly qualitative research. All three studies drew from the same population of teachers who use Minecraft Education Edition, but the samples differed. Specifically with each study, the sample size shrunk from 236 to 92 to eight. Conversely, the level of granularity and closeness to the teachers' experience increased with each iterative step. This mixed-methods approach and iterative zooming allowed me to cover the phenomenon from multiple levels; I produced a thick description of teachers' lesson designs, challenges, and uses of the game as seen at the teacher community level, and from the journeys of three expert teachers.

The studies varied in their use of primary and secondary data. In study one, I drew entirely on secondary data, publicly available lesson plans found on the Minecraft Education Edition website. In study two, I analyzed primary data and teachers' responses to open-ended and closed-ended items on an online questionnaire. Study 3 involved a combination of primary and secondary data. Primary data included teachers' responses to a pre-interview survey, verbal data in response to an interview, and textual data in follow-up correspondence with me. Secondary data included curricular materials that teachers shared during the interview, textual

data and imagery found on the teachers' websites and blog posts, and verbal data from teachers' appearances in interviews and talks, which were available online. To analyze the data sources, I used several methods, including statistical analysis, grounded theory analysis, thematic analysis, and a case study approach (Charmaz, 2014; Maguire & Delahunt, 2017; Small, 2011; Yin, 2018). The triangulation of multiple primary and secondary sources aimed to mitigate my bias as a researcher and support ecological validity and credibility of my findings.

Table 2. An overview of the research methods and output across the three studies.

	Study 1	**Study 2**	**Study 3**
Method Summary	An analysis of a large repository of lesson plans from the Minecraft Education website	An online Survey of teachers who use Minecraft Education Edition	Case studies of teachers' views, use, and curricular design with Minecraft Education Edition
Qualitative / Quantitative	Mixed Methods: Quantitative + Qualitative	Mixed Methods: Quantitative + Qualitative	Qualitative Analysis
Sample	236 educators who uploaded lesson plans to the Minecraft Education Edition website	92 teachers who use Minecraft Education Edition	Eight teachers with expertise with Minecraft Education Edition
Data Types	<u>Secondary Data:</u> CSV spreadsheet with textual data pulled from the Minecraft Education Edition website.	<u>Primary Data:</u> Closed-ended responses. Open-ended responses.	<u>Primary data:</u> Verbal data.

	Virtual Minecraft worlds. Supplemental materials (e.g. worksheets).		Online correspondence. Screening survey responses. <u>Secondary data:</u> Curricular materials. Personal websites / blogposts. Publicly available interviews / talks.
Data Analysis	Descriptive statistics. Grounded-theory analysis of texts and artifacts (curricular materials and game assets).	Descriptive statistics. Thematic analysis of open-ended responses.	Case study methodology.
Main Output	Providing a snapshot of teachers' lesson designs	Describing teachers' use of Minecraft Education Edition in terms of years	Providing a rich description of three teachers'

	with Minecraft Education Edition. Identifying a taxonomy of seven design dimensions that explain variations in teachers' lesson plans with the digital sandbox game. Categorizing four lesson types, which illustrate how teachers arrange the socio-technical environment for learning with the digital sandbox game.	of experience and frequency of teaching with the game throughout the year. Describing teachers' lesson sourcing practices and the subjects they teach with the game. Identifying nine challenge themes that teachers experience when integrating Minecraft Education Edition into formal K-12 classroom instruction.	views of, uses of, and curricular design processes with Minecraft Education Edition as a teaching tool. Comparing similarities and differences across the three expert teachers' experiences and journeys with the digital game.

Generalizing and Transferability

A central goal of any research endeavor is a generalization, reaching a 'general statement or proposition made by drawing an inference from observation of the particular' (Schwandt, 1997, p. 57). When researching a particular case, sample, or process, researchers attempt to design, conduct and report their work to inform other instances of the phenomenon outside of the study. Given my area of research, I had to contend with two main issues regarding generalizability. There is an ongoing debate about generalizing from qualitative and mixed-methods in general and educational research in particular (Firestone, 1993; Tsang, 2014). Moreover, as stated in the introduction, generalizing about game-based learning is challenging

given the diversity of game titles and genres (Plass et al., 2019). Hence, in the following paragraphs, I will specify my positionality on generalizability and transferability.

Due to a relative dearth of studies on the matter, the literature does not yet have theories or models that explain teaching with digital games. As covered in the literature review, a few review and case study publications have started to work toward theory-building in the subject. My main goal in this dissertation is to contribute to this theory-building (Charmaz, 2014; Tsang, 2014); by further exploring what teaching with a digital game looks like, what challenges teachers face in their game integration, and how they design curricula with a digital game. Through three studies and various data sources, I closely explore the case of K-12 teachers' integration of Minecraft Education Edition, a commercial digital sandbox game. Findings from this case may be generalizable to other commercial-off-the-shelf games, high-quality entertainment games, that require teachers to adapt and device curricula around them (Becker, 2017; Eck, 2009). Additionally, the case may generalize to other digital sandbox games that provide similar affordances to Minecraft, such as open-mindedness and the ability to modify and explore virtual environments. Examples include games like Roblox and Kerbal Space Program, sandbox games teachers, and researchers use toward educational ends (Meier et al., 2020; Rosenthal & Ratan, 2022).

The field of teaching with virtual reality (VR) and augmented reality (AR) may draw from the findings in this dissertation. The literature on VR/AR seems to follow the same trend as game-based learning, wherein most publications advocate for the promise of these platforms, focusing on designs and the effects of short interventions rather than on teachers' real-world use. Moreover, many of the educational benefits of these technologies mirror those of digital games,

namely motivation and engagement (Maas & Hughes, 2020; Papanastasiou et al., 2019). Recently, the social media giant Facebook changed its name to Meta and stirred worldwide excitement around the concept of the Metaverse (Kraus et al., 2022), people communicate, work, and learn in a network of virtual worlds using VR and AR technology (Dionisio et al., 2013). While I see this excitement primarily as business hype (Kraus et al., 2022), I think advances and investments in these technologies may very well lead to an uptake in practice. Many technology experts point to sandbox games like Minecraft and Roblox to understand and explain what the Metaverse might look like, warranting the same critical view of these games and the Metaverse for learning (Rospigliosi, 2022). Therefore, the insights from this dissertation about how teachers source, design, and integrate learning activities with Minecraft are likely to be applicable to how teachers may use technological tools like VR, AR, and other Metaverse platforms if these technologies were to permeate formal educational practice.

Another way to generalize from the particular studies of this dissertation is through case-to-case transfer or transferability (Firestone, 1993; Ispa-Landa, 2013). A case-to-case transfer is a decision by a person to adopt ideas from one case to another (Firestone, 1993). For example, a technology coach in school A is interested in implementing a program on game-based teaching that school B had tested prior. To do so, the coach must know the details of the program and the conditions under which it took place in school B. Then they can determine if and how such a program may be designed and enacted in school A. Since the person considering the program, 'the reader' (Firestone, 1993) , needs to weigh the relationship between the two cases, the researcher is responsible for providing a thick description of the case. Throughout the three studies, I attempt to lay out a rich and detailed description of the cases. Moreover, as I discuss

the dissertation as a whole, I make the same effort in treating the broad case of teaching with Minecraft Education Edition. I hope that researchers and practitioners who wish to support teachers' use of digital games, especially those similar to Minecraft, will be able to read my work and determine whether and to what extent the findings inform their intended case-to-case transfer.

Chapter 4. Crafting Game-Based Learning: Teacher-Designed Lessons with Minecraft Education Edition

Abstract

While surveys show that teachers are increasingly accepting digital games as a teaching tool, scarce research explores how teachers integrate of digital games in their teaching. Especially wanting, are studies on teachers' curricular design with immersive interactive digital games. In this study, we examine a large corpus of publicly available lesson plans designed for Minecraft Education Edition, a commercial sandbox game. We provide descriptive statistics about the number of lessons per teacher, target student ages, and subjects covered. Then using qualitative methods, we closely analyze 159 lessons to describe variations in teachers' designs. This analysis identified seven design dimensions along which the lesson plans varied. By unpacking lessons in light of these dimensions, we illustrate how teachers arrange the socio-technical learning environment scripting interactions between themselves, students, the game, and external media. These findings contribute to the field of game-based learning. First, the analysis captures the state-of-the-art real world use of a popular sandbox game by teachers. Second, the design dimension taxonomy provides a language through which to examine teachers' designs with sandbox games. This work illustrates the creativity and labor of teachers who design game-based curricula. We conclude by suggesting directions for future research and implications for practitioners.

Introduction

While game-based learning has gained traction as an innovative educational approach, many questions remain open about how teachers integrate this novel technology into K-12 classroom practice. Particularly limited are studies on teachers' lesson planning and curricular design with digital games. To help fill this knowledge gap, this study starts exploring the real world curricular designs of teachers who use a popular sandbox game, Minecraft Education Edition. In this study, my colleague Kathryn E. Ringland and I examined a corpus of lesson plans and curricular resources designed with and for the game. I begin by describing related work on game-based teaching, teachers' lesson planning with games, and methodological considerations when studying secondary data as we did in this study.

Game-Based Teaching

To date, most game-based learning research has focused on the design of educational games (Plass et al., 2019) and student learning s(Clark et al., 2016; Wouters et al., 2013). This focus on games and learners backgrounds teachers as agents integrating this novel technology into their teaching practice. While some studies might mention pedagogical activities (Kangas et al., 2016), teachers and their practice are rarely deliberately sampled or examined (Hwang & Wu, 2012; Taylor, 2015). Studies that do focus on teachers have demonstrated that their implementation shapes classroom interaction and student learning (Eastwood & Sadler, 2013; Wilson et al., 2018). This gap in the literature led a report by the National Research Council to call for additional studies on practice and policy towards teachers' effective integration of digital games as a teaching tool (Honey & Hilton, 2011).

Studies of experienced game-using teachers have shed light on the complex processes that teachers undergo when enacting game-based learning (Becker, 2017). At a high level, we can treat these phases as before, during, and after gaming scenarios (Marklund & Taylor, 2016). A study of experienced military instructors who used games articulated a coaching cycle consisting of three main phases; scenario preparation, gameplay and debriefing (Taylor et al., 2012). Hanghøj offers another argument, that teachers shift back and forth between four roles when teaching with digital games, these are *instructor*, *playmaker*, *guide and evaluator* (Hanghøj, 2013). In the instructor role, teachers plans and communicates the goals of the gaming scenario in relation to the learning objectives. As playmaker, the teacher communicates the tasks, roles and goals from the player's perspective regarding gameplay. As guide, the teacher scaffolds the student's meeting of learning objectives through gameplay. Lastly, teachers act as evaluators (later called *explorers* (Hanghøj & Brund, 2018) mediate student sense-making through dialogue. As captures in the above literature, several studies have documented teachers' pedagogical activities while enacting game-based learning in the classroom.

Planning and Designing Game-Based Lessons

As with other aspects of GBL, lesson planning depends on the type of game that teachers use. With drill & practice tools, authoring game-based activities is relatively simple. Teachers can create and execute quizzes or allow students to use the tool to do the same (Siko & Barbour, 2012; Wang & Tahir, 2020). With educational games that academic teams or companies develop, content will be embedded into the game, and in some cases curricular materials will be provided as well (Bauer & Butler, 2017; Wilson et al., 2018). In contrast, commercial-off-the-shelf (COTS) games require significantly more work on the part of teachers to design and plan

curricular activities and materials (Becker, 2017; Eck, 2009; Squire, 2006). COTS titles are not designed with educational applications in mind, and therefore require of teachers to identify a fit with learning objectives, script gameplay activities and mediate the connection between gameplay and learning goals.

The Case of Minecraft

As stated in the literature review chapter, it is important to be explicit about specific game genres and titles given the diversity across games and their applications (Plass et al., 2019). In this study, I look at Minecraft Education Edition, a unique case of a COTS sandbox game modified towards educational use. Minecraft was developed as an entertainment game, and has become one of the biggest commercial successes in gaming history (Michael Dezuanni, 2020). Through grassroots adoption, educators worldwide integrated the game into informal and formal educational activities (Garrelts, 2014; Nebel et al., 2016). Moreover, teachers created a bespoke mod, Minecraftedu, which provided mechanics for instruction and classroom management. Following Microsoft's purchase of Mojang, the studio that developed Minecraft, the company adopted this mod into a dedicated educational product Minecraft Education Edition.

Minecraft Education Edition relates to a number of past educational game projects that allowed researchers and teachers to create virtual worlds and curricula. As a collaborative multiplayer game, Minecraft is a multi-user virtual environment (MUVE). Quest Atlantis (Barab et al., 2007) was a 3D MUVE that served as an authoring tool for inquiry-based units in the form of quests. Teachers created virtual environments, scripted in-game dialogues, and embedded resources. Students who played as avatars in the game explored the virtual world and interacted with NPCs, objects, and embedded media as they completed quests. Like other educational MUVE projects

such as River City Project (Dieterle & Clarke, 2006) Quest Atlantis is no longer supported. Minecraft on the other hand offers a unique scenario wherein an educational game that allows teachers to design curricula is licensed commercially rather than on a more precarious project dependent on time-limited funding.

Using Publicly Available Lesson Plans as Secondary Data

In this study, we draw on an existing repository of lesson plans available on the Minecraft Education Edition website[5]. Our choice to use these data confers both benefits and caveats. Secondary data or "existing data" are data that the researcher does not elicit originally (O'leary, 2017). This allowed us to save time and logistical work as we could immediately analyze a large data set of lesson plans from around the world. Moreover, since we did not elicit these data, the curricular materials represent the real-world artifacts that teachers uploaded to the Minecraft website. This allows a buffer between the researchers and the researched thus reducing interactional biases. Alongside these benefits, several considerations are important when dealing with secondary data. Chief among these is the need to establish credibility of the data and its source. The data need to be checked for accuracy and currency, that is, in this case ensuring the dataset reflects what is on the website and that links are not broken. Finally, as researchers it is our responsibility to manage our subjective interpretation of the data. This is established by staying "close to the text" (Friese, 2019) and by comparing notes between one another.

Research Questions

The central, overarching question of this study was as follows:

[5] https://education.minecraft.net/en-us/resources/explore-lessons

Research Question: When teachers design lesson plans with a sandbox game, what curricular materials do they produce and how can we describe these varied lesson designs?

From this high-level research question, we drew a number of sub-questions:

RQ1. Who are the teachers who upload lessons to the Minecraft Education Edition website?

RQ2. Who and what do teachers report to teach with the sandbox game?

RQ3. What are the design dimensions along which lessons plans with the sandbox game vary?

RQ4. How do teachers arrange the socio-technical environment for learning in and around the game? What lesson types emerge from these arrangements?

Methods

Data Collection

The official Minecraft Education Edition website includes a platform for lesson sharing and downloading. When uploading a lesson, users describe the lesson plan, and may attach supporting materials such as worksheets or Minecraft world files. Moreover, users use checkboxes to specify the subjects, skills, and target ages of the lesson. The lesson plans consisted of several data. Through discussions with members of the Minecraft Education team at Microsoft, we got a dataset of every lesson plan available on the website as of March 2020. This dataset was a csv file that included 627 lessons.

Each row of the data set contained content from a single lesson plan as displayed on the website. Refer to figure 1 to see a webpage of a single lesson plan. On the top left side is the lesson name with a short description. Directly under the description are info tabs representing the target

subjects and student ages that users checked when uploading the lesson plan. Under the info-tabs are four textual lesson plan descriptions in the following order: learning objectives, guiding ideas, student activities, and performance expectations. On the top right hand side, the name of the user who uploaded the lesson plan is displayed. Underneath the name are the skills checked upon uploading. Estimated time was not present on the web page or the data set at the time of data collection. Finally, when relevant, hyperlinks to supporting files are included containing resources such as worksheets, presentations, and Minecraft world files. The data set included the following pieces of information: lesson name, brief description, username, language, subjects, student ages, skills, and the four textual lesson plan descriptions.

Figure 1. A single lesson plan as found on the Minecraft Education Edition website in 2022.

BIOME HUNTER

As a member of the Explorer's Guild, you have been tasked with hunting for new and undiscovered biomes in the land of Minecraft.

Geography | Animals | Climate & Environment

6-7 | 8-10 | 11-13

Submitted by: Mark Grundel
Updated: March 26, 2018

BIOME HUNTER

Learning Objectives

- Students will be able to research and identify features of biomes.
- Students will be able to compare and contrast Real World Biomes with Minecraft Biomes.
- Students will be able to use coordinates to navigate within Minecraft and on a map utilizing lines of longitude and latitude.
- Students will be able to communicate their results with peers and classmates.

Guiding ideas

What is the climate of your Biome?

How does climate affect the structure of the Biome?

How does climate affect wildlife?

How do you utilize latitude and longitude on maps and globes?

Where on the globe do you find your certain Biome?

How does the geography play a role in your Biome's climate?

Student activities

Performance expectations

External reference

Share or assign

Print

Skills

Communication
Critical thinking
Project Based Learning

Estimated time

Unknown

Supporting Files

- Biome Hunter Worksheet
  Editable worksheet with a table and Venn Diagram in Word Document format for students to complete digitally.
- Biome Hunter Worksheet
  PDF Version of the worksheet with a table and Venn Diagram for students to complete by hand.

Download all

Data Analysis

Cleaning and establishing credibility

After obtaining the dataset, we examined the data to check for credibility in terms of accuracy and currency. In the data set, we found 18 lessons without language tags. We opened each of those lessons and tagged them accordingly. Out of 627 lessons, 522 (83.25%) were in English with the remaining 105 lessons being in a variety of languages. We then checked for duplicate lessons in the data set and removed such cases. To ensure the currency of the data, we searched for 200 of the lesson plans on the website and confirmed that the web pages matched the data set.

Quantitative data analysis

We answered research questions 1 and 2 using statistical analysis with Excel and Python Pandas. The analysis included separating comma-delineated values from single cells, frequency counts, and simple descriptive statistics. These statistics allowed us to identify sixteen "power users" who produced 159 lessons. We selected this narrower group of teachers for a closer qualitative analysis.

Qualitative data analysis

For research questions 3 and 4, we took a grounded theory approach (Charmaz, 2014). We copied the power user data from the data set into a new spreadsheet. After downloading all the assets for the 159 "power user" lessons, we started to explore and analyze three lesson plans per teacher. This included annotating the textual descriptions from the website, summarizing supplemental materials and playing through game worlds. After initial analysis, we created a summary of the profiles for each of the sixteen teachers, pulling in images from lesson assets. To

guide our analytical process, we used heuristics such as “what kind of world builder is this teacher?” “What kinds of media do they use?” and “What are students expected to do in the lesson?”

For each teacher, we then looked through every lesson plan and noted patterns of similarity and dissimilarity. Through individual memoing and shared discussions (Creswell & Clark, 2018), we noted patterns in the data, and identified a set of candidate codes. These codes condensed thematically to represent dimensions along which we understand and explain the lesson designs. With candidate codes in mind, we did a second pass through the lessons, color-coding and marking in the texts, materials, and game worlds indications of the codes. Through this process, we refined the codes, and removed instances that were either ambiguous or that appeared less than ten times in the data. It is worth noting that the resulting dimensions (as described below) are not an exhaustive list, but rather the dominant themes, which emerged during our coding process (Charmaz, 2014).

Results

Descriptive Statistics

Teachers

237 unique users contributed lessons to the website. Of these, “Minecraft Education”, the website admin account, uploaded 143 lessons. We decided to exclude these from further analysis as we were interested in what designs teachers generated with the sandbox game. This meant user-generated content (UGC) and not content designed by Microsoft. Looking at the remaining 236 authors and 484 lessons, we found that the average number of lessons uploaded by an author was 2.05 (SD = 2.87). The distribution was a right tailed skewed distribution. The median

number of lessons per teacher was one, meaning that the overwhelming majority of authors uploaded one or two lessons to the website. Sixteen teachers fell above one standard deviation and contributed 32.8% of the total UCG lessons. We refer to these authors as "power users." Each power user uploaded between 5 and 30 lessons.

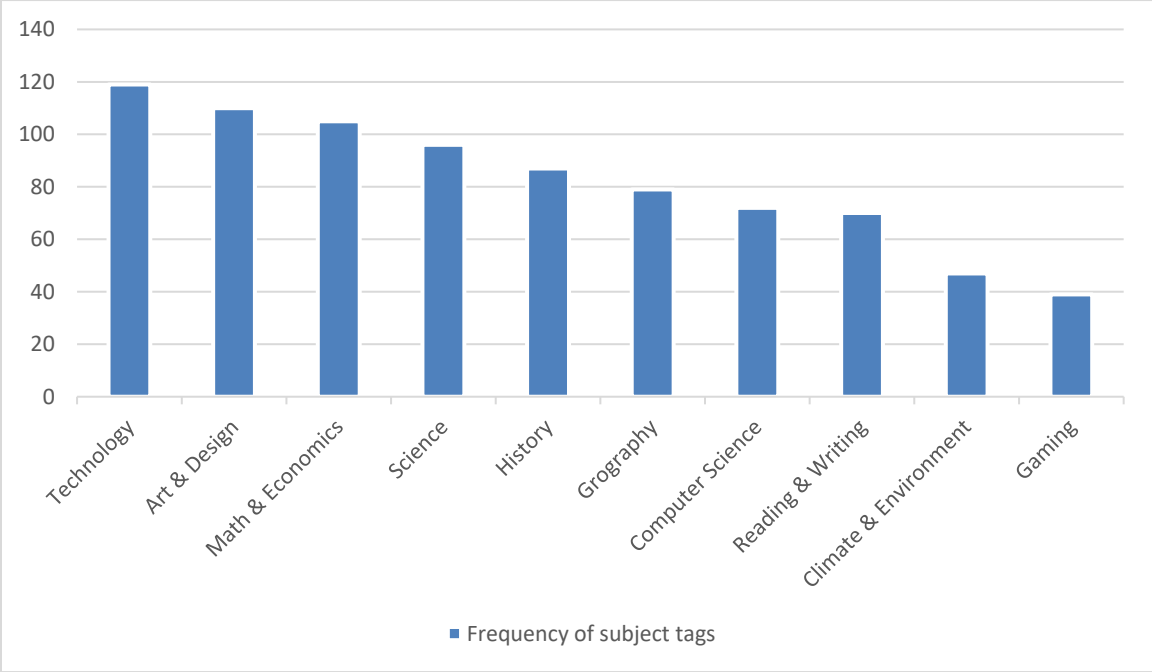
Target Student Ages

The 484 lessons contained 717 age tags. The most frequent age tag was 8-10 year olds with 216 instances, followed by 11-13 year old (166) and 14-18 year olds (152). There were no lessons that contained only the 3-5 tag. In all 10 instances, the 3-5 year tag appeared together with the 6-7 tag. 18+ was only tagged twice as a single tag, once in a lesson for parents and once for teachers to learn about Minecraft Education Edition. The other 32 instances occurred when users tagged 14-18 target age. The most common age groups seem to be elementary and middle schoolchildren.

Subjects

Of the 484 user generated lessons, 6 lessons did not include any subject tags. 118 included only one tag. 106 and 254 lessons included two or three subject tags respectively. Of the 25 subject tags, the ten most frequent were: Technology (119), Art & Design (110), Math & Economics (105), Science (96), History (87), Geography (79), Computer Science (72), Reading & Writing (70), Climate & Environment (47), and Gaming (39). Figure 3 displays these ten subject tags and their frequencies. It seems therefore, that teachers report to design lessons with Minecraft Education Edition for a range of subjects from STEM, social sciences, to the humanities at similar frequencies.

Figure 2. Frequency of subject tags used across the 484 user generated lessons.



Skills

Seven lessons did not include skill tags. 65 included one skill. 88 lessons included two skills, and 324 included three skills. The following seven skill tags were found in this frequency: Creativity (295), Collaboration (266), Critical Thinking (242), Project Based Learning (171), Communication (144), Citizenship (56), and Character (39). It is worth noting that teachers could only pick skills out of these seven options.

Qualitative Findings

After looking at the descriptive statistics of the user-generated content, we decided to examine the curricular materials more closely. We chose the 16 power users identified above, as they provided a subset of teachers who generated multiple lessons. This subset of 159 lessons was more manageable for a closer reading of the data. Moreover, we assumed that these were

teachers with relative expertise and comfort designing curricular materials with the game, as opposed to novices who have only ever designed (or at least uploaded) one lesson.

Design Dimensions

Our coding process resulted in seven design dimension codes. Table 4 provides a description of each code. In the following sections, we describe each dimension code in further detail, provide the frequency of instances of each code across the 159 lessons, and use examples to illustrate the codes in relation to the raw data.

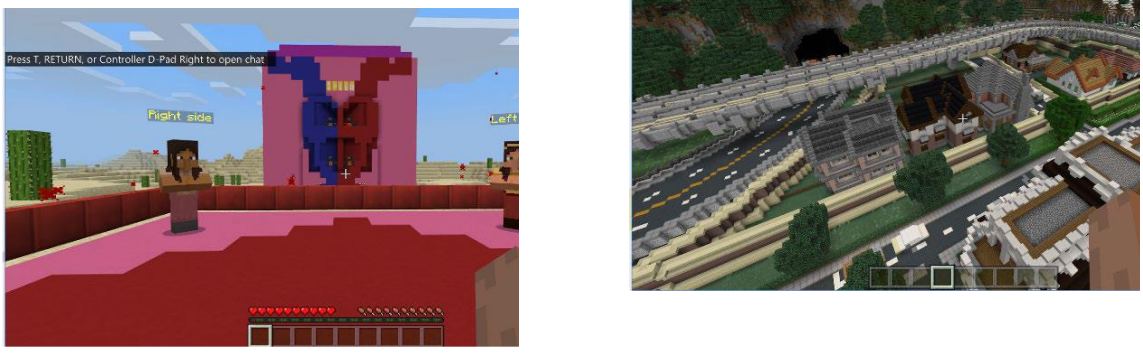
Table 3. Design dimensions of teacher generated lessons with Minecraft Education Edition.

Code	**Definition**
World Builder	Does the lesson include a world built by the teacher (Yes / No)?
NPCs (Non-Playable Characters)	Does the world include NPCs (Yes / No)? If yes, what do they do?
Single or Multiplayer	Do students play individually or in groups?
Students as Builders	Are students expected to build (Yes / No)?
External Media	Do students interact with media outside of the game (Yes / No)?
Documentation	Are students asked to document their work explicitly (Yes / No)?
Game World to Real World Connection	Does the lesson ask students to think and compare the game world and the real world?

World builder

A central affordance and practice of Minecraft and other sandbox games is world building (Abend & Beil, 2015). Eleven of the 16 power users were world builders. That is, their lesson plans included world files that they had produced either alone or in collaboration with others. In fact, of the 159 lesson plans, 100 included worlds built by the teachers. Figure 2 shows two worlds built by different power users. One world includes interactive quizzes about the human heart (figure 3 left), while the second comprises of a large urban environment used in multiple lessons about city planning and sustainability (figure 3 right). Of the five power users who we did not categorize as world builders, three had uploaded worlds to accompany their lesson plans; however, these were worlds built by their students as they completed the lesson. For example, one teacher uploaded eight lesson plans that included worlds built by his students throughout a months-long curriculum.

Figure 3. A world with two interactive quizzes about the human heart (left) and a world containing a large city as a context for sustainable urban planning and construction (right).



NPCs

Non-playable characters (NPCs) are entities that users can place in the game. Users can modify NPCs to include dialogue bubbles, to execute in-game commands, and to direct to URLs

outside of the game. Nine of the sixteen power users used NPCs in their lessons. The seven who did not, were the five who did not build worlds, and two others who did not include NPCs in worlds they had built. Of the 100 worlds built by teachers, 71 included NPCs.

NPCs functioned primarily in four different roles. The first role is to provide context to the environment and the narrative. For example, in the lessons about sustainable urban planning, several NPCs stand in a municipal building and represent stakeholders from whom students learn about the professional process of city planning (figure 4 left). The second role is instructional. The NPC provides instructions on how to perform a particular task. For example, in one lesson, students must plant a garden within a 10 by 10 grid and write the fraction of the ratio of flowers to the 10 spots. The NPC, aptly named Archimedes provides the student with clear instructions regarding the task (figure 4 right).

Figure 4. NPCs as stakeholders in the city planning process (left) and a NPC providing instructions to students about representing fractions in a 10 x 10 grid (right).

The third role is informational, the NPC directs students to external resources via URLs. These resources could themselves serve several functions (See section below on External Media). The fourth role is to build interactivity into the game worlds. Teachers programmed NPCs to execute commands that teleport students to given locations or provide students with in-

game items. It is noteworthy, that while we did not code for students' use of NPC, several lesson plans asked students to place NPCs in their Minecraft worlds.

Single or multiplayer

Minecraft Education Edition is playable individually or as a multiplayer game with up to 30 players. Looking at the textual information in the lesson plans, we saw that of the 159 lessons, 37 (23%) did not include explicit mentions of single or multiplayer gameplay. Among the lessons that did mention single player or multiplayer gameplay, single player was coded 11 times (7%), multiplayer was coded 83 times (52%), and a code for both multiplayer and single player was coded 26 times (16%). Multiplayer configurations included working in pairs, in teams of 2-6, and as an entire classroom. Minecraft has been described as multiplayer open-world game and studied as a collaborative virtual environment (Müller et al., 2015; Nadolny et al., 2020). The results show that indeed teachers designed multiplayer activities in most lesson plans. Nonetheless, at least a quarter of lessons afforded students the option to work individually in a single player capacity.

Students as builders

Building through placing and removing blocks is arguably the core mechanic of Minecraft. Drawing on Howard Becker's 'null hypothesis trick' (Becker, 2008) we might expect that all lessons with Minecraft will require students to build. We found that all sixteen of the power users created lessons that asked students to build, however this was the case in 101 of the 159 lessons (63%). The five teachers who did not upload their own worlds with the lesson plan, had students build their own world as part of their activity in the game. In lessons that included

teacher designed worlds, students were usually asked to engage in building in specific areas of the world, towards a particular goal (e.g., building a castle) or as part of a process (e.g., building a row of blocks to represent the blood circulation cycle). That the majority of lessons asked students to build is not surprising, but that 58 (37%) of the lessons did not highlights the sometimes flipped role of teachers as world builders. Moreover, this raises questions about what other activities teachers scripted for the students other than building.

External Media

Another dimension that varied across lessons was the use of supplemental materials outside of the Minecraft world files. Eighty-four of the 159 lesson plans (53%) included external media. These were either tangible media such as printed worksheets or graph paper for sketching designs or digital media such as YouTube videos, images, or Wiki entries. That most lessons included external materials reveals another aspect of teachers' lesson planning with Minecraft Education Edition; teachers design and pull together curricular materials for both in game and around the game learning.

Documentation

Minecraft Education Edition contains several unique items for student documentation. Students can equip a camera that allows them to aim and take photos of the Minecraft world from the perspective of the 3D avatar or direct the camera to themselves and capture a selfie of the avatar and its background. The portfolio or the book & quill are two items that allow players to bring in images form the camera as well as annotation. Additionally, students can use items like signs, blackboards or even NPCs to document their work. Fifty-four-percent (54%) of

lessons included the documentation code. These were instances where teachers specified the use of either in-game items or other tools outside of the game to document and report on their design process and or learning. Examples from outside the game tools include written reflections, presentations, and video recordings of student gameplay.

Game World to Real World Connection

In Minecraft, players interact with a digital world that follows its own natural rules, mirroring the real world to varying degrees. The game world is comprised of several biomes, which narrowly represent the geographical diversity on Earth (e.g., plains, desert, and mountains). While students might spontaneously draw connections between the Minecraft world and the real world (Redstone and electricity paper), we found that in thirteen lessons, teachers explicitly asked students to draw such comparisons. For example, in one lesson, the teacher asked students to research and summarize the features (e.g. vegetation and wildlife) of five real world biomes. The students then had to choose their favorite biome and find its analog in Minecraft. The students then explored the Minecraft biome and noted the features found in the game and contrasted them with the real world features. Other examples were lessons that asked students to simulate social processes through gameplay and reflect on how they would take place in the real world. Examples include devising safety plans for a fire escape, or planning and reshaping people's homes.

Arrangements of the socio-technical: four lesson types

With this taxonomy of individual design dimensions, we could examine how lesson designs emerged from teachers' combinations of these dimensions. Specifically, we analyzed the

ways in which teachers arranged the socio-technical environment, scripting interactions between students, the game, and external media. To illustrate these arrangements, we describe four lesson plan categories (i.e., stations, expeditions, individual builds, and team builds). The first two categories emphasized structured interactions between students and the game environment, while the latter two categories emphasized construction by individual or multiple students. It is important to note that these four categories are by no means an exhaustive set of lesson plan types.

Stations

In station lessons, students play in a teacher-built world and complete several in-game tasks. For example, in Science Island[6] students follow a path and stop at five different stations. At each station, signs instruct students to form a hypothesis about in-game phenomena such as the speed of an item flowing downstream in relation to wider streams. Students are asked to document their hypothesis and findings using in-game items, thus practicing their hypothesis testing skills. In this lesson plan, we see that the teacher has designed a clear and constrained environment where students perform a series of in-game tasks, which they then report on. It is noteworthy that several lessons in the station category resemble drill & practice activities, relating to prior research on the prevalence of quizzing as a use of digital games in by teachers (Takeuchi & Vaala, 2014).

[6] https://education.minecraft.net/en-us/lessons/science-island-2021-updated

Expeditions

In expedition lessons, students either play in a teacher-designed world or start a new Minecraft world of their own. The students will often play individually, and act as explorers, tasked with collecting and cataloging in-game items. Moreover, in these lessons the teacher asks the student to compare and contrast the game world and the real world. For example, in Biome Hunter[7] described above, the teacher provided a worksheet with tables where the students wrote their observations and a Venn diagram to visualize the overlap and distinction between biomes in the game and the real world. Here, we can see how the teacher arranges a series of activities to be performed by the student both in the game and using external media, both digital (researching biomes online) and offline (writing observations). Moreover, we see an explicit call to reflect on the mapping between the game world and its phenomena and the real world.

Individual Builds

Many lessons centered on student building as the main activity. In some lesson plans, students worked individually on their devices with an option of pairing up with one peer. Two noteworthy versions of individual build project included coding challenges and design prompts. In coding challenges, the teacher built a dedicated Minecraft world with a set of building challenges to be completed using the in-game coding interface and agent. In design prompts, teachers provided external media as inspiration for a design challenge, without necessarily providing a custom-built world.

[7] https://education.minecraft.net/en-us/lessons/biome-hunter

Team Builds

Teachers divided students into team and the lesson's central activity was for the students to build virtual representations and document them for classroom showcases and reflections. Here, as in the individual builds, the two main design dimensions along which the lessons varied were whether the teacher provided a world and the use of external media. Two examples of these lesson plans are structured team builds and building as a classroom. In structured team builds, the teacher designed a dedicated world, which set the stage for a construction process by the students. For example, one teacher collaborated with colleagues to build an elaborate city environment (Figure 3 left). The teacher used this world for five different lessons around urban planning and sustainable design. The teacher uses a lecture to frame the lesson, students then research the topic further using provided videos and websites, finally, teams of 2-4 must build or renovate a section of the city in line with the lessons' goals.

In building as a classroom, entire classes worked together to build a specified world. For example, in one lesson about ancient Lisbon under the Roman Empire the teacher gave a lecture about the ancient city and provided a YouTube video with a 3D model of the ancient city. Students were then required to recreate the ancient city in the game, with each student building a particular section. Moreover, the teacher notes in her plan that every few minutes she would ask students to pause and document their process using the in-game camera, and at the end of the lesson that they provide a sign in the game with information about what area or object they had built and its importance in the ancient city and society.

Discussion

While a large body of research posits that games can be beneficial to academic learning, many questions remain about how teachers integrate digital games into formal classroom practice. In this paper, we sought to shed light on teachers' lesson planning and curricular design with a popular sandbox game. Drawing on an existing repository of curricular materials from the Minecraft Education Edition website, we examined 484 teacher-generated lessons.

Descriptive statistics provided a screenshot of the online community and information regarding the lesson plans and the teachers who uploaded them. Results showed that the lessons spanned across curricular areas with a majority being multidisciplinary represented by multiple subject tags. Academic studies have used Minecraft for learning in a variety of subject areas such as Math, Art, and Social Emotional Learning (Beth Bos et al., 2014; Overby & Jones, 2015; Slovak et al., 2018). The current results demonstrate that K-12 teachers who adopt Minecraft Education Edition indeed design lessons across subject matter. The target audiences for most lessons were elementary and middle school aged students, though teachers also tagged high school ages alongside middle school age tags. These findings fit with prior work on the popularity of informal Minecraft gameplay among elementary and middle school students (Mavoa & Gibbs, 2018). However, considering that the average Minecraft gamer is 24[8], it is surprising that no lessons plans for higher education exist on the Minecraft Education Edition website.

[8] https://techacake.com/minecraft-statistics/

In terms of the online lesson contributors, 236 educators uploaded lesson plans onto the Minecraft Education Edition website as of March 2020. Of these, we identified 16 as power users who uploaded almost a third of all user-generated content. This small number of teachers conforms to prior studies on participation proportions that predict that a small number of users in online communities contribute a large volume of all content (Brandtzæg & Heim, 2011; Matthews, 2016). We continued the analysis by qualitatively examining the 159 lessons that the power users uploaded. Taking a grounded theory approach (Charmaz, 2014) we identified seven dimension codes that help to understand the design choices and variations in teachers' lesson design with Minecraft Education Edition. Finally, while using the seven design dimensions we broke down and illustrated four lesson types as different arrangements of the socio-technical learning environment.

Taken together these findings provide a snapshot of the state-of-the-art real world adoption of a commercial sandbox game, a promising game genre that has remained understudied from the teachers' perspective. Moreover, the qualitative findings contribute foundational research on how teachers design curricular materials with a sandbox game and the types of learning activities that they curate for their students. In the remaining paragraphs, I expand on two contributions to the literature, recognize limitations and propose directions for future research.

Minecraft as a Creative Tool for Teachers

Academic papers, news articles, and books have all celebrated Minecraft as a creative environment for children (Cipollone et al., 2014; Dezuanni & Mara, 2013). One cannot ignore the cultural phenomenon that is Minecraft in its commercial popularity (Michael Dezuanni,

2020) and the myriad examples of small and large scale creations that Minecraft gamers keep producing since the game launched just over a decade ago. The findings of the current study I would argue provide a new frame through which to look at Minecraft, as a creative tool for teachers. Captured best by the World Builder dimension code, we see that teachers will construct virtual worlds curated for their learners. In his seminal book Mindstorms, Seymour Papert described the potential of the personal computer as a protean tool in the hands of children (Papert, 1980). The current study highlights how Minecraft may serve as a protean tool in the hands of teachers who shape a variety of learning experiences. Lessons types such as team builds curate gameplay activities that resemble the traditional description of an open-world multiplayer sandbox game (Nadolny et al., 2020) while station style lessons resemble more a traditional educational game design or drill & practice games (Takeuchi & Vaala, 2014). In this way, Minecraft serves as a commercial game authoring tool (del Blanco et al., 2012) where teachers modify the learning environment.

Understanding How Teachers Design Curricula for COTS Games

Commercial-Off-The-Shelf (COTS) games are harder to adopt than educational games since the former do not come packaged with curricular materials or learning content (Becker, 2017; Eck, 2009). The teachers in the current study provide a glimpse into what curricular design might entail for adopters of a commercial sandbox game. Specifically, we see that teachers may create virtual worlds and populate them with NPCs for four main functionalities. Teachers will produce or source external media and script interaction both in the game and outside of the game with said media. Finally, teachers will script different activities, asking students to perform a range of tasks. These include world building, exploring a virtual environment, documenting their

thinking or work, and reflecting on connections between the game world and the real world. Research on teaching with digital games enumerated some of these pedagogical activities in real-time based on observations (Kangas et al., 2016; Marklund, 2014). The current study complements this prior work by evidencing teachers' curricular products and design variations as found in their lesson plans and curricular materials.

Limitations and Future Research

The central limitation of the current study is the focus on a unique sample of Minecraft using teachers and the sixteen power users especially. High-contributors in online communities may represent a small percentage of users who differ in their knowledge, expertise and engagement as captured by the high volume of uploads (Matthews, 2016). We chose to examine this subset of the teacher sample in order to have a manageable data set and because we assumed that, the sixteen teachers had developed a comfort and understanding of how to design lessons with Minecraft over the course of several lessons. Novice lesson planners with the game might design different curricular materials than those captured in the current study. Future research should compare novice and expert Minecraft using teachers to determine whether such differences manifest.

A second limitation of the current study are the secondary data based on constrains of the Minecraft Education Edition website. The data regarding age and subject info tags as well as the framing of the textual rubrics across the lessons are pre-determined by the upload portal. Higher resolution data could would have allowed for richer detail in the analysis. For example, open-ended entries regarding curricular objectives would allow for better understanding as compared to vague subject tags such as Technology or Gaming. Moreover, two important parameters

would allow for a richer understanding of teachers' lesson planning with the game. First, the duration of a lesson or unit plan was not available as a rubric at the point of data collection. This parameter is especially relevant in the case of immersive interactive digital games as opposed to drill & practice games (Stieler-hunt & Jones, 2019; Takeuchi & Vaala, 2014). Second, teaching with digital games is challenging (Marklund & Taylor, 2016), a rubric with expected challenges or teacher advice would offer a window into the practical and pedagogical considerations teachers have when planning curricular materials with the game.

Chapter 5. Teaching with a Sandbox Game: Teachers' Use and Challenges with Minecraft Education Edition

Abstract

While game-based learning continues to grow as an educational approach, little research exists on how teachers use particular game genres and the real-world practicalities of teaching with immersive interactive digital games. This study draws on an online survey of 92 K-12 teachers to explore their experiences using Minecraft Education Edition, an exemplar of the sandbox game genre. The teachers used the game frequently in their teaching across subject areas. Moreover, though the teachers had been using Minecraft for several years, they still faced multiple challenges when integrating the game into formal classroom practice. Qualitatively analyzing open-ended responses, I narrow these challenges into five themes: technical, content, time, pedagogy, and lack of expertise. The results contribute toward theory building on teaching with interactive and immersive digital games. Firstly, they nuance the relationship between challenges and use, demonstrating that teachers who use digital games regularly face challenges nonetheless. Secondly, the qualitative challenge themes illustrate the demanding endeavor teachers undergo in sourcing curricular materials and implementing classroom instruction with the game. Alongside proposing directions for future research, the study lends suggestions for practitioners interested in supporting teachers' adoption of Minecraft Education Edition and similar sandbox games.

Introduction

As digital games continue to enter K-12 classrooms, we must understand how teachers are using this technology and the challenges that teachers face. Surveys across several countries point to increased use of digital games in classroom instruction (Fishman, Riconscente, Snider, Tsai & Plass, 2014; Millstone, 2012; Ruggiero & Loe, 2013; Takeuchi & Vaala, 2014; Wastiau, Kearney& Van den Berghe, 2009). Key arguments behind this trend are the potential of games to increase student motivation, engagement and learning outcomes (David et al., 2005; Gee, 2009; Klopfer et al., 2009; Plass et al., 2019). Empirical evidence supports these arguments demonstrating that digital games can produce increased outcomes when compared to non-game interventions (Clark et al., 2016; Vogel et al., 2006; Wouters et al., 2013). However, digital games are not a neutral piece of technology, but a tool in the hands of teachers (Egenfeldt-nielsen, 2007; Marklund et al., 2021; Marklund & Taylor, 2016). The ways teachers adopt digital games affect the implementation and outcomes of digital game-based learning (Hanghøj & Brund, 2018; Mutch-Jones et al., 2021; Wilson et al., 2018). Moreover, teaching with digital games is not an easy task (Egenfeldt-nielsen, 2001; Takeuchi & Vaala, 2014; Ulicsak & Williamson, 2006). Therefore, to support the scaling of digital game use in schools, additional research is needed on teachers' integration of this technology (Honey & Hilton, 2011; Stieler-hunt & Jones, 2019).

To date, game-based learning research has mostly focused on: (1) the educational potential of the digital game medium (Becker, 1983; David et al., 2005; Gee, 2003;Squire, 2006); (2) the design of educational games (Barab, 2005; Barzilai & Blau, 2014; Klopfer et al., 2009; Schrier, 2014); (3) game-based interventions (Charsky & Ressler, 2011; Khalili et al.,

2011; Wouters et al., 2013); and (4) surveys of teachers' perceived barriers to integrating digital games (Baek, 2008; Hsu et al., 2020; Proctor & Marks, 2013; Takeuchi & Vaala, 2014; Watson et al., 2008). With researchers focusing on these areas, relatively few studies have attended to teachers' actual use and experiences integrating digital games into classrooms (Egenfeldt-nielsen, 2001; Marklund & Taylor, 2016; Stieler-hunt & Jones, 2019). Particularly scarce, are studies on how teachers integrate immersive interactive digital games (IDGs). Unlike brief drill-and-practice type games, IDGs afford multi-lesson activities and deep exploration (Mutch-Jones et al., 2021; Stieler-hunt & Jones, 2019).

In response to this knowledge gap, I aim to extend our understanding of teachers' use and challenges when integrating digital games into K-12 classroom instruction. The paper draws on an online survey of 92 teachers who used the popular sandbox game Minecraft Education Edition. First, by quantitatively analyzing close-ended items, I show how the teachers use Minecraft extensively in their teaching practice and towards what subjects. Then, by analyzing open-ended responses, I enumerate nine real-world challenges teachers face when integrating the commercial sandbox game. To set up the research questions, I will outline background literature. I will start with the practicalities of teaching with digital games. I will then argue for studying specific game genres and titles. Finally, I will describe the context of this research by describing Minecraft Education Edition and research conducted on its educational applications.

The Practicalities of Teaching with Digital Games

Digital games can be powerful media for learning(Clark et al., 2016; Plass et al., 2019; Wouters et al., 2013). However, integrating games in formal K-12 classrooms is not a simple task. First, whenever teachers adopt "emerging technologies" like digital games, they must

develop novel pedagogies different from those employed with “transparent technologies” such as pencil and paper (Cox & Graham, 2009; Webb et al., 2007). Studies of game implementation show that teachers perform multiple pedagogical roles, setting up the digital game classroom, orchestrating gameplay activities, and directing student reflection and post-play discussions (Hanghøj & Brund, 2018; Marklund & Taylor, 2016; Mutch-Jones et al., 2021). Second, when digital games enter classrooms, difficulties surface from the tension between informal gameplay and the goals and logistics of school (Egenfeldt-nielsen, 2001; Marklund, 2014). These include classroom time constraints, learning the game versus curricular objectives, and technical infrastructure (Marklund & Taylor, 2016; Sandford et al., 2006). Third, teachers find, design, and adjust curricular materials when using emerging technologies (Kali et al., 2015; Mckenney et al., 2015)**.** In the case of digital games, this may include creating game resources (e.g. virtual worlds) (Arnseth & Silseth, 2018; Bar-El & Ringland, 2020; Barab et al., 2007) and scripting gameplay and discussion scenarios (Arnseth & Silseth, 2018; Taylor et al., 2012; Ulicsak & Williamson, 2006)**.** These three aspects ground the practicalities of teaching with digital games within the broader literature on teaching with novel technologies.

Studying Specific Digital Game Genres and Titles

This article drives from the need for an evidence-based approach to game-based learning. Research in this way can help us discover and suggest best practices in terms of educational game design (Plass et al., 2019) and teacher practice (Honey & Hilton, 2011; Wilson et al., 2018). However, to produce relevant insights and recommendations, researchers need to be specific in their writing and recognize the limitations to generalizability. First, researchers of game-based learning should differentiate digital games, non-digital games and gamification

(Jesmin & Ley, 2020; Kam, 2019). While overlapping in certain respects, these tools differ materially and present different design and implementation challenges. Secondly, researchers should be explicit about the digital games and genres they report on. Digital games differ widely in terms of intended use, topics they cover, genre and target audience, making generalizing about all digital games a difficult proposition (Plass et al., 2019). In the current study, I aim to produce knowledge that is generalizable to digital games within the sandbox genre. Moreover, I attempt to provide a "thick description" (Firestone, 1993) to allow transferability to other applications of Minecraft Education Edition (or similar titles).

Minecraft Education Edition

Minecraft Education Edition is a classroom-dedicated version of the popular sandbox game Minecraft. Sandbox games are open-world environments where players do not have to follow scripted goals or a linear storyline. Rather these games afford a high degree of exploration and customization (Bauer & Butler, 2017; Cipollone et al., 2014; Nadolny et al., 2020). Minecraft is both the most popular (Michael Dezuanni, 2020) and the exemplar case of the sandbox game genre, whereby almost every aspect of the game is modifiable (Abend & Beil, 2015). Minecraft presents the player with a virtual world made of blocks. The player can place or remove blocks, collect materials, combine them into new items, and build with them (Acharya & Wardrip-fruin, 2019). Microsoft, which owns the rights to Minecraft as of 2014 added unique, features to the education edition, such as in-game documentation items and a classroom management tool that allows teachers to monitor the students, teleport them around the game world, and toggle game settings (Kuhn, 2018). Schools purchase the game on an annual license basis, and can then run it on iPad, laptop, PC or Chromebook. Teachers can implement lesson

plans available on an online library or create their curricular materials, including virtual worlds (Bar-El & Ringland, 2021, 2020).

For over a decade, researchers have designed and studied educational interventions with Minecraft (Nebel et al., 2016). This prior work has demonstrated that Minecraft in its various versions can support collaboration, student creativity, and learning in a range of subject areas. Nonetheless, relatively few studies have examined the experiences of teachers who teach with Minecraft (Dikkers, 2015; Marklund & Taylor, 2016). Dikkers (2015) interviewed 17 Minecraft using teachers and described their journeys – picking up the game, using it in a variety of ways, and the positive impacts they saw. Marklund and Taylor (2016) followed and assisted three teachers through five months of teaching with Minecraft. They noted many practicalities, which teachers later said, would prevent them from using the game without the researchers' assistance. These included: (1) setting up and maintaining the technical infrastructure; (2) accommodating students with different expertise and interest in Minecraft; and (3) mediating students' association between gameplay and curricular subjects. These studies started to illustrate the uses and challenges of teaching with Minecraft. However, both drew on small samples and took place at a time before the availability of Minecraft Education Edition and the wider use of the game in formal education.

Research Questions

The current study asked, "*How do teachers who adopt Minecraft Education Edition use the game in their teaching practice, and what challenges do they face?" F*rom this overarching question, I drew the following three research questions:

RQ1. How often do teachers use Minecraft in their teaching practice?

RQ2. What subjects do teachers teach with Minecraft?

RQ3. What are the challenges that teachers experience with Minecraft?

Methods

To answer these research questions, I utilized a survey study design, attempting to sample as many teachers who use the game. An international sample of teachers who use Minecraft Education Edition responded to an online questionnaire (see appendix A) in the spring of 2021. Data collection took place during the coronavirus disease 2019 (COVID-19) pandemic. In this period, 107 countries and local governments enforced measures such as school closures; schools taught either entirely online or in hybrid configurations (Viner et al., 2020).

Recruitment

Northwestern University's IRB office ethically approved the study. To reach the particular target population of teachers who use Minecraft Education Edition, I used snowball sampling (O'leary, 2017). Recruitment took place through two channels. First, I posted calls to participate on Twitter and several Facebook groups for Minecraft Education Edition educators. Second, through correspondence with leadership at the Minecraft Education team at Microsoft, they included an invite to participate in the survey on a monthly newsletter for members of the Minecraft global mentors program - an international group of educators who volunteer to support others in adopting the game into their teaching (Farber & Williams, 2019).

Participants

Participants were 92 K-12 classroom teachers. Fifty-four (58.7%) teachers identified as male, 38 (41.3%) identified as female. In terms of education level, 45 (48.9%) held a Bachelor's degree, 44 (47.8%) had a Master's degree, two were high school graduates, and one held a doctoral degree. The average age was 43.22 years (SD = 8.72). Teachers spent an average of 16.41 years (SD = 8.99) in the teaching profession. The teachers represented twenty-two countries with the most frequent nationalities being the USA 25 (27.2%), Australia 19 (20.7%), and Canada 15 (16.3%). The teachers taught across grade levels; 61 (66.3%) taught primary students, 45 (48.9%) taught middle school students, and 33 (35.9%) taught high school students. 45 (48.9%) were members of the Minecraft global mentors program.

Procedure and Measures

The survey ran on Qualtrics. The teachers started the questionnaire by providing consent to use their anonymous data for research purposes. Following the consent form, the teachers answered closed-ended and open-ended questions. Pertinent to the current study were items on demographics, use of digital games, and two open-ended questions about the challenges to integrating Minecraft Education Edition. These were:

When choosing or creating lesson plans for Minecraft Education Edition, what are some challenges you face?

Please share a struggle or failure you have experienced with Minecraft Education Edition

Data Analysis

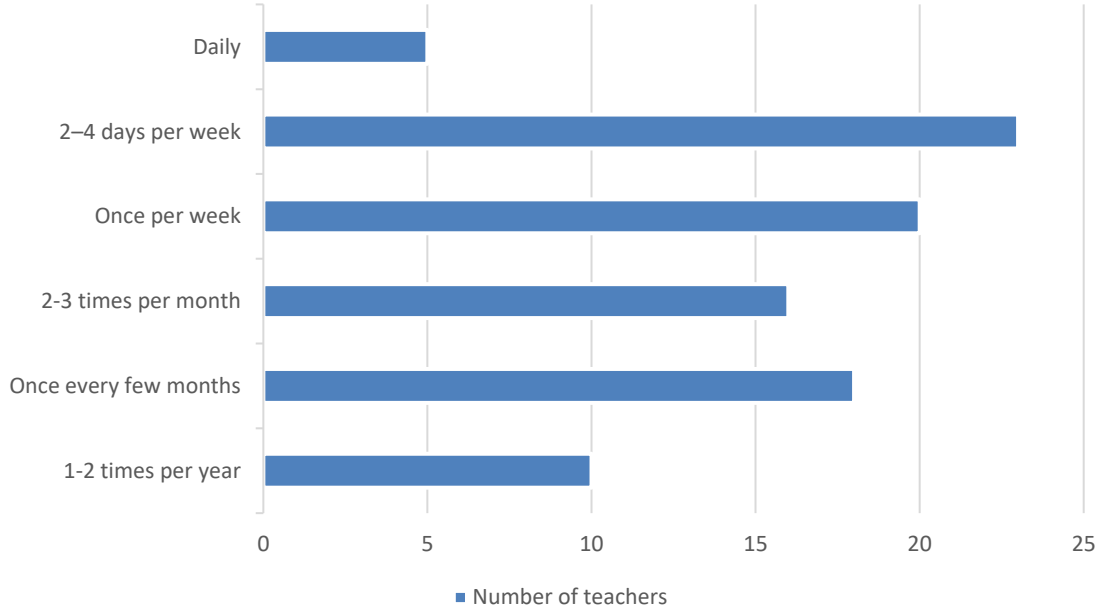
The close-ended items were analyzed using IBM SPSS Statistics (Version 28) predictive analytics software. To analyze responses to the open-ended items, I conducted a thematic analysis (Greg Guest, Kathleen M. MacQueen, 2012) using Atlas.ti version 9 (Friese, 2019; Muhr, 1994). Drawing on Miles, Huberman, and Saldaña (2014), I coded responses in two cycles. In the first cycle, I open-coded each participant's responses using in-vivo coding, using the raw text as codes. Then, I turned to second cycle coding; I refined and narrowed these in-vivo codes into higher-order codes (Miles et al., 2014). Finally, through analytical memoing (Charmaz, 2014), I looked at second cycle codes that appeared at least ten times, and used them to identify themes. These represented challenges that the teachers experienced when designing and implementing curricular materials with Minecraft Education Edition.

Results

Minecraft Use

81.5% of the teachers had used Minecraft Education Edition for over a year, with 20 (21.7%) and 36 (39.1%) using the game for three and four years, respectively. As figure 5 shows, teachers varied in their game-use throughout the year. A majority (52.2%) used Minecraft once a week to every day. These statistics suggest that teachers in the Minecraft education community integrate the game regularly as part of their teaching practice. Moreover, given that Minecraft is not a mandated tool in schools, the use over several years suggests that the teachers experienced Minecraft as a positive in their teaching practice.

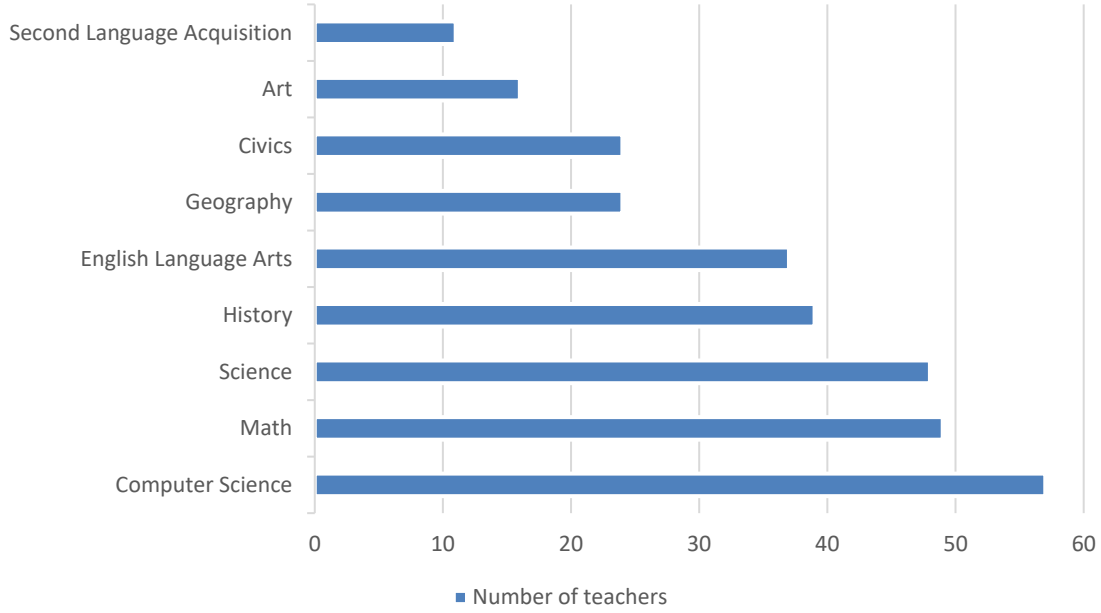
Figure 5. Frequency of Minecraft Education Edition use throughout the year.



Subjects Taught with Minecraft

Teachers reported using Minecraft to teach an average of 3.5 subjects (SD = 2.26), with 76% of teachers teaching between one and four subjects with the game. As figure 6 demonstrates, teachers taught subjects across several disciplines. Note that teachers could check 'yes' on multiple subjects. STEM subjects, computers science, math, and science, were the most taught subjects with Minecraft Education Edition. However, many teachers also used the game to teach subjects in the humanities such as English language arts and social studies such as civics.

Figure 6. Frequency of subjects taught by the teachers with Minecraft.



Challenges in Teaching with Minecraft

Looking at the above descriptive statistics, it is evident that teachers in the current study use Minecraft regularly in their teaching practice and in a range of subject areas. Nonetheless, they faced various challenges in this integration of the digital game. Teachers offered many responses to the two open-ended questions regarding the challenges and failures they experienced in teaching the game. Through iterative coding, I narrowed these into nine codes. Table 4 contains the codes, their frequency, definitions, and example quotations. I organize the codes into five broad themes of teachers' challenges with Minecraft Education Edition. In the following sections, I expand on these challenges and relate them to the relevant literature.

Table 4. Teachers' reported challenges when teaching with Minecraft.

Code and Frequency	Definition	Quotations
Internet connection (32)	Connecting a classroom of students onto a multiplayer server was challenging, especially during remote learning.	"Many times that (Minecraft) requires an internet connection is a problem, since the Wi-Fi may not work properly." "Connection issues in a remote teaching environment."
Time (25)	Limited time to create or adapt Minecraft lesson content. Additionally, working within a 45-50 minute classroom period.	"Creating lessons requires a lot of time and dedication." "Lack of time since my class is 45 minutes."
Equipment (24)	Access to adequate devices and differences between platforms such as iPads and Laptops.	"My school's student laptops cannot run Minecraft properly…" "I found it easier to manage Minecraft on a PC more than an iPad."
Classroom management (29)	Making sure that students treat the game as a learning activity rather than default to non-educational use of the game. Promoting collaboration and setting a respectful environment.	"Students can tend to get off track and want to play when on the same server as their peers". "Preventing one student from breaking blocks that were placed by another."
Technical issues (21)	Sign in, loading up lessons and incompatibility when devices have older versions of the game.	"In the day to day, the problem is often technical problems." "Not all students can sign in easily."
Lack of expertise (18)	Lacking expertise or knowledge, either in a technical aspect of Minecraft, or more generally in how to design content with the game.	"Not fully understand commands on Minecraft". "I'm not an expert Minecraft player."

Student mixed ability (14)	Students differ in their levels of interest in and experience with Minecraft. Teachers need to attend to both ends of these continua.	"The mix in student ability in regards to using the game." "I struggle with being inclusive as a few of my students do not like Minecraft."
Difficulty to create lessons (13)	Designing or redesigning lessons and Minecraft worlds to fit learning objectives.	"Creating a world that matches what I need to teach." "Tweaking the lessons to fit my curriculum."
Finding content (12)	Finding existing lesson plans of quality or curriculum relevance.	"Actual usable content in worlds that can reinforce curriculum." "Finding ways to align it to Ontario curriculum."

Technical

The most frequently reported theme related to technical aspects of using Minecraft Education Edition. One set of challenges in this theme was networking difficulties. Setting up and operating reliable multiplayer servers was challenging. As data collection took place during the COVID-19 pandemic, 15 of the 32 instances of the internet connection code explicitly stated difficulties that emerged from remote teaching. The second set of technical challenges was equipment issues: a lack of a sufficient number of devices, incompatible hardware, and software. The third set of issues included sign-in difficulties, unexpected bugs, and occasional loss of saved data.

Content

To teach with commercial games and IDGs, teachers often need to source curricular materials for their teaching objectives (Becker, 2007; Eck, 2009; Marklund & Taylor, 2016). Through the lens of Teachers as designers of technology-enhanced learning (Kali et al., 2015), we can expect three main approaches to the design of learning with digital games, implementing readymade curricular materials (Executing), adapting readymade materials (Redesigning), or creating original content (Co-designing). Teachers in the current study sourced curricular materials in these three approaches for instruction with Minecraft Education Edition; 48 (52%) and 47 (51%) executed and redesigned existing lesson plans, respectively, while 68 (74%) co-designed original curricular materials.

This lesson sourcing and curricular design represent a key challenge in teaching with Minecraft Education Edition. 25 responses expressed two challenges in this regard. Twelve teachers (13%) said that finding existing lesson plans was difficult. This included complaints about struggling to find quality curricular materials as well as content that would target particular subject areas, age groups, or curricula, often citing regional or national standards. Thirteen (14%) teachers reported challenges pertaining to the redesign and co-design of curricular materials. Some teachers struggled with finding good templates or virtual worlds that they and their students could build on. Others stated that they did not know how to modify in-game elements in order to build or adjust the virtual world. Taken together, the content theme demonstrates an important and underreported process of sourcing curricular materials for teaching with IDGs and sandbox games in particular.

Time

Insufficient time is a commonly cited barrier in GBL literature (Kirriemuir, 2003; Klopfer et al., 2009; Sandford et al., 2006; Takeuchi & Vaala, 2014). However, insufficient time can mean different things and so I will describe the specific challenges that teachers in the present study raised. Eight teachers wrote general statements about the lack of time in relation to using Minecraft. Others shared two specific ways in which insufficient time posed a challenge. First, seven teachers indicated that a 45-50 minute classroom period is often too short to meet target objectives with the game. This is in line with the IDGs being more suitable for multi-session activities rather than short single class interactions. Second, ten teachers lamented the fact that creating curricular materials was very time-consuming. Some stated that they did not have time to experiment with the game, build worlds or create good lessons. This second challenge renders more complex the design aspects of the content theme. Redesigning or designing curricular materials with Minecraft requires both knowledge and skills, but also substantial time.

Pedagogy

The fourth theme relates to pedagogical challenges - issues teachers contended with while planning and conducting lessons with the game. The term pedagogy has several definitions (Alexander, 2004; Webb et al., 2007), here I focus specifically on teachers' challenges concerning classroom management and student mixed ability with Minecraft. Classroom management came up in 29 (31%) responses. One aspect of classroom management is keeping students on task towards completing prescribed activities. Teachers wrote about students getting carried away building in the game or playing their way rather than aligning with lesson activities.

Teachers also offered suggestions to deal with student distractions. These include embedding clear instructions within the game through signs and non-playable characters' text bubbles or setting and revisiting clear expectations and classroom norms. The second aspect of classroom management is promoting collaboration and communication between the students and the teacher. Teachers stated that they worked hard to promote a more effective and respectful environment when students learn together within a multiplayer game. A third aspect is dealing with unacceptable behaviors such as students acting disruptively and destroying other students' work. In the gaming context of Minecraft, such negative behaviors are called Griefing and Trolling (Slovak et al., 2018).

A fourth aspect is the mix of abilities students have with Minecraft. Students differ in their use of game mechanics, the particular device found in the classroom, and prior gaming practices or lack thereof. Teachers shared that the mixed-ability classroom requires several considerations. First, teachers need to allow novices to learn game mechanics and develop a comfort level before advancing to complex activities. Second, they must plan learning activities in ways that engage and challenge students with varying expertise. Finally, several teachers stated that often, experienced Minecraft players specifically behave disruptively in multiplayer gameplay. Therefore, the mixed experiences of students with the game seem pertinent to teachers' design and implementation of instruction.

Lack of Expertise

Eighteen teachers (20%) voiced concerns about lacking expertise in Minecraft Education Edition. Examples included specific gaps in knowledge of in-game navigation tools, the coding interface, and in-game commands. The quotation "I'm not an expert Minecraft player" is

especially noteworthy in light of the mixed ability challenge. Hundreds of millions of children play Minecraft and watch streamers playing the game online (Michael Dezuanni, 2020). Therefore, we may expect that when teachers begin to use popular commercial games such as Minecraft, some students will know more about the game than they do.

Discussion

The game-based learning field now recognizes that teachers are key agents who integrate digital games into classrooms and that further research is needed to understand and support their efforts (Egenfeldt-nielsen, 2007; Honey & Hilton, 2011; Marklund & Taylor, 2016). The aim of this study was to shed light on the experiences of teachers who have adopted a digital sandbox game, a popular immersive and interactive game genre. Ninety-two K-12 teachers who use Minecraft Education Edition responded to an online survey. Results showed that the teachers use the game regularly as part of their teaching practice across a range of subject areas. Moreover, findings show nine challenges teachers face when integrating the game into formal instruction. Through thematic analysis, I condensed these challenges into five themes. These findings contribute to the GBL field, replicating, extending on prior literature, and providing applied implications.

Teachers' Use of Minecraft Education Edition

Surveys studies show that an increasing number of teachers around the world are now open to and are using digital games (Millstone, 2012; Takeuchi & Vaala, 2014; Wastiau, Kearney & Van den Berghe, 2009). Mostly these are drill & practice games designed for short classroom interactions rather than immersive and interactive games (IDGs) (Stieler-hunt & Jones, 2019; Takeuchi & Vaala, 2014). The current study provides a window into the game use

and experiences of a community of teachers who have adopted an IDG. Results show that the teachers integrated the game into their classroom practice extensively. Researchers have used Minecraft for experimental and educational interventions in various subjects (Nebel et al., 2016). Moreover, the Minecraft Education Edition website has hundreds of lesson plans across curricula (Bar-El & Ringland, 2020). The study's findings help to corroborate that K-12 teachers use the game across a range of subject areas, predominantly STEM followed by social studies and the humanities.

The Relationship between Challenges and Use

The teachers' extensive use of Minecraft despite experiencing multiple challenges helps to nuance the discussion of challenges and barriers to integrating digital games. Many prior survey studies have framed barriers as hindrances that prevent teachers from teaching with digital games (Baek, 2008; Watson et al., 2008). On the other hand, longitudinal implementation studies have articulated the practicalities of teaching with digital games (Egenfeldt-nielsen, 2001; Marklund, 2014; Marklund & Taylor, 2016) as the reality of using this novel technology in formal education. Challenges in this way do not necessarily prevent teachers from using games but require attention. The current study supports this latter framing by highlighting that game-using teachers face multiple challenges. In a case study of teachers trying to teach with Minecraft (Marklund & Taylor, 2016) , the three teachers said that they would not use the game further without the assistance of the research team. The perseverance of teachers in the survey study warrants further inquiry about how teachers deal with said challenges and successfully integrate Minecraft and other IDGs into their teaching practice. Future research should examine what

resources and support systems allow teachers in the Minecraft education community to overcome said challenges and continue to use the game in their teaching practices.

The Challenges of Teaching with Minecraft Education Edition

The five challenge themes paint a rich picture of the challenges teachers dealt with when teaching with Minecraft Education Edition, an exemplar of the sandbox game genre. Moreover, surveying 92 teachers who use the game regularly, the challenges and their frequency extend our understanding from prior studies with smaller samples. In the following paragraphs, I will relate four challenge themes to the literature and draw implications for theory and practice.

Technical challenges have been barriers to integrating digital games in k-12 classrooms, especially the lack of computing equipment (Baek et al., 2008; Klopfer et al., 2009). The prevalence of responses that included technical challenges indicates that even seasoned adopters of Minecraft Education Edition deal with technical issues regularly. This finding echoes the argument of researchers who state that teaching with digital games is still complicated at the technical level (Egenfeldt-nielsen, 2001; Marklund & Taylor, 2016). In the case of Minecraft, and especially during COVID-19, a persistent technical issue seems to be around networking and online gameplay. These technical issues stress the need for schools and game publishers to provide teachers with technical support to allow for consistent use of digital sandbox games, especially for multiplayer gameplay.

Prior studies indicate that teachers struggle to find quality digital games and games that are suitable for curricular goals (Jesmin & Ley, 2020; Klopfer et al., 2009; Takeuchi & Vaala, 2014). The content theme shows that after choosing a digital game, they may still need to find quality and fitting curricular materials. For most teachers in the study, sourcing content for Minecraft

included a combination of finding readymade lessons, redesigning them, or co-designing new curricular materials from scratch. Finding curricular materials is difficult when teachers worldwide share an online lesson repository. The time theme further illustrates the labor teachers invest in these curricular design. Teachers need time to find lessons or virtual world templates, modify them, and plan specific classroom activities. Several approaches could reduce this labor intensiveness of designing curricular materials. First, game publishers like Microsoft should identify and make accessible template lessons and virtual worlds based on teachers' recommendations of readymade lessons. These could scaffold novice teachers' design processes and save time. Second, policymakers and schools interested in scaling teachers' use of IDGs should allocate time for teacher curricular design.

The pedagogical theme speaks to the considerations and roles that teachers have during the implementation of Minecraft lessons: (1) keeping students on task, (2) promoting collaboration, (3) preventing disruptive behavior, and (4) considering mixed ability. Promoting a positive collaborative environment and dealing with disruptive behavior are salient issues in online spaces (Slovak et al., 2018). In the case of Minecraft, students may destroy classmates' work, disturb each other, or even cause the game to crash. In informal Minecraft servers, it is common for communities to have guidelines, moderators, and consequences for disruptive behaviors that range from discussing a conflict to banning players from the server (Acharya & Wardrip-fruin, 2019; Ringland, 2018). Research from Minecraft afterschool clubs has demonstrated that good moderation practices can help students work collaboratively and mediate their conflicts (Jagannath & Salen, 2020; Slovak et al., 2018). Future research should explore how best moderation practices can support classroom use of sandbox games such as Minecraft. Finally,

prior work has identified the need to address students' mixed abilities and interests in digital games around Minecraft and other games (Egenfeldt-nielsen, 2001; Marklund & Taylor, 2016). However, teachers in the current study point to a potential interaction between student experience and behavior; teachers found that experienced Minecraft players were more likely to behave disruptively. This potential behavioral difference warrants further investigation and a particular focus on ways to moderate diverse classrooms.

Limitations and Future Research

This study aimed to build theory on how teachers integrate digital sandbox games in formal classroom instruction. The findings provide a rich description of how teachers who have adopted Minecraft Education Edition use the game, source curricular materials, and the challenges they face in this implementation. However, the study has two noteworthy limitations to the generalizability of these findings. The first limitation stems from the sample and choice of a digital game to focus on. In this study, I used purposive sampling (Miles et al., 2014) to gather data from and about teachers who are adopters of Minecraft Education Edition. This sample does not represent the general K-12 teacher population, or game-using teachers, as most do not use IDGs (Takeuchi & Vaala, 2014). Moreover, Minecraft Education Edition is a unique game in a number of ways. It is a commercial title that has popular appeal among youth globally (Dezuanni, 2020) and an educational product that is owned and supported by a large gaming publisher and software giant, Microsoft (Kuhn, 2018). Considering the uniqueness of both the community of teachers represented in this study and the game they use is important when considering the generalizability of the findings.

A second limitation of this study is the exclusive use of self-report data. An online questionnaire made feasible the collection of data from a larger sample than that of prior observational studies. Moreover, this remote research approach allowed me to reach teachers across large geographical distances during the COVID-19 pandemic when schools were closed (Lobe et al., 2020; Viner et al., 2020). However, self-report data have noteworthy weaknesses. To answer survey questions, respondents go through mental processes of understanding the question, retrieving information from long-term memory, judging and editing the retrieved information, and reporting an answer (Groves et al., 2004). It is possible that when teachers in this study responded to open-ended questions, they failed to retrieve certain information, edit their recalled memory, or answer in a vague or terse manner. By using in-vivo coding and developing into themes only codes that appeared at least ten times, my findings maintain credibility. That is, they reflect the best of my ability the experiences of the teachers as expressed in their written responses (Whittemore et al., 2001). Nonetheless, it is possible that teachers face additional challenges which they did not share in their questionnaire responses. Future research should follow teachers as they integrate Minecraft or other sandbox games and triangulate multiple data sources to complement survey data.

Generalization and Transferability

The findings of this study contribute to theory-building about teachers' integration of interactive immersive digital games, and sandbox games, in particular, a nascent area of scholarship (Egenfeldt-nielsen, 2001; Marklund, 2014; Stieler-hunt & Jones, 2019). The teachers' self-reported use patterns and challenges help to nuance and further explain the relationship between constructs in game-based learning. In this way, the case of the Minecraft teacher community

allows for theoretical generalization (Tsang, 2014). Moreover, I attempt to provide a "thick description" (Firestone, 1993; Geertz, 1973) of the teachers' experiences. It is my hope that researchers, teachers, and policymakers will be able to read these findings and use them to inform future applications of Minecraft Education Edition or similar sandbox games.

Chapter 6. Curricular Design and Implementation Practices in Game-Based Learning: A Case Study of Three Experienced Minecraft Teachers

Abstract

This case study looks at how three teachers with expertise teaching with a digital sandbox game use it as a teaching tool in K-12 classroom instruction. Digital games are an emerging technology with promises to support student motivation, engagement, and learning. However, the literature is scarce on how teachers integrate this technology into practice. Especially needed are studies on teachers' lesson planning and experiences with immersive interactive digital games. To address this gap, I qualitatively compiled and compared the cases of three teachers who are experienced users of Minecraft Education Edition. Triangulating interviews, curricular materials, and online resources, I asked how the teachers viewed the game, used it, and designed lessons for the game. Results showed that all three teachers had positive experiences and integrated Minecraft into their teaching practices. Teachers differed in some of their views, uses, and approaches to designing curricula with the game. In the discussion, I argue that these findings contribute to existing models of teacher integration of digital games. Moreover, I suggest directions for future research and implications for practice.

Introduction

How do teachers integrate digital games into their classroom instruction? While game-based learning, using digital games for education has increased in recent years (Jesmin & Ley, 2020; Takeuchi & Vaala, 2014), many open questions remain on how teachers use games as a teaching tool. How do teachers source or develop curricular materials for digital games? What considerations do they have for fitting a particular game into their instructional objectives? Prior

studies have identified several aspects of teaching with digital games. These include roles (teachers shift between several responsibilities during gameplay); challenges (teachers have many logistical tasks around digital game-based learning); and practices (teachers combine various instructional activities before, during, and after gameplay) (Bado, 2019; Hanghøj & Brund, 2018; Kangas et al., 2016; Marklund & Taylor, 2016; Nousiainen et al., 2018; Peddycord-liu et al., 2019). However, we know relatively little about how teachers design curricular materials for commercial and immersive-interactive digital games (Becker, 2017; Stieler-hunt & Jones, 2019).

Teaching with digital games is challenging (Egenfeldt-nielsen, 2001; Marklund, 2014). Researchers have documented that teachers require significant support and guidance during classroom implementation (Thomas et al., 2009; Wilson et al., 2018). Teachers also face several barriers to integrating digital games, like high costs and finding suitable titles (Klopfer et al., 2009; Takeuchi & Vaala, 2014). A way to overcome these and other barriers is using commercial-off-the-shelf (COTS) games, high quality, and engaging games, that teachers can appropriate toward educational ends (Charsky & Mims, 2008; Eck, 2009). However, teaching with COTS games is often uniquely challenging as they are designed for entertainment, are not embedded with learning content, and require teachers to come up with curricula and teaching scenarios (Eck, 2009; Tokarieva et al., 2019).

Research should explore how teachers integrate digital games in formal K-12 classroom instruction (Honey & Hilton, 2011). Such research could inform teacher resources and professional development, which thus far have not emphasized curricular design with COTS games. The present study sought to document the curricular design, implementation, and

thinking of several experienced game-using teachers. I aimed to identify and analyze commonalities and differences in teachers' curricular design and experiences of teaching with an immersive interactive digital game. Teachers with expertise in teaching with Minecraft Education Edition participated in semi-structured remote interviews (Gray et al., 2020), sharing their curricular materials on the screen and discussing them with the researcher.

Digital Game-Based Learning

Since the proliferation of games on home computers (PCs), researchers and game designers have been excited at the idea of learning with this novel technology (Klopfer et al., 2009; Marklund, 2015). Leading scholars have advocated the power and promise of digital games as a medium that engages learners in new literacies (Gee, 2003), collaboration (Steinkuhler, 2007), and complex systems thinking (Shaffer et al., 2005; Squire & Jenkins, 2003). Buttressing these promises is a growing number of empirical studies and meta-analyses demonstrating that learning with digital games yields improvements in student engagement, motivation, and learning (Clark et al., 2016; Vogel et al., 2006; Wouters et al., 2013). However, much of the discourse has been techno-centric, positioning learning with games in contrast to traditional schooling, thus backgrounding teachers as the key agents who integrate digital games into classroom instruction (Egenfeldt-nielsen, 2007; Hwang & Wu, 2012). For example, in a recent handbook on game-based learning, none of the chapters were dedicated to teachers' classroom experiences (Plass et al., 2019).

Teaching with Digital Games

"*A municipality, school, or classroom environment is not an empty vessel to pour a learning game into, and a game's impact will not be determined solely on how well it balances subject matter representation with notions of good game design. The context matters.*"

(Marklund, 2014, p.12)

Teachers are critical actors in the context, which impact the successful and positive impacts of game-based learning (Kangas et al., 2016; Marklund & Taylor, 2016; Wilson et al., 2018). Some argue to shift the conversation from game-based learning to game-based teaching, centering on digital games as tools in the hands of teachers (Marklund et al., 2021; Pivec, 2009; Sandford et al., 2006). Focusing on how teachers use digital games in formal instruction helps to reveal the complicated processes adopting this novel technology entails. An ethnographic study of Swedish military trainers who use simulation games identified a three-step coaching cycle including (1) scenario planning, (2) gameplay, and (3) debriefing (Taylor et al., 2012). This coaching cycle echoes scholarship on game-based learning in K-12 classrooms framing teacher activities as taking place before, during, and after gameplay (Bado, 2019; Felicia, 2020).

Kangas et al. (2016) reviewed 35 studies of game-based interventions and identified five categories of teacher pedagogical activities. (1) Planning – the teacher contemplates learning goals and the organization of gaming scenarios. (2) Orientation – the teacher introduces the classroom to the topic, and relevant prior knowledge and sets expectations about the gaming and learning scenario. (3) Playing – the teacher guides, plays alongside and supports students technically and pedagogically as they complete gaming tasks. (4) Elaboration – The teacher

facilitates discussions and questions to mediate sense-making and connections between gaming and target learning goals. At this point, teachers also assess student learning. (5) Reflection – Throughout the integration of digital games, the teacher reflects on their processes.

Lesson planning and Curricular Design with Digital Games

While planning is part of teaching with games, few studies have examined how teachers plan lessons or design curricular materials with digital games. This gap warrants attention as many teachers, especially newcomers to game-based learning often do not know where to begin (Caldwell et al., 2017; Marklund & Taylor, 2016). Moreover, as stated before, commercial-off-the-shelf (COTS) games especially, require of teachers to source or design their own curricular materials (Eck, 2009).

The literature on lesson planning with games comprises mostly handbooks that provide templates and examples of lesson plans with digital games (Becker, 2017; Felicia, 2020; Torrente et al., 2011). The templates highlight design considerations around learning objectives, student characteristics, narrative descriptions of before, during, and after gameplay, evaluation approach, and logistics. These prescriptive resources are valuable as a starting point and a guiding model for teachers interested in teaching with digital games. However, as research on teachers' planning has shown, there is often a gap between textbook models of lesson planning and how teachers prepare for classroom instruction in practice (Munthe et al., 2017; Roche et al., 2014). Therefore, there is a need for additional research to capture and understand how teachers plan and design lessons in real-world practice.

Teachers as Designers of Technology Enhanced Learning

In this study, I view teachers' curricular design with digital games through the lens of teachers as designers of technology-enhanced learning (Kali et al., 2015; McKenney et al., 2015). This framework argues that teaching is design science and that teachers these days do more than lesson planning, "*they also design new learning activities and create their own (technology-enhanced) learning materials"* (Mckenney et al., 2015, p.2). The framework specifies that teachers may take up three roles when designing materials and activities for technology-enhanced learning (Cviko et al., 2014): enactors (teachers integrate readymade activities, making slight changes); re-designers (teachers reshape readymade activities and materials to fit their curricular needs); or co-designers (teachers design original learning activities and materials). In the literature, teachers' co-design may involve collaborating with other teachers, curriculum experts, and research teams (Cviko et al., 2014; Penuel, Mcwilliams, et al., 2009). It is noteworthy that a critique of this framework claims that defining teaching as a design science is redundant, as teacher practice has not changed in any qualitative way with the introduction of computing technologies (Kirschner, 2015).

The Current study

In this article, I address the gap in lesson planning and curricular design with digital games. In particular, I report on case studies of three K-12 teachers with expertise in teaching with Minecraft Education Edition. By illuminating how the teachers think about, design curricular materials, and use the game, I hope to contribute to theory and practice regarding teachers' integration of game-based learning. The research questions guiding this study were as follows:

1) How do teachers view the Minecraft as a teaching tool?
2) How do teachers use Minecraft in their teaching practices?
3) How do teachers design learning activities with Minecraft?

Methods

To understand how experienced game using teachers think about, design, and implement learning activities with a digital sandbox game, this study utilized a case study methodology. Case studies are well suited when investigating phenomena within their real world context (Tsang, 2014; Yin, 2018). Rather than bounding the unit of analysis to a school or classroom where game-based learning takes place, I defined the case (Miles et al., 2014) as the K-12 teachers' thinking, curricular designs, and practices with the sandbox game Minecraft. To mitigate my own biases as a researcher, and to strengthen the reliability and validity of my assertions, I triangulated multiple data sources. Specifically, I combined in-depth interviews (interview methods), curricular materials (artifact analysis), blogposts, and past interviews or presentations given by the teachers (archival data). In the following paragraphs, I briefly share participant information, explain the online interview procedure and finish by presenting my positionality as the researcher in this qualitative study.

Participants

Eight teachers from Canada and the United States participated in the study. They volunteered to participate based on recruitment via Social Media or by emailing an expression of interest following a previous survey study (study 2). These were native English speakers, as verbalization in a non-native language may present a hindrance during think-aloud tasks (Charters, 2003; Qi, 1998). Of the eight, I selected three focal teachers based on the diversity of

their experiences and the rich conversations we had during the interview. Table 5 provides background details about Jake, Kate, and Miles. Throughout the paper, I use pseudonyms for the three teachers.

Table 5. The three focal teachers' backgrounds.

Name	**Age (Years)**	**Grades**	**Subjects**	**Teaching experience (Years)**	**Minecraft Experience (Years)**
Jake	59	7	History	29	10 years
Kate	45	5,6	Generalist – Art, Health, Language Arts, Math, Religion, Science, Social Studies	21	Two years
Miles	49	5,6	Generalist – Art, French, Health, Language Arts, Math, Science, Social Studies	20	Seven years

Researcher as Instrument

In this study, I played a role as a researcher in both shaping the interview interaction (part of data collection) and in interpreting the findings (data analysis). It is important therefore to understand my positionality, how my experiences and worldview may have shaped my research activity (Schwartz-shea & Yanow, 2013). At the time of this study, I was a PhD student conducting several studies on the educational use of Minecraft over the course of four years. Following several research projects on informal learning with Minecraft, I shifted my focus to Minecraft as a teaching tool in the K-12 classroom context. I do not have direct experience as a

classroom teacher. However, I have taught and facilitated learning in higher education, makerspaces and summer camps. Most relevant, I have conducted summer camps and quasi-experiments where I instructed middle school students with the use of Minecraft JAVA edition and Minecraft Education Edition.

Procedure

After responding to the call to participate, the teachers completed a brief screener survey (Travis & Hodgson, 2019), which included a consent form and items regarding demographics and experience with Minecraft (see appendix B). Following the screener, I conducted semi-structured interviews with each of the teachers (see appendix C). These lasted an average of 97 minutes (SD = 10.15). The interviews took place remotely using the Zoom video-conferencing tool (Gray et al., 2020). Zoom enabled automatic transcription of both teacher and researcher speech, for subsequent data analysis. The interview started with a short scripted introduction, where I explained the goals of the interview study (Jacob & Furgerson, 2012). The interview consisted of two tasks, each succeeded by follow-up questions. In both tasks, interviewees were referring to on-screen lesson plans. These lesson plans served as elicitation devices to ground the interview and participants' thinking in relation to material artifacts (Abildgaard, 2018) and provide an additional data source to augment verbal data (Ericsson & Simon, 1980).

The first task was a think-aloud to elicit the teachers' thinking (Charters, 2003) about the design of lessons with Minecraft Education Edition. Teachers shared their screens using the "screen share" function on Zoom and opened a link to a lesson plan on the Minecraft Education Edition website. The researcher then asked the teachers to scroll through the lesson plan and verbalize their thinking as though they were commenting on a lesson plan created by a fellow

teacher. The teachers repeated this for two lesson plans, after which the researcher posed questions about points of interest. For the second task, the researcher asked the teachers to share their screens and show and describe curricular materials they had designed. During this task, the researcher interjected with questions about the teachers' designs, implementation experiences, and thinking.

To augment the textual and artifact data collected during the interviews, I sought additional data sources regarding the teachers' curricular designs and thinking. These included websites by two of the teachers (Kate and Jake) and interviews and presentations given by two of the teachers (Jake and Miles). This use of secondary sources – data not elicited by myself as the researcher – helped to mitigate my biases as a researcher at the point of data collection. As O'Leary explains, secondary data "provides an objective buffer between the researcher and the researched" (O'leary, 2017, p.486). Moreover, the additional data afford further triangulation of data sources, aimed at lending more credibility to my assertions (Yin, 2018).

Data Analysis

Data were analyzed in multiple cycles of coding, analytic memoing and revisiting of data (Charmaz, 2014; Miles et al., 2014). I used Atlas.ti version 9 (Friese, 2019; Muhr, 1994) for computer-aided qualitative data analysis. Atlas.ti supports the analysis of video and transcripts and affords "closeness to the data", the ability to tag and create connections at the quotation level (Friese, 2019). In the first cycle, I open coded the interviews, tagging quotations of interest across the interviews. I then wrote a memo for each interview, commenting on and summarizing tagged quotations. In the second round of coding, I revisited the tagged quotations, my comments on them; curricular materials, participant screen casts, and produced memos on each

of the three teachers. I then moved to making assertions from the evidence; using a virtual board[9], I organized the central themes that came up during the interviews regarding the three research questions. To triangulate my assertions, I cross-referenced quotations, images, and texts from the secondary data.

Results

In the following paragraphs, I go teacher by teacher and answer the research questions. In this way, I chronicle how the three teachers view Minecraft as a teaching tool, their use of the game, and curricular design with the game.

Jake

Jake's Background

Currently a 6-8th grade history teacher in California, Jake has taught middle school across all subject areas for over 28 years. The most experienced Minecraft teacher in this study, he has been using the game for over a decade. He started using Minecraftedu, a teacher-designed mod of Minecraft Java Edition. He was active in the community of early adopters of the game mod and worked iteratively and collaboratively with his online peers to hone his skills with the game. Jake is the co-author of three books about learning with Minecraft at home and a contributor to another book on teaching with Minecraft in the classroom. He has written numerous articles and blog posts about the subject and has given presentations at conferences worldwide. Jake holds a MA in Education.

[9] I used Miro.com, a visual collaboration tool that functions like a virtual whiteboard. The board allows users to create rectangular frames, add sticky notes with texts, and to embed images and URLs.

How Jake Views Minecraft

- Minecraft increases the motivation and engagement of my students.
- Minecraft affords collaboration and communication between my students.
- The most powerful way to use Minecraft is as an immersive experience that places students in narratives and allows them to interact with and empathize with characters representing real people.
- Minecraft inspires my students to read and write about history.

Jake views Minecraft as an engaging environment with an inherent motivational pull. Through his experience, he has learned that teaching effectively with Minecraft requires an ability to structure activities well and not to break the students' immersion in the game. In Jake's words - *"once students were in the game, you couldn't get them out"* (Interview). Jake views Minecraft as a collaborative environment in several ways; students can work collaboratively in teams, classes can work across time and countries, and he can collaborate with his students on sophisticated build projects. Jake's lessons and description reflect that Minecraft serves as an immersive context where students can interact with characters and players within a narrative. Finally, while Jake teaches history, he emphasizes the importance of developing his students' literacy skills. To him, Minecraft has had a highly positive effect on his students' engagement and improvement in reading and writing historical and fictional texts. In the following paragraphs, I will demonstrate how Jake's use of and design for Minecraft as a teaching tool relates to his views of Minecraft.

How Jake Uses Minecraft in his Teaching Practice

Jake's use of Minecraft presented four main features. First, he uses Minecraft throughout the school year as an integral part of his history curriculum. Specifically, Jake has "*a Minecraft unit for every unit we cover in history*" (Interview). He frames his Minecraft use as a time-traveling adventure, where the students are chasing a time bandit who is messing with time. Secondly, when implementing learning activities with the game, Jake prefers to use long-form lessons, which span multiple classroom periods. Jake has developed a suite of short-form STEM lessons commissioned by Microsoft following his publication of books on teaching with Minecraft. However, when I asked him if he uses both short-form and long-form activities, he stated his preference is square with the latter. As he developed his practices with Minecraft, he became increasingly oriented toward student exploration and inquiry which dovetails with long-form Minecraft activities.

Third, Jake blends Minecraft gameplay within sequences of traditional instructional activities. For example, in a lesson that Jake developed on Vikings in the Dark Ages (described in further detail below), Jake dedicated several classroom periods to close reading and annotating historical fiction texts. After the activities, students entered a Minecraft world where they experienced the historical events and interacted with characters from the texts. This transition captures Jake's clear separation between gaming and non-gaming activities, which stems from his experience that trying to pull students out of the game is disruptive.

Fourth, in line viewing Minecraft as a tool for literacy skills, Jake focuses his assessment on his students' writing in and out of the game. This surprised me, given that in many of his lessons, Jake's students built some of the most impressive, detailed and large-scale constructions I have seen in educational implementations of Minecraft. For example, in a lesson on the Middle

Ages Chinese Tang dynasty, 150 students across Jake's five classes built a gigantic representation of the dynasty's capital city. Collaboratively, they built farms, houses, palaces. Moreover, they placed 1500 NPCs representing citizens and wrote biographies for each where they hit rubrics on the social structure, roles, and culture of the time as expected in the curricular standards.

Jake spoke proudly of his students' creative building. However, for assessment, Jake focused solely on their writing. "*The assessment for me was already completed; because what I assess them on was their writing and I didn't care what they built*" (Interview). Throughout the yearlong history curriculum, Jake's students write a 25-30 pages long book on their history learning. Jake described the Minecraft-inspired writing with excitement while contrasting it with the more mundane texts he would otherwise expect. "*Usually as a history teacher the normal assignment is to give me the five paragraphs let's say on Vikings and they say the same thing... But, now because the kids get to explore the world on their own and they don't have to go in a linear fashion because they can interview certain people and miss certain people, they are getting their own perspective of history. The content's in there, but they are all writing from 150 different perspectives and I get 150 wonderful essays that I actually enjoy reading and commenting on*." (Minecon 2016).

How Jake Prepares and Designs Learning Activities with Minecraft

Looking at Jake's history lessons shared during our interview and on his website, several commonalities and variations emerge in his curricular design. These include building dedicated Minecraft worlds; scripting narratives and in-game experiences; and creating curricular materials, either alone or co-designing with teachers and students.

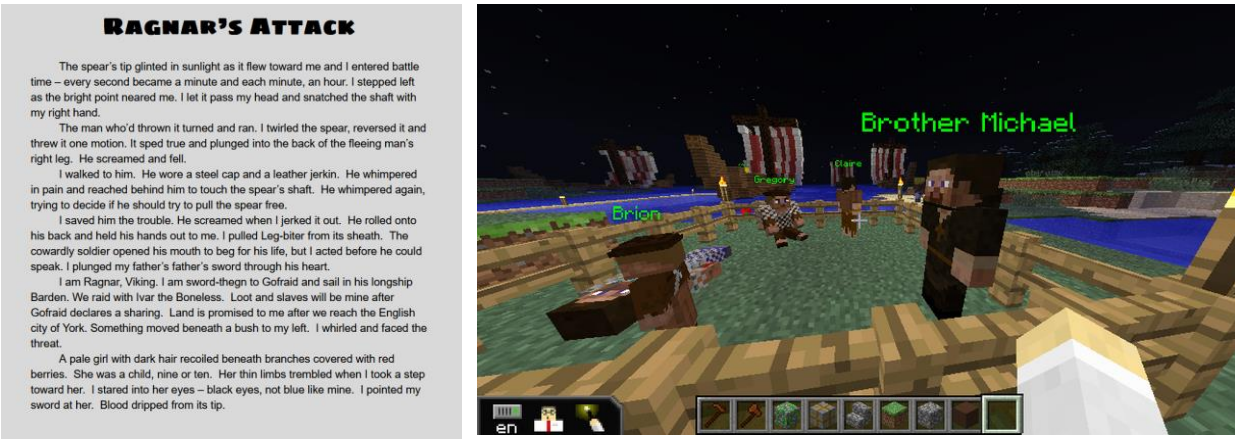
First, world-building, creating virtual worlds (Abend & Beil, 2015; Bar-El & Ringland, 2021) , is a staple of Jake's lesson plans. For every lesson, Jake will create a dedicated Minecraft world to set the stage for his teaching. The scope and complexity of the world differ according to the roles students play during the gaming sessions, specifically around the question of whether they build the world as well or not. For example, in the referred above lesson on the Tang Dynasty, Jake created an initial virtual world with a grid delineating plots for students to build in. He tagged these with three different colors corresponding to the level of difficulty of the target structure on that plot (figure 7 left). Students self-assessed their experience with Minecraft and worked on construction by said assessment; novices worked in groups on simple structures such as farmhouses while experts worked alone on complex builds like palaces (figure 7 right). In such a world, Jake plans for students to take on the role of world builders.

Figure 7. Jake's world comprised of a grid and numbered plots color coded by complexity (left). A section of the Tang dynasty capital city after students built within the allotted plots (right).

Second, Jake often creates narratives and in-game interactions with NPCs and virtual representations of ancient civilizations. This design approach aligns with Jake's view that Minecraft is best for creating immersive and interactive narratives for his students to experience. "*I see myself now as not just a teacher, but a designer of experiences for my kids. Because they need experiences to write well*" (Minechat, 2014). An example of Jake's creation of virtual

experiences and narratives manifests in a lesson about the Viking raids on England in the Dark Ages. Jake worked with a colleague who wrote fictional history texts about historical events. The texts referred to historical events and characters and used the correct vocabulary, albeit within an adventure story that aimed at being appealing to the 7th graders (figure 8 left). Jake took these six 250-350 word vignettes and built a Minecraft world, which allowed his students to immerse themselves in the scenes and interact with characters from the story (figure 8 right).

Figure 8. A fictional history vignette writer by Jake's colleague, Robert Walton (left). An area of Jake's Minecraft world representing a scene from the vignette (right).



Ragnar's Attack

The spear's tip glinted in sunlight as it flew toward me and I entered battle time – every second became a minute and each minute, an hour. I stepped left as the bright point neared me. I let it pass my head and snatched the shaft with my right hand.

The man who'd thrown it turned and ran. I twirled the spear, reversed it and threw it one motion. It sped true and plunged into the back of the fleeing man's right leg. He screamed and fell.

I walked to him. He wore a steel cap and a leather jerkin. He whimpered in pain and reached behind him to touch the spear's shaft. He whimpered again, trying to decide if he should try to pull the spear free.

I saved him the trouble. He screamed when I jerked it out. He rolled onto his back and held his hands out to me. I pulled Leg-biter from its sheath. The cowardly soldier opened his mouth to beg for his life, but I acted before he could speak. I plunged my father's father's sword through his heart.

I am Ragnar, Viking. I am sword-thegn to Gofraid and sail in his longship Barden. We raid with Ivar the Boneless. Loot and slaves will be mine after Gofraid declares a sharing. Land is promised to me after we reach the English city of York. Something moved beneath a bush to my left. I whirled and faced the threat.

A pale girl with dark hair recoiled beneath branches covered with red berries. She was a child, nine or ten. Her thin limbs trembled when I took a step toward her. I stared into her eyes – black eyes, not blue like mine. I pointed my sword at her. Blood dripped from its tip.

Third, all of Jake's lessons are original designs where he exhibits the *co-designer* role, creating novel curricular materials (Kali et al., 2015; Mckenney et al., 2015). While the literature on teacher curricular design emphasizes teacher teams or teacher-researcher partnerships (Kali et al., 2015; Penuel, Mcwilliams, et al., 2009), Jake's curricular design with Minecraft seems unique in several ways. Most of Jake's design work is his own; he builds virtual worlds, plans instructional activities outside of the game, and creates writing templates to guide his students' writing after each Minecraft activity. However, Jake works collaboratively at times with two groups of stakeholders. The first is other teachers, such as the early adopters of Minecraft and his fellow teacher who wrote the vignettes for the Viking unit.

The second stakeholder group is building teams, groups of students who help Jake to build dedicated virtual worlds. In one example, Jake offered an elective class to 28 students themed around building in Minecraft. Over several weeks, the students and Jake created a representation at a 1:2 scale of the round city of Baghdad (figure 9 left) while drawing on primary sources. Jake intended for the large-scale world to set the stage for a narrative-based learning activity in line with a new Californian history framework, specifically around the topics of sites of religious encounters, ancient cities, the Muslim empires, and the relationship between civilizations and the environment. In another example, Jake and his team of builders recreated a model of Medieval Birmingham (figure 9 right).

Figure 9. Recreations of the ancient cities of Baghdad (left) and Birmingham (right) co-created by Jake and his team of student builders.

Summary of Jake

Jake views Minecraft as a medium that allows him as a teacher to design immersive experiences for his students. These experiences engage his students in history learning and literacy practices and learning. Minecraft has become an integral part of how he teaches 7th-grade history and therefore has Minecraft activities for each unit of his yearlong curriculum. His use of Minecraft is for long-form activities where his students immerse themselves in narrative-

driven experiences, exploring, interacting with, and sometimes building representations of ancient civilizations and their historical environments. With a focus on literacy, Jake sequences multiple reading and writing activities before and after gameplay activities. To assess his learning, Jake focuses solely on student writing. In terms of design, Jake takes up the role of co-designer (Cvicko, 2014), creating curricular designs and lessons. Two noteworthy aspects come up in his curricular design. First, in line with his intent to create immersive experiences, Jake will build dedicated Minecraft worlds to set the stage and host his students' learning. Secondly, while Jake leads the co-design process, he sometimes collaborates with student builders to help him create the dedicated virtual worlds or with other teachers to design external resources.

Kate

Kate's background

Kate is an elementary school teacher at a Catholic school in Canada and has worked as a teacher for 21 years. She teaches math, science, language arts, social studies, art, health, and religion. Relatively new to Minecraft she has been using the game for two years. To develop her expertise with the game, Kate draws on several sources. First, she follows and engages with the online communities of teachers who use the game via Twitter and Facebook groups. Second, she has been active on Minecraft Education Edition's forums, has consulted with global Minecraft mentors, and has recently joined the mentor program herself. Third, Kate relies on her students sometimes, noting that though she does not see herself as a Minecraft expert, she can problem-solve with her students. Kate holds a MA in Educational Technology.

How Kate Views Minecraft

- Minecraft increases the motivation and engagement of my students.

- Minecraft affords collaboration and communication between my students.
- Minecraft supports cross-curricular learning.
- Minecraft is a protean tool in my hands and in the hands of my children.

Kate views Minecraft as a motivating and engaging medium for her students. Under school lockdowns in the Covid-19 pandemic, learning online with Minecraft was especially useful; to motivate many of her students who otherwise disengaged in online learning. She describes collaborative projects between her students as a uniquely authentic and powerful experience for developing soft skills like collaboration, communication and problem solving. Minecraft allows her to cover multiple topics and skills in a single activity, thus using time wisely and promoting better learning. “I love that kids are reading and writing, every time they're doing a Minecraft build” (Interview). Finally, related to the need to teach across the curriculum, Kate reiterated that Minecraft to her is unlike any other educational technology. It is malleable and she can teach with it whatever she wants. Specifically, Kate cites the affordances of the sandbox game to allow her students to “*open a world of creation for students that I cannot do in another way in the classroom*” (Correspondence – 22/03/2022).

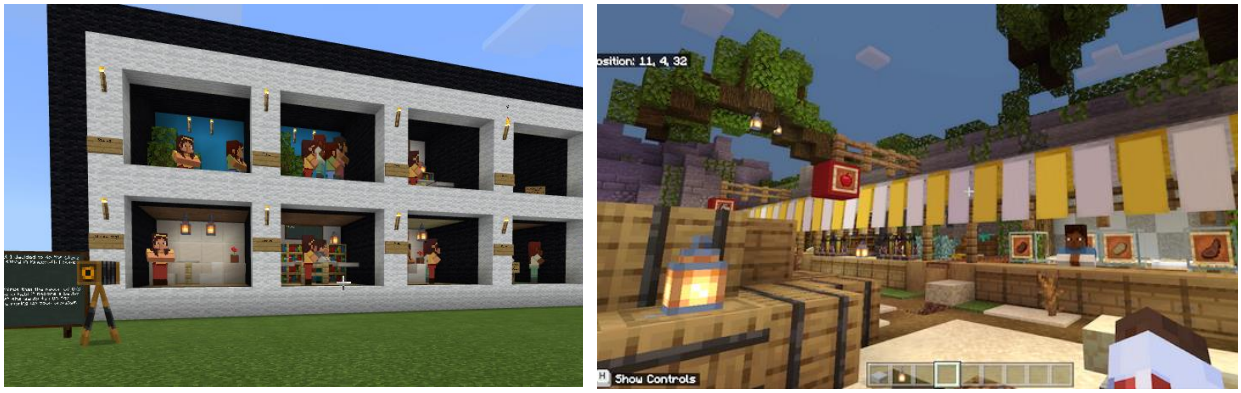
How Kate Uses Minecraft

Although Kate is relatively new to teaching with Minecraft, she integrates the game in many of her classes and plans to continue expanding her repertoire with the game. In line with her view of Minecraft as protean, she uses it to teach across the curriculum. These varied uses fall under three main categories: (1) readymade lessons from the Minecraft library for coding and computational thinking; (2) long-form build projects for social studies and religion; and (3) quick

collaborative build challenges as part of her Career and Technology Foundations class. During the interview, Kate shared her curricular designs and implementations of these last two uses. In the following paragraphs, I will elaborate on Kate's use of the game, the centrality of student construction in her teaching, and her assessment of student creations and presentations.

Kate uses Minecraft predominantly to teach social studies and religion, where she offers the game as an optional medium for student projects. In these projects, her students build representations individually or in teams, much like the traditional cardboard box diorama. The projects are long-form, elapsing 8-10 classroom periods. During the interview, Kate shared two projects from her grade six social studies teaching democracy and citizen participation. In the first example, Kate conducted a formative assessment to gauge her students' understanding of content about bylaw legislation and election processes in Canada. After noticing that the students had not grasped the material, she decided to allow them to engage with the material via a project. Rather than leading her students to review the sources Kate used and "parrot it back" (interview), she allowed them to seek out online sources and build representations of their understanding. One student created a world that invited visitors to play out the various steps of an election process, canvassing for and submitting a vote for a particular candidate (figure 10 left). Others represented municipal problems like dirty streets and designed solutions with NPCs explaining how legislation addressed the issue. In another example, students represented Athenian democracy and demonstrated their critique of the system and ways of improving it (figure 10 right).

Figure 10. A student built comic strip depicting an election process (left) and the Athenian agora as part of a student's representation and critique of Athenian democracy (right).



Secondly, Kate uses Minecraft for collaborative build challenges; activities inspired by the Minecraft build challenges accessible via the in-game lesson library. Unlike her use of the game as a medium for projects, these challenges are typically short form, running during a single classroom period. Kate implements these challenges as part of the Career and Technology Foundations (CTF) curriculum found in Alberta, Canada. The curriculum prioritizes planning, communicating, and collaboratively problem-solving. To her, Minecraft and the CTF program are "*a perfect match*" (website). In these activities, Kate provides her students with a simple prompt, like "*This week, your challenge is to work collaboratively on a team to design and build a Christmas tree with the theme of one of your science units*" (Website). In Kate's experience, these learning activities allow her students to work collaboratively in authentic ways, citing an instance where one of the Christmas trees in the game caught fire, and all the students came rushing in to put it out and explained how to fireproof structures in the game.

To assess student learning Kate focuses on student builds and their explanations during feedback sessions. Talking about the government project, Kate describes delight by her students' builds and engagement with the materials, despite the difficulty of working asynchronously from home. However, she recognized that some of the projects did not reflect a good understanding of the learning objectives. "*While the projects were amazing there was some of them that didn't meet the outcomes at all. Amazing builds but they really didn't cover content or the content was Americanized or there were aspects that were missing*" (Interview). Therefore, Kate decided to introduce multiple points of formative assessment into future build projects, to facilitate better content learning while students researched and built their representations. "*I thought if I could catch this earlier on in the process, then we can build on that*" (interview). Therefore, in her subsequent project, she introduced several check-ins and feedback sessions. Moreover, she positioned the Minecraft project, not as summative assessment after formal instruction, but rather as a continuous project with synchronous lessons spread in between the asynchronous builds at home.

How Kate Designs Learning Activities with Minecraft

Examining Kate's use of Minecraft in her Social Studies, Religion, and CTF teaching, several commonalities emerge in her game-based curricular design. These include: (1) No use of teacher-designed worlds; (2) placing students as world builders; and (3) designing clear outcome rubrics.

The first notable aspect of Kate's curricular design with Minecraft is her not building dedicated virtual worlds. For the project on local government described above, Kate had initially planned to adapt a template world and set the stage with an election scene. Ultimately, she chose

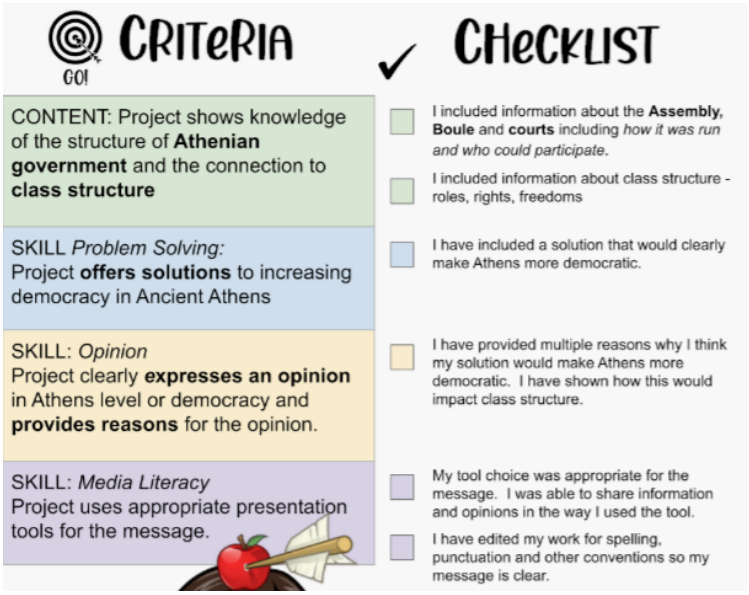
not to build the world, as “It felt like I was doing all the learning in collecting the information and deciding how to effectively showcase it in the world.” (Correspondence- 22/03/2022). In her view, brainstorming with students and supporting their ways of visualizing their learning is a powerful way to teach, and requires that students learn to produce their builds.

Secondly, Kate positions her students as world builders. Alongside the benefits of increased motivation, engagement, creativity, and collaboration, Kate notes two challenges in her experience. The first is coaching group projects and collaboration, “*I find that the trickiest parts of group projects are not the content and not you know the structures it's the: communication. With each other it's the problem solving it's including everybody's ideas*” (interview). The second is knowing which student contributed what and what each student learned "*Because the goal is to know whether or not you know the outcomes and I need to know that each individual knows the outcomes not the group*" (Interview). Kate explained that when she first started to use Minecraft, she was wary about students working in groups due to these two challenges. However, over time, she learned to overcome these by setting clear expectations and providing continuous feedback on student work.

Third, Kate sets up outcome rubrics and feedback sessions. She starts by identifying outcomes for a given unit, usually one main outcome that requires deep thinking and connections to other aspects of the unit. She then considers how students might demonstrate their learning and connects it to communication-based outcomes in the curriculum. Kate explains how in Social Studies she will often “pull one of our challenges pull one of our thinking outcomes too which really challenge the kids to find a way to share and defend opinions” (Correspondence 23/03/2022). Once she creates the rubric, she introduces it to her students at the start of the unit.

Then, through brainstorming, Kate and her students pick apart the outcome and create a checklist – a set of bullet points that cover the outcome criteria. The class revisits the rubric and checklist (figure 11) throughout the unit, at the beginning of each session, during formative feedback sessions, and eventually when for assessment. *"Essentially, the process is build rubric, collaborate with students to build checklist from rubric, use checklist to set goals for building during class, use checklist for formative assessment in all conferences, peer and self-assessment and finally, use rubric for summative assessment."* (Correspondence 23/03/2022). The co-design of the checklist by Kate and her students provides the expectations for student builds and learning before, during, and after the gaming activities.

Figure 11. Outcome rubrics and checklist for a long-form build project on Athenian Democracy.



Summary of Kate

Kate views Minecraft as a unique educational tool that allows her to teach across the curriculum and gives her students an outlet to demonstrate their learning creatively. Moreover,

she values its affordances as a collaborative environment for short-form and long-form learning activities. The central motif of Kate's use of Minecraft is positioning her students as the creators of a virtual world and representations of their learning and thinking. Kate creates and implements original learning activities with the game in a co-designer role (McKenney et al., 2015). However, she does not produce game assets in the way of world-building. Rather, her curricular design work centers on identifying target learning outcomes for a given unit and then brainstorming with her students a set of clear outcome expectations to guide their Minecraft builds and assessment cycles. In this co-design process, Kate uses her curricular expertise when drawing outcomes from standards, while allowing her students to bring forth their understanding, interests, and ability to demonstrate their learning in the game.

Miles

Miles' Background

Miles is an elementary school teacher from Canada who has been in the profession for 20 years. He teaches language arts, math, science, social studies, French, art, and health. His journey with Minecraft as a teaching tool started seven years ago when his school principal asked him to try the game with his students. Up until that point, he had only seen his son playing Minecraft on his computer and thought that it was terrible. However, once he started to use Minecraftedu with his students he learned a lot from them and started seeing the potential in this game. Now a leading Minecraft teacher, Miles serves as a Minecraft mentor in his school division (district) and collaborates with another leading teacher to support other teachers in adopting the game.

How Miles Views Minecraft

- Minecraft increases the motivation and engagement of my students.

- Minecraft affords collaboration and communication between my students.
- Minecraft is a powerful way for students to demonstrate their learning.
- Minecraft allows certain students shine in their builds and leadership.

Miles sees Minecraft positively and raised a number of affordances that make it a powerful teaching tool. First, he views Minecraft as an engaging modality and a way to tap into students' strengths. Reflecting on teaching the same curricula with and without Minecraft, he recalls that students would get bored in history or social studies, but once he got them into a Minecraft world "*They loved it*" (Interview). Second, Miles explains that Minecraft clearly engenders collaboration and communication amongst his students. "*I was hearing sharing of ideas, I was hearing collaboration right all the stuff that we want in our in our classrooms to be*" (Interview). He attributes this collaboration to the need to work as a community when creating a shared virtual environment. Moreover, while disagreements do occur in his collaborative activities, Miles treats these as teachable moments about respect and working together.

Third, throughout the interview, Miles stressed Minecraft as a tool that allows students to demonstrate their thinking and learning. While critiquing a lesson plan, he thought aloud "Experience or explore and collaborate, which I like to see in there and then the big one for me is demonstrate because that's what Minecraft is all about is a demonstration of your learning…"(Interview). Fourth, while Miles views the game as engaging and empowering to students in general, he also points out that some students shine with it. In his view, some students can express themselves well with a modality like art, but for others Minecraft serves as such a medium and not having the game would rob them of that experience. Moreover, he observed that during gameplay sessions, strong players might show up as leaders, and students who might

otherwise be quite in class will join the discussion and sometimes even be the leaders themselves.

How Miles Uses Minecraft

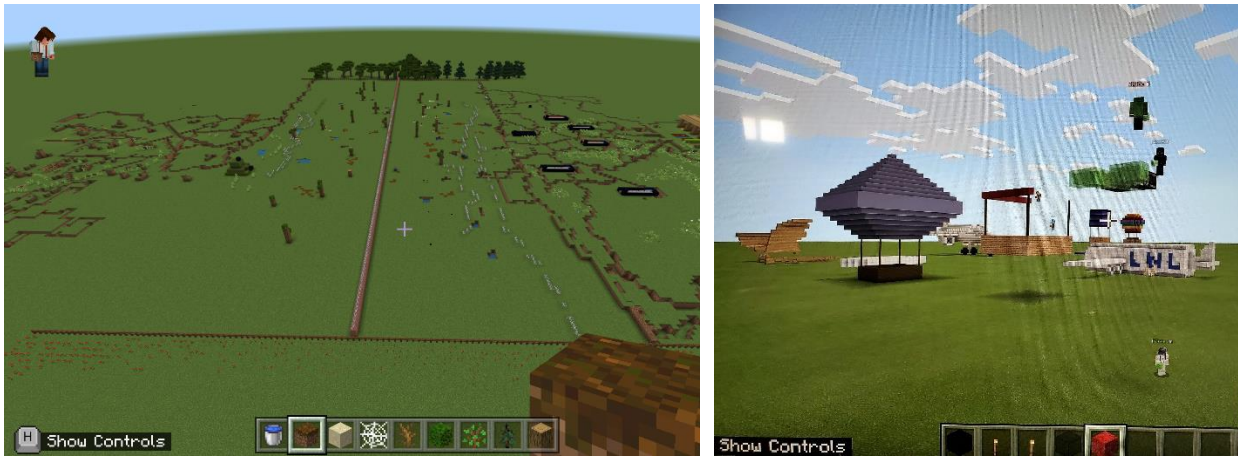
Miles uses Minecraft during the school year to teach different subjects, primarily Science and Social Studies. His activities with the game fall under three main categories: (1) short-form build challenges; (2) a yearlong Social Studies portfolio for his classroom; and (3) long-form use of a world and lessons he designed with multiple stakeholders. The first two categories represent his preferred and main use of the game, as a blank canvass that allows for collaborative representations of learning. Moreover, they follow logically from his views on the game as a tool for students to demonstrate their learning and as a collaborative platform. In contrast, the third use represents a different learning experience, a carefully curated virtual world with prescribed activities and lessons. This third use is a unique design case, which I will expand on later when discussing how Miles designs curricular materials for teaching with Minecraft.

Short-Form Build Challenges

In line with his view that Minecraft is primarily a tool to allow students to demonstrate their thinking and learning, Miles prefers to treat the game as an blank canvass for his studens. Therefore, he tends to initiate Minecraft gameplay with a template world called "Blocks of Grass" - a flat environment that allows students to build from scratch. "*I always like to use the blocks of grass world because blocks of grass is an open canvas*" (Interview). Applying this open canvass in short-form, three to four times a year Miles asks students to demonstrate what they have learned at the end of a unit within a 45-minute build challenge (figure 12 left). For

example, during remote learning in Science, he taught his students about flight. The students built a flying vehicle that had to carry a payload and document their design and what they had learned. Miles reflects on how teaching this subject and having students complete the project remotely was not productive for some of his students, and he struggled to assess what they had learned. Therefore, he had them complete a 45-minute build challenge "*that shows me something you picked up in our flight unit these last few weeks*" (Interview). Each student built a model of a plane, space shuttle, or hot air balloon (figure 12 right) and explained what they had learned about it.

Figure 12. a 45-minute builds collaborative recreation of trench-warfare at the end of a Social Studies unit on WW1 (left) and a build challenge at the end of a Science unit on flight (right).



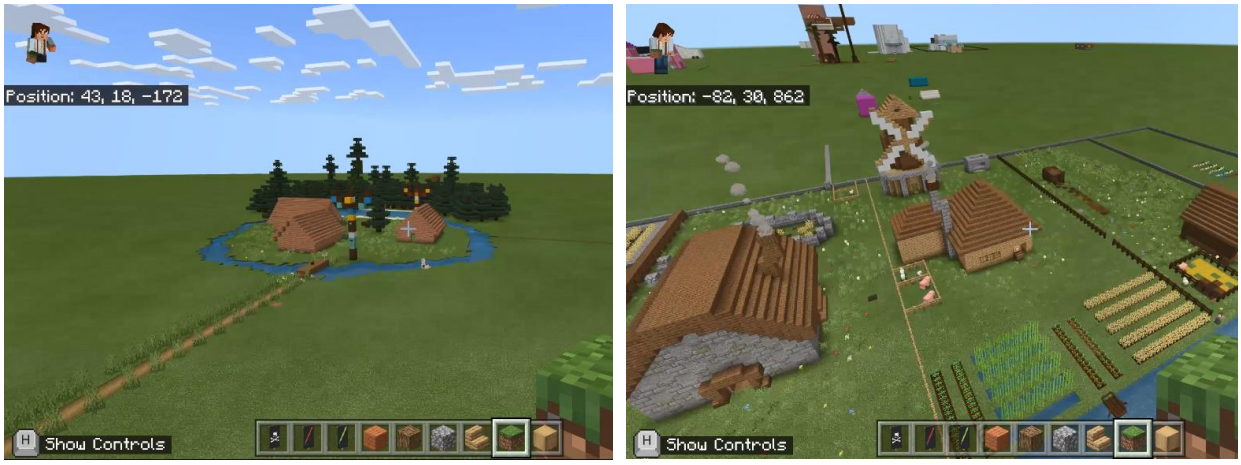
Social Studies portfolio

Extending this open canvass view to long-form learning activities, Miles also uses the game for multi-lesson projects wherein his students collaboratively build constructions concerning the curriculum. In fact, in his fifth grade Social Studies teaching, Miles will use an initial Blocks of Grass world as a yearlong portfolio where students construct representations of the various units. Miles uses these predominantly as inquiry-based learning activities. It is in this

use of Minecraft that Miles's full view of the game as a teaching tool manifests. He notes that the addition of the game to his traditional activities and media such as lectures, videos and textbooks motivates his students and keeps them engaged. Building representations while going through Social Studies units, allows his students to continuously demonstrate their understanding and make concrete representations of the material. Minecraft serves as a collaborative environment as the students work in groups over the course of multiple several weeks. Moreover, these multi-session activities let students with competence and confidence in their Minecraft skills to increase in their classroom participation and in some cases to lead group work.

At the start of the portfolio, Miles was teaching a unit on the First Peoples of North America. He asked students to go into teams of 4-5 and choose an indigenous nation. The student teams then researched their indigenous nations' names, habitats, way of life, and governance. Finally, the teams built representations of their group (figure 13 left) while using game materials analogous to those used in the real-world and placing in-game chalkboards with information about their findings. Moving from the First Peoples unit to a unit on colonialism in Canada, and specifically Nouvelle-France (New France). Here Miles guided his students as they built a colony with the characteristics of the Seigneurial system, a form of feudalism found in the overwhelming majority of rural areas in New France in the 17th and 18th centuries (figure 13 right). Although this unit took place remotely, the students were highly motivated and engaged. Over the course of two weeks, they worked in teams to construct the colony while Miles monitored their progress in the game, and conducted discussions on an online meeting.

Figure 13. A habitat built by a team of students representing an Indigenous nation (left) and a model of a New France colony depicting the Seigneurial system (right).



To assess student learning with the game, Miles uses for indicators of learning his outcome rubric to focus on student research of the topic, explanations of choices for demonstration, their final Minecraft builds, and collaboration. These indicators include behaviors inside as well as outside of the game. For example, for the First People's project, Miles looked at whether students researched and explained the habitat and ways of living of their chosen indigenous nation. In examining the builds, Miles also paid attention to students' choice of Minecraft materials to portray the Indigenous habitat realistically "*Proper materials used to recreate indigenous groups habitat and lifestyle. (i.e. Grasses and wood blocks…no metals and special materials)*" (First Peoples Project Plan). Finally, Miles listened into the student teams and examines the final builds to check that the students work together while respecting each other's input. Miles explains his students' creations in the New France project as a demonstration of their learning in the virtual environment: "as a teacher, I can come in here and say okay yeah they get it. Here's the long narrow strips (lots of land) and there's the windmill (the seignior's

home) and I can see the corn, I can see the wheat, which were the main staples of what they were trying to grow…"(Interview).

Long-form curriculum

Outside his use of Minecraft for short-form challenges and long-form build projects, Miles also implements long-form, multi-session lessons with the game in a curriculum named Manito Ahbee Aki. These lessons differ qualitatively from in Miles's other two game uses. First, the Minecraft world is not a blank canvas. Instead, the lessons take place in a dedicated world, a carefully curated stage, with designated areas for activities and interactions. Secondly, while students do sporadically engage in building, the students perform a myriad of other in-game activities such as exploring the world, interacting with NPCs, and crafting items central to the Indigenous way of life. Third, contrary to the demonstration of learning through construction, the lessons prescribe other modes of documentation and sharing. As students explore and interact with the virtual world, they are encouraged to document their noticing and learning using the Camera and Portfolio items, reflecting on their adventure. Moreover, worksheets with guiding questions prompt and capturing student learning. In similar fashion to Miles's other use of Minecraft, discussions take place before and after gameplay sessions.

How Miles Prepares and Designs Learning Activities with Minecraft

Dovetailing with his distinct uses of Minecraft, Miles shared two divergent approaches to curricular design with the game. The first approach is not building a dedicated world and coming up with clear outcome rubrics that position students to work collaboratively to research a topic and create representations in the game to address learning goals. The second approach involves a

long period of co-designing with another teacher, indigenous knowledge keepers, and developers in the Microsoft Minecraft Education team.

When planning collaborative projects such as the Social Studies portfolio, Miles engages in curricular co-design quite similar to Kate. First, he does not design a dedicated Minecraft world with scripted interactions or tasks. He uses his preferred open canvas, the Blocks-of-Grass template world. Second, Miles defines outcome and assessment rubrics for student research, Minecraft builds, and in-game collaboration. Third, he positions the students as collaborative builders of their representations. Miles starts his long-form projects by presenting the outcome rubrics and ideas to his students and talking to them about the feasibility of demonstrating their learning in such a way. Miles frames this as a form of co-design between himself and his students. During the interview and in subsequent correspondence, Miles addressed this co-design relationship as follows "*I always say I'm the brain trust and they are the magic. I come up with the ideas to demonstrate the learning and discuss it with the students to see if it's possible in Minecraft"* (Correspondence 25/03/2022).

The second curricular design approach that Miles shared manifests in the Manito Ahbee Aki lessons developed to teach about the heritage of the Anishinaabe people and their life in pre-colonial days. These learning activities and resources are noteworthy in their final design and the co-design process that led to their publication. The co-design of these lessons was a joint project between Miles, a fellow expert Minecraft teacher, indigenous knowledge keepers, and members of the Minecraft Education team. Miles and his collegue interviewed the knowledge keepers and synthesized their stories into chunks that fit within the Minecraft world. They then scripted a series of learning activities and texts to be embedded within the game. The activities included

exploring the world, interacting with NPCs, gathering resources, crafting items, and building specific structures. Relaying these ideas to the Minecraft Education team, the Minecraft developers built a dedicated world with custom-made the NPCs. The NPCs, based on the knowledge keepers, inform the students and guide them through the activities (figure 14 left and right). Moreover, videos of the knowledge keepers accompany the curriculum, allowing students to learn from the real world version of the characters with whom they interact in the game. The co-design team worked iteratively, with the two teachers testing the world and its activities with their classes and sending feedback to the Minecraft team.

Figure 14. NPCs representing guides and knowledge keepers (left); and NPC guiding the player through the final activity of Manito Ahbee Aki, the bison hunt (right).

Summary of Miles

Miles views Minecraft as a creative modality that allows his students to work collaboratively and demonstrate their thinking and learning. To him, the sandbox game offers many students a medium for engagement, expression, and leadership in a way that traditional activities and media do not. He uses the game regularly in his teaching practice, albeit in three distinct ways. His preferred uses are as blank canvasses, allowing students to demonstrate their learning either in a quick 45-minute build challenge or often within multi-session projects that

compile into a Social Studies yearlong portfolio. These uses flow logically from his views of the game as an environment wherein students can collaborate and demonstrate their learning in a way complementary to instructional activities such as role-playing and presentations.

To prepare for these game-based learning activities, Miles takes up the role of co-designer (Cviko et al., 2014), selecting and framing outcomes and assessment rubrics. These include clear standard-based learning objectives on what students should research, build, and collaborate on. He shares his design process with his students by allowing them a say regarding the feasibility of demonstrating their learning with the game and positioning them as builders within the open world. However, Miles also uses Minecraft in a qualitatively different way when teaching about the indigenous peoples of Canada. He uses lessons that position students not as builders in a virtual world but as explorers and learners participating in a prescribed set of activities within a carefully designed virtual world. The process of creating the Manito Ahbee Aki curriculum captures a unique opportunity for teachers and game publishers to engage in co-design. In this way, teachers can bring their expertise in teaching with the game, curate content receive custom-designed game assets, and iterate on the entire process with student feedback.

Cross-Case Comparison and Discussion

Views of Minecraft as a Teaching Tool

All three teachers had positive perceptions of Minecraft as a powerful teaching tool. Looking closely, the teachers shared two views, that Minecraft increases student engagement and motivation and acts as an environment that engenders collaboration and communication within and around the game. These two affordances echo common arguments and findings from the game-based learning literature (Klopfer et al., 2009; Wouters et al., 2013). A point of similarity

and divergence lied in the views of Minecraft as a malleable tool. Seymour Papert in his book "*Mindstorms"* talked of the computer as a protean tool, *"Because it can take on a thousand forms and can serve a thousand functions, it can appeal to a thousand tastes."* (Papert, 1980). Papert, primarily talked of this shapeshifting capability in the context of learners being able to connect emotionally and cognitively with the computer and what it simulated or represented. Kate and Miles share a view of Minecraft as a tool that empowers their students to demonstrate their thinking and learning. That is, the video game serves as a malleable tool in the hands of learners. In contrast, while Jake provides his students with opportunities to build Minecraft, his view of the game suggests that the game is actually a creative tool for him to create environments and experiences for his students. These two views suggest that Minecraft can serve as a protean tool in the hands of students and of teachers.

Use of Minecraft in Teaching Practices

The three teachers all used Minecraft regularly as a teaching tool throughout the year. This finding strongly suggests that they benefit from the game and successfully made it part of their teaching practice. This echoes the results of my earlier survey study of 92 K-12 Minecraft using teachers (study 2), where the majority of participants indicated a regular use of the game. Beyond the regularity of Minecraft use, the current study provides a rich description of the different learning activities that teachers designed and implemented with the immersive interactive and commercial digital game (Eck, 2009; Stieler-hunt & Jones, 2019). Prior work on game-based teaching has shown that most teachers who use digital games integrate drill & practice games for single class activities (Richards et al., 2013; Takeuchi & Vaala, 2014). The current study shows that the teachers used Minecraft in several ways, predominantly for long-

form activities with durations ranging from several weeks to months, but also for short-form build challenges.

Considering the three teachers' pedagogical activities we see patterns that support but expand prior reports on how teachers conduct the game-based learning process. Prior work has mostly discussed teachers activities before during and after the gaming sessions (Bado, 2019; Kangas et al., 2016; Nousiainen et al., 2018; Taylor et al., 2012). The teachers in the current study, especially in their long-form projects, illustrate how these pedagogical activities stretch well beyond the single gaming session. In terms of planning, the teachers prepare both gaming and non-gaming activities that will complement each other, such as Jake's text annotations and post gameplay writing activities. I elaborate on planning and design in the next section. In terms of orientation, we see differences between the teachers. Jake provides an overall orientation in the form of a yearlong narrative about chasing the time bandit throughout Minecraft and across the eras in their curricula. Moreover, Jake prescribes the expectations to his students based on his design of the dedicated world and learning goals around history and literacy. In contrast, Kate and Miles share their planning and orientation processes with their students. That is, they come up with an initial outcome rubric, but brainstorm with their students about operationalizing it into a checklist of expected outcomes in their collaboration, research, and Minecraft builds. The teachers then use this negotiated set of outcomes throughout the long-form project to orient the students, setting and revisiting expectations.

Playing, the category of teacher activities during the gameplay session (Kangas et al., 2016) was not referred to significantly in the current study. This probably stems from my choice to focus on the expert teacher's curricular design as well as methodologically, not being present

during classroom implementations. Prior case study work has detailed the minutia of teacher roles, activities and practicalities during gameplay sessions (Hanghøj & Brund, 2018; Marklund & Taylor, 2016; Taylor et al., 2012). However, three playing activities came up during the interview, monitoring, and co-construction. All three teachers mentioned monitoring student gameplay, noticing student work, understanding and collaboration. Monitoring collaboration was mentioned by Kate and Miles, which is logical giving their explicit outcome rubrics for collaboration skills. Jake mentioned co-construction, an activity wherein he helped students to construct complex structures, such as in the round city of Baghdad world.

In terms of elaboration – debriefing after gameplay and assessment- the three teachers showed several patterns, some similar and some different. All three teachers talked about students presenting their creations when building was involved. This included walking through the builds as Jake and Miles' students did, as well as presentations via online means as in Kate's case. Moreover, rather than a single discussion as the end of a gameplay session, the three teachers seem to conduct discussion and other non-gaming instructional activities throughout their long-form learning. Finally, we see clear differences in what and how the teachers' assess student learning with Minecraft. Jake focuses entirely on his students' writing as the measure of their learning. This use of creative writing as an assessment is unique, considering that prior work has mostly cited assessment based on gameplay, student discussions, built-in assessment, tests and quizzes (Takeuchi & Vaala, 2014; Torrente et al., 2009). Kate and Miles focus on student gameplay and discourse as measures of their collaboration. Additionally, they look at student and team builds and students' explanations of those builds as measures of content learning. It is beyond the scope of this study to identify what the source of these differences are.

Possible explanations are the differences between the Canadian elementary school curricular requirements of Miles and Kate versus the US middle history curricular requirements of Jake.

Curricular design with Minecraft Education Edition

The focus of this study is the curricular design of three teachers with expertise in teaching with Minecraft. Of the various pedagogical activities that teachers enact in game-based learning, planning is the least reported on, with most studies looking at teachers implementing readymade curricula (Bell & Gresalfi, 2017; Peddycord-liu et al., 2019; Wilson et al., 2018). The current study sheds light on several curricular design processes with Minecraft. Although Kate mentioned enacting readymade programming lessons, the three teachers overwhelmingly shared co-design approaches to lesson planning with Minecraft (Cviko et al., 2014). However, these co-design processes differed in the main features of the learning activities and in terms of whom with the teachers collaborated.

Using the taxonomy from study 1 to understand the different lesson plans, we see the main variations running along the World Builder, NPCs, and Student as Builder design dimensions (Bar-El & Ringland, 2021). All of Jake's lessons and Miles' Manito Ahbee Aki curriculum show a dedicated virtual world setting the stage for the students. In contrast, most of Mile's and Kate's lessons do not include world building. Given that Kate does not build dedicated worlds, she does not use NPCs. Jake and Miles however, do use NPCs in their dedicated worlds. These NPCs perform all four functions identified in study 1, providing context for immersiveness, giving instructions about tasks, giving information pertinent to particular content in the virtual world, and executing functions such as teleporting students around (Bar-El

& Ringland, 2021). Whether students at as builders or perform other activities in the Minecraft world differed across the lessons. In all of Kate's and most of Miles' curricular, students were primarily builders of representations of their learning. In most of Jake's lessons, students were not building in the world. Instead, they would explore, interact with, and write about a world built ahead of time by Jake and sometimes by his team of student builders.

The three cases offer three approaches to co-designing curricular materials with the game. The first is independently developing lesson plans and curricular materials, as is exhibited in Jake's lesson on the Chinese Tang Dynasty. The second is co-designing with one's students. All three teachers exhibited this approach in different ways. Jake by working with a team of student builders to construct complex Minecraft worlds with structures and NPCs that organize learning activities for other students. Kate and Miles by brainstorming and negotiating outcomes for long-form build projects. Finally, the Manito Ahbee Aki curriculum presents a unique opportunity for teachers to collaborate with multiple stakeholders including the game publisher. Miles and his colleague worked for 14 months with indigenous knowledge keepers and members of the Minecraft Education Edition team to plan and iterate on a curriculum.

Limitations and Future Research

The central limitation of this study is the reliance on a small and purposeful sample of three teachers with expertise in teaching with Minecraft. Future research should compare the views, use, and curricular design of novices and experts. A second limitation of this study is the lack of documentation of the teachers' design process over time. The analysis of curricular design was conducted retrospectively through interview data in tandem with other data sources. Future research should examine the process of how teachers design curricula with Minecraft

Education Edition and other digital sandbox games. Such research could uncover in real time the design choices, issues, and iterations that lead to teaching with sandbox games.

Chapter 7. Dissertation Discussion and Conclusion

Overview

This chapter takes the work from across the three studies (chapters 4-6), synthesizing their contributions to theory and implications for practice. Across three studies, I investigated K-12 teachers' real-world use, curricular design, and challenges with Minecraft Education Edition as a teaching tool. As delineated in the methods chapter (chapter 3), these studies examined this phenomenon with different data sources and analytical approaches. In this closing chapter, I bring together the key findings from all three studies, making explicit their contribution to knowledge and practice in light of prior work (chapter 2). The chapter begins by restating the research questions set in the introduction (chapter 1) and briefly describing the work pursued to answer them. What follows is a synthesis of findings from the dissertation in answering the driving research questions. I then elaborate on the theoretical and practical implications of these findings. Finally, I discuss the limitations of this work. I suggest future work throughout these last two sections to build on the dissertation's findings and address limitations.

Review of the Research Program

This three-paper dissertation aimed to understand how K-12 teachers integrate a digital sandbox game into formal teaching practice. To pursue these goals, I focused on the real-world case of Minecraft Education Edition, a commercial digital sandbox game with an active global community of teachers. Specifically, the dissertation asked the following three high-level questions**:**

When K-12 teachers integrate a commercial digital sandbox game as a teaching tool

RQ1. What learning activities do they create?

RQ2. What challenges do they face?

RQ3. How do they design their lesson plans and curricular materials?"

To answer these questions, I developed and conducted three separate studies iteratively while drawing on different data sources and analytical methods. In study 1, I examined a corpus of 627 publicly available lesson plans found on the Minecraft Education Edition website in March of 2020. Using quantitative methods, I summarized the descriptive statistics regarding the lessons as available on the website, which included target student age, subject, and skills. Moreover, by looking at the distribution of lessons uploaded by each contributor to the website, I identified a subset of 16 teachers who were the most prolific "power users". I then analyzed 159 lessons plans uploaded by these 16 teachers to uncover design patterns and variations to describe what kinds of learning activities teachers create for the sandbox game.

In study 2, I moved to collect and analyze primary data about teachers' use and experiences with Minecraft Education Edition. Ninety-two classroom teachers from around the world responded to an online survey. The survey included closed-ended and open-ended items touching on several topics including the frequency of Minecraft use, ways of sourcing curricular materials, and barriers to integrating Minecraft and digital games into classroom practice. I used quantitative analysis methods to report on the teachers' use patterns. Moreover, a thematic analysis of two open-ended questions allowed me to surface challenges that teachers experience in their integration of Minecraft Education Edition into their teaching. Finally, in study 3, I

conducted qualitative interviews with seven teachers with expertise in teaching Minecraft Education Edition. Taking a case study approach, I narrowed my analysis to three focal teachers and examined how they viewed, used, and designed curricula for the sandbox game. This included triangulating multiple data sources including the interview data, curricular materials, teacher websites, and secondary audio-visual content.

Summary of Findings

In this section, I review the findings from the three studies and synthesize them to answer the three driving research questions.

The learning Activities that Teachers Create with Minecraft Education Edition

Instruction books for teachers on the use of Minecraft for education and prior research provide examples of uses of Minecraft across subject areas (Dikkers, 2015; Gallagher, 2014; Nebel et al., 2016). In studies 1 and 2, results from hundreds of K-12 teachers show that many create lessons with Minecraft to address a range of subject matter. Nonetheless, the findings of studies 1 and 3 revealed that learning activities with the game vary. These variations represent different ways in which teachers use the affordances of the sandbox game and arrange the socio-technical environment. Study 1 identified seven design dimensions, which serve as a taxonomy to describe these lesson design variations. Moreover, study 1 outlined four categories of lessons based on combinations of these design dimensions: *stations*, *expeditions*, *individual builds*, and *team builds*. Study 3 expanded on this taxonomy and revealed additional potential dimensions of variation in learning with Minecraft. First, Miles' use of Minecraft as a yearlong portfolio is an extension of the team build lesson category. It reveals an important dimension, which was not explicit in the data from study 1. That is, the time frame of a particular set of learning activities.

While immersive interactive digital games lend themselves to long-form learning activities (Stieler-hunt & Jones, 2019; Takeuchi & Vaala, 2014), it is the teachers' design choice whether to implement single lesson activities or use digital sandbox games over the course of multiple classroom periods.

Second, the Manito Ahbee Aki curriculum that Miles co-designed represents a large virtual world that encompasses multiple lesson types. Third, Jake's curriculum on the history of Vikings does not fit neatly into any of the four lesson categories from study 1. In an earlier draft of study 1, I proposed a lesson category "a game within a game" where the learning activity is solely contained within the sandbox game without interactions with external media (Bar-El & Ringland, 2020). The Viking curriculum challenges my initial conceptualization of this category. It includes defined scripted role-playing activities within the game placed in between periods of reading, annotating and writing texts. Future research should further examine the variations in teachers' lesson design with sandbox games to refine and expand on the taxonomy offered in this dissertation.

The Challenges of Integrating Minecraft Education Edition into Classroom Practice

As stated in the literature review (chapter 2), empirical work has consistently shown that teachers perceive and experience a multitude of barriers to integrating emerging technologies such as digital games (Baek, 2008; Takeuchi & Vaala, 2014; Torrente et al., 2010; Watson et al., 2008). Most of these prior studies sampled teachers who either were not adopters of digital games, or used drill & practice games. Study 2 sampled K-12 teachers who are highly engaged in using an immersive interactive digital sandbox game. The findings echo and strengthen prior results by Marklund and Taylor (2016). Namely, that when teachers bring an immersive digital

sandbox game like Minecraft into the classroom they have to contend with many technical difficulties and pedagogical requirements. The pedagogical challenges included a need to keep students on task, facilitating collaborative work, mediating conflicts, and supporting students with different levels of expertise and or interest in Minecraft. In study 3, the teachers discussed these pedagogical challenges as opportunities and offered their ways of dealing with them. Kate and Miles discussed setting collaboration and conflict mediation as assessed outcomes and therefore set an expectation in their classrooms of these aspects being an integral part of the learning process. Jake addressed the diversity of student expertise with Minecraft by planning and building ways for students to engage at different levels based on their skills with the game. Moreover, study 2 surfaced a challenge regarding the sourcing of curricular materials. That is, teachers who use Minecraft regularly as a teaching tool, nonetheless report it challenging to find lesson plans or designing curricular materials for the sandbox game.

Curricular Design with Minecraft Education Edition

Data from studies 2 and 3 showed that experienced Minecraft teachers predominantly take a co-designer role (McKenney et al., 2015), creating their original curricular materials. While I could not obtain the teachers design reasoning in study 1, the seven dimensions hint at potential design choices that teachers make during curricular design with the sandbox game. Moreover, the focal teachers in study 3 allow us to understand some of the reasoning behind how and why teachers design different learning activities. A central finding design choice and variation that came up in studies 1 and 3, is whether the teachers or the students use the sandbox game a creative platform. Jake shared a clear preference for the former. As a designer of experiences for his students, he took it upon himself to set the stage for his students' history and

literacy learning in carefully curated virtual worlds. Kate and Miles on the other hand expressed a clear preference for using the sandbox game as a blank canvas with which their students can build representations of their learning.

A second key finding regarding curricular design with Minecraft was that teachers shared different approaches to co-design in study 3. Curricular co-design is a process that typically takes place in teams of teachers (Cviko et al., 2014; Penuel, Gallagher, et al., 2009). The three focal teachers shared four approaches to co-design with the sandbox game. These were: (1) independent co-design, (2) co-design with another teacher, (3) co-design with students, and (4) co-design with teachers, content experts, and game publishers. Future research should explore the design process, challenges and benefits of each of these co-design approaches. Moreover, researchers and practitioners ought to seek ways to promote these co-design processes as a way to overcome challenges related to sourcing curricular materials with sandbox games.

Knowledge Contributions

The work presented in this dissertation contributes to both the theory and practice of teaching with digital sandbox games.

Theoretical Implications

At the theoretical level, this work makes the following contributions:

- A grounded state-of-the-art description of the ways in which teachers use Minecraft Education Edition, a popular educational sandbox game as a teaching tool. This description provides a "nuanced view of reality" (Flyvbjerg, 2006) about teacher practice and curricular design with digital games. This account extends the game-based learning

field, an area that is saturated with theoretical arguments about the innate educational value of games, and lacks studies on the practicalities of teaching with digital games (Egenfeldt-nielsen, 2006; Marklund, 2014).

- A taxonomy of design dimensions along which we can categorize and understand teacher-designed lessons with the sandbox game. By qualitatively analyzing 159 lesson plans, I provide a foundational categorization of variations in lesson designs with Minecraft and demonstrate how teachers arrange the socio-technical environment to accommodate different ways of learning with the game.
- A set of common challenges to the integration of Minecraft Education Edition in K-12 classroom practice, based on the experiences of regular adopters of the digital game. The literature on game-based learning and teachers' technology adoption has identified and often cites multiple barriers to the integration of digital games (Baek, 2008; Watson et al., 2008). While these barriers play some role in explaining teachers' use of digital games or lack thereof, they do not necessarily explain the challenges and practicalities that teachers face once integrating games or a particular game.
- A thick description (Geertz, 1973) of different teacher views and practices in terms of curricular design and implementation of learning activities with the sandbox game. This rich description allows me to contribute to current models of pedagogical activities that teachers play as part of teaching with digital games (Kangas et al., 2016; Marklund & Taylor, 2016; Taylor et al., 2012). In particular, I demonstrate how teachers act as designers of technology-enhanced learning (Mckenney et al., 2015); I capture how

teachers co-design curricular materials, develop virtual worlds, and direct learners through activities both inside the game and outside.

Practical Implications

The findings of this dissertation draw from the real-world practices of K-12 teachers who use Minecraft Education Edition as a teaching tool. It is my hope and a token of my gratitude to the many teachers who shared their experiences with me, that the findings of this dissertation support future practice. Specifically, the findings inform future practice in the following ways:

- Teachers, who are novices to the use of Minecraft or similar digital sandbox games, can draw on the examples found in this dissertation to inspire and inform their first steps in teaching with such digital games. Teachers may want to start by enacting readymade lessons and examining their designs in light of the provided taxonomy. They then may move to redesign or co-design original lesson plans including dedicated virtual worlds to support their teaching.
- Teacher educators can draw on the descriptions of what expert Minecraft teachers know and do to inform their professional development goals. This includes understanding what lesson planning with the game entails, concerns for classroom management, and different approaches to assessing student learning.
- School leadership and policymakers may find in this work information to support and scale efforts to teach with digital games. For example, throughout the dissertation, the labor intensiveness of sourcing content for teaching with a commercial sandbox game came up. This includes for example designing dedicated virtual worlds that set the stage and host student-learning activities. The findings should inform policies that promote

collaborations between teacher teams and or teacher-student teams to offload the time and effort of sourcing content. Moreover, teachers should be recognized and rewarded for their contributions in this vein.

- Game publishers may draw on these findings to understand and respond to their users' needs. Teachers are the agents that integrate digital games into K-12 classroom practice. This dissertation highlights the labor that teachers put toward adapting and developing curricular materials for Minecraft Education Edition. This labor deserves the attention of game publishers such as Microsoft. This is in terms of cultivating a community of practice and in terms of recognizing and rewarding teachers for their work in developing content for the game.

Limitations

A central limitation of the dissertation is the sampling of teachers with expertise in teaching with Minecraft Education Edition. This sampling was purposeful (Miles et al., 2014) as I intended to explore the real-world use, challenges, and curricular design of teachers who use the game. While this sampling gave me access to a community of teachers who use Minecraft, it limits the generalizability of the findings to teachers with expertise with the game. It is likely that the experiences of teachers in their early stages of adopting Minecraft are somewhat different from those of experts with several years of experience. This limitation is likely most relevant in terms of curricular design. Research on teachers' lesson planning has established that experts and novices often differ in their lesson planning processes and skills (Munthe et al., 2017). Given that, studies 1 and 3 examined the lesson plans of 16 power users and 3 experts respectively, it is possible that the lesson plans of novice teachers would be different, adding to the diversity found

in this dissertation. Concerning challenges to integrating Minecraft, prior research on novice teachers and college students learning to use Minecraft Education Edition found a number of challenges in common with to those reported on in study 2. Namely, technical challenges, dealing with a mixed ability classroom, and the time needed to make lessons (Marklund & Taylor, 2016; Mccolgan et al., 2016). However, it is certainly conceivable that a larger sample of newcomers to Minecraft would uncover a set of new challenges related to learning how to use the game.

A second limitation of this dissertation is the lack of classroom observations. Due to the inability to enter classroom during the COVID-19 pandemic (Viner et al., 2020) and my decision to focus on teachers' experiences. The scope of this dissertation is therefore limited when it comes to the experiences educational impact on the students and the student experience in learning with Minecraft Education Edition. Studies 2 and 3 provide support for the argument that Minecraft supports teaching and learning, given the teacher's positive experiences, extensive use, and reported student outcomes. However, future empirical work should examine the relationship between different learning activities, and teacher practices with a digital sandbox game on student learning.

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9. Appendices

Appendix A – Teacher Questionnaire (study 2)

Demographics

First, we will ask you several questions about your background and the school you work in.

1) What is your age?
2) What is the highest level of school you have completed or the highest degree you have received?
    a. Less than high school.
    b. High school graduate.
    c. Associate's degree (2-year).
    d. Bachelor's degree.
    e. Master's degree.
    f. Doctoral degree.
3) What is your gender
    a. Female.
    b. Male.
    c. Other.
4) Which of the following BEST describes your CURRENT position?
    a. K-12 classroom teacher.
    b. Informal educator (museum, youth club, etc.).
    c. Librarian.

d. Classroom assistant teacher/ Classroom aid.

e. Administrator / School leadership.

f. Student or pre-service teacher.

g. Higher education faculty.

h. Home school teacher.

i. Other (please specify).

5) Which of the following BEST describes your classroom teaching position?

a. Subject matter teacher, e.g., I teach stand-alone classes in math, science, history, etc.

b. Self-contained classroom teacher, I teach all subjects (Generalist).

c. Self-contained classroom teacher, but I switch classes with another teacher for some subjects (including team teaching).

6) Which grade level(s) do you CURRENTLY teach? Please check ALL that apply.

a. K

b. 1

c. 2

d. 3

e. 4

f. 5

g. 6

h. 7

i. 8

j. 9

k. 10

l. 11

m. 12

n. Adults

7) Which subject(s) do you CURRENTLY teach? Please select ALL that apply.

a. Native language (e.g. English language arts).

b. Foreign / Second language.

c. Mathematics.

d. Computer Science.

e. Science.

f. History/Social Studies.

g. Arts.

h. Other (please specify).

8) Do you have a designated specialty?

a. Health/PE.

b. Computer or Technology.

c. Special Education.

d. School-based Staff Developer or Coach.

e. Librarian or Media Specialist.

f. Other (Please specify).

9) INCLUDING THIS YEAR, how many years have you been in the teaching profession?

10) What country do you work in?

a. USA.

b. Canada.

c. Australia.

d. Other (Please specify).

11) In what setting is your school located?

a. Urban.

b. Suburban.

c. Rural.

12) What type of school do you work in?

a. Public.

b. Charter.

c. Private / Religious.

13) How would you best describe the economic level of the children that you teach?

a. Low-income.

b. Middle-income.

c. High-income.

14) How would you describe the level of resources at your school?

a. Low-resourced.

b. Medium-resourced.

c. High-resourced.

Minecraft Education Edition

15) Are you a member of the Minecraft Mentors Program?

a. Yes.

b. No.

16) Have you ever been assisted by a Minecraft Mentor?

a. Yes.

b. No.

17) What first motivated your decision to use Minecraft as a teaching tool? Please check ALL that apply.

a. Playing Minecraft personally.

b. Gaming as a hobby.

c. Online information and communities.

d. A friend's recommendation.

e. Enthusiasm of students at school.

f. Watching a child at home.

g. A conference.

h. Required to use Minecraft by school, district or government.

i. Other (please specify).

18) What subjects do you teach with Minecraft Education Edition? Please check ALL that apply.

a. Language Arts.

b. Math.

c. Science.

d. History.

e. Civics.

f. Geography.

g. Second Language Learning.

h. Arts.

i. Computer Science.

j. Other (please specify).

19) Do you run a Minecraft afterschool club?

a. Yes, I currently run a Minecraft club.

b. No, but I ran a Minecraft club in the past.

c. No, I never ran a Minecraft club.

20) How often do you play Minecraft in your own spare time?

a. Never.

b. Once a month.

c. Once a week.

d. Several times a week.

21) How long have you used Minecraft Education Edition in your teaching?

a. I just started.

b. A few months.

c. 1 year.

d. 2 years.

e. 3 years.

f. 4 years.

22) Please indicate the degree to which you agree with the following statement: "I am an expert in the use of Minecraft Education Edition as a teaching tool"

a. Strongly agree.

b. Agree.

c. Neither agree nor disagree.

d. Disagree.

e. Strongly disagree.

23) Please indicate the degree to which you agree with the following statement: "I feel confident in my ability to use Minecraft as a teaching tool"

a. Strongly agree.

b. Agree.

c. Neither agree nor disagree.

d. Disagree.

e. Strongly disagree.

24) Did you use other editions of Minecraft before trying Minecraft Education Edition?

a. Yes.

b. No.

25) How often do you use Minecraft Education Edition in your teaching?

a. Daily.

b. 2–4 days per week.

c. Once per week.

d. 2-3 times a month.

e. Once every few months.

f. 1-2 times per year.

g. Never.

26) When do you use Minecraft Education Edition?

a. For a single lesson in the year.

b. For a few lessons during the year.

c. Throughout the year.

d. Other (please specify).

27) What devices do your students typically use for Minecraft Education Edition? Please check ALL that apply.

a. iPad.

b. Laptop.

c. Desktop.

d. Chromebook.

28) How often do you ask students in your classroom to play Minecraft Education Edition in the following ways? Individually on their own devices.

a. Never.

b. Sometimes.

c. Often.

d. Always.

29) How often do you ask students in your classroom to play Minecraft Education Edition in the following ways? In pairs.

a. Never.

b. Sometimes.

c. Often.

d. Always.

30) How often do you ask students in your classroom to play Minecraft Education Edition in the following ways? In teams of 3-6.

a. Never.

b. Sometimes.

c. Often.

d. Always.

31) How often do you ask students in your classroom to play Minecraft Education Edition in the following ways? As an entire classroom.

a. Never.

b. Sometimes.

c. Often.

d. Always.

32) In the same physical space or remotely? Please check All that apply.

a. Same classroom (or other space).

b. Remotely and synchronously (shared server).

c. Remotely and asynchronously (completing challenges on their own time).

33) Where do you source your Minecraft Education Edition lesson plans from? Please check ALL that apply.
    a. I use readymade lesson plans.
    b. I redesign existing lesson plans.
    c. I create original lesson plans.
    d. Other (please specify).
34) When choosing or creating lesson plans for Minecraft Education Edition, what are your main goals?
35) When choosing or creating lesson plans for Minecraft Education Edition, what are some challenges you face?
36) Please share a success you have experienced with Minecraft Education Edition.
37) Please share a struggle or failure you have experienced with Minecraft Education Edition.

Video Games and Game Based Learning

38) How often do you use digital games in the following ways? During free choice time, where children can choose any game to use.
    a. Never.
    b. Sometimes.
    c. Often.
    d. Always.
39) How often do you use digital games in the following ways? For structured learning activities, where children only do a specific activity with a game chosen by the teacher.
    a. Never.

b. Sometimes.

c. Often.

d. Always.

40) How often do you use digital games in the following ways? To assess learning.

a. Never.

b. Sometimes.

c. Often.

d. Always.

41) How often do you use digital games in the following ways? To practice material already learned.

a. Never.

b. Sometimes.

c. Often.

d. Always.

42) How often do you use digital games in the following ways? To teach new material.

a. Never.

b. Sometimes.

c. Often.

d. Always.

43) How often do you use digital games in the following ways? As a reward.

a. Never.

b. Sometimes.

c. Often.

d. Always.

44) How often do you use digital games in the following ways? To strengthen home-school connections.

a. Never.

b. Sometimes.

c. Often.

d. Always.

45) How often do you use digital games in the following ways? To facilitate social interactions between children.

a. Never.

b. Sometimes.

c. Often.

d. Always.

46) How often do you use digital games in the following ways? To facilitate social interactions between children and adults.

a. Never.

b. Sometimes.

c. Often.

d. Always.

47) Do you play digital games for entertainment or other non-work related reasons?

a. Yes.

b. No.

48) How often do you personally play digital games?

a. Daily.

b. 2–4 days per week.

c. Once per week.

d. 2-3 times a month.

e. Once every few months.

f. 1-2 times per year.

g. Never.

49) How often do you teach with digital games?

a. Daily.

b. 2–4 days per week.

c. Once per week.

d. 2-3 times a month.

e. Once every few months.

f. 1-2 times per year.

g. Never.

50) Please list a few digital games that you use in your teaching.

51) How is your teaching with Minecraft Education Edition similar or different to your use of other digital games?

52) How did you first learn about using games in the classroom?

a. Another teacher.

b. Coach or supervisor.

c. Figured it out myself.

d. In-service professional development.

e. Conference.

f. Pre-service teacher preparation program.

g. My own students.

h. My own children.

i. Online source.

j. Other (please specify).

53) For what purposes do you use digital games in your teaching? Please check ALL that apply.

a. To teach supplemental content not mandated by curriculum standards.

b. To teach content mandated by local/district curriculum standards.

c. To teach content mandated by state/national standards.

d. To assess students on supplemental knowledge and/or skills.

e. To conduct formative assessment of students' standards-based knowledge/skills.

f. To conduct summative assessment of students' standards-based knowledge/skills.

g. N/A to my position.

54) In what ways do you assess student performance with/around digital games? Please check ALL that apply.

a. I am able to tell what students have learned through their game play in whole-class discussions.

b. I look at student scores on certain games to assess their knowledge/skills on topics we cover in other formats.
c. I use the built-in assessment systems that come with certain games.
d. I create my own tests/ quizzes to assess what students have learned by playing a digital game(s).
e. I do not assess student performance with or around digital games.

55) At your school, what are the greatest barriers teachers face in the educational use of digital games? Please check ALL that apply.

a. Insufficient time.
b. Cost.
c. Lack of tech resources.
d. Not sure how to find quality games.
e. Not sure how to integrate games.
f. Unfamiliar with technology.
g. Hard to find games that fit the curriculum.
h. Lack of admin support.
i. Emphasis on standardized tests.
j. Lack of parental support.
k. There are no barriers.
l. Other (please specify).

56) I am able to plan the integration of digital games into my instruction.

a. Strongly agree.

b. Agree.

c. Neither agree nor disagree.

d. Disagree.

e. Strongly disagree.

57) I know how to integrate digital games into my instruction.

a. Strongly agree.

b. Agree.

c. Neither agree nor disagree.

d. Disagree.

e. Strongly disagree.

Professional development

58) When looking for information on the use of digital games in education, I most often go to: Please check ALL that apply

a. Website(s).

b. Colleagues(s).

c. PLNs.

d. Technology Specialist.

e. Children in my classroom.

f. My own children.

g. Parents of children in my classroom.

h. Other (please specify).

59) Have you ever received pre-service or in-service PD specifically in educational use of digital games?

a. Yes.

b. No.

60) How often does your school or district offer any in-service PD on Digital Game Based Learning?

a. Never.

b. A few times a year.

c. Once a month.

d. Two to three times a month.

e. Weekly

61) Please indicate the degree to which you agree with the following statement - My school provides support for the use of digital games in my teaching.

a. Strongly agree.

b. Agree.

c. Neither agree nor disagree.

d. Disagree.

e. Strongly disagree.

62) Please indicate the degree to which you agree with the following statement - My district provides support for the use of digital games in my teaching.

a. Strongly agree.

b. Agree.

c. Neither agree nor disagree.

d. Disagree.

e. Strongly disagree.

63) Please describe what PD or resources you would be interested in and how they could support your use of digital games and Minecraft Education Edition in your teaching?

Covid-19 pandemic

64) Do your students have access to the technologies they are expected to use such as a computer and a stable internet connection?

a. Yes.

b. No.

65) Have you used Digital games or are planning to use digital games as part of your remote teaching?

a. Yes.

b. No.

c. I have not taught remotely during the Covid-19 pandemic.

66) How has Covid-19 affected your use of digital games in your teaching?

67) Have you used Minecraft Education Edition during the Covid-19 pandemic? If so, in what ways?

Appendix B – Pre-interview screener survey (study 3)

Demographics

1) Full Name
2) Email
3) Years in teaching profession
4) Age
5) Gender
    a. Female
    b. Male
    c. Non-Binary
    d. Not listed
    e. Prefer not to answer
6) What is the highest level of school you have completed or the highest degree you have received?
    a. Less than high school
    b. High school graduate
    c. Associate's degree (2-year)
    d. Bachelor's degree
    e. Master's degree
    f. Doctoral degree

Your experience with digital games and Minecraft Education Edition

7) For how long have you been using Minecraft / Minecraft Education as a teaching tool?

a. Less than 1 year
b. 1 year
c. 2-3 years
d. 4-5 years
e. More than 5 years

8) To what extent do you agree with the following statement: "I am an expert in using Minecraft Education Edition as a teaching tool"
   a. Strongly disagree
   b. Disagree
   c. Neither agree nor disagree
   d. Agree
   e. Strongly agree
9) For how long have you been using digital games in your teaching?
   a. Less than 1 year
   b. 1 year
   c. 2-3 years
   d. 4-5 years
   e. More than 5 years
10) To what extent do you agree with the following statement: "I am an expert in using digital games in the classroom"
   a. Strongly disagree
   b. Disagree
   c. Neither agree nor disagree

d. Agree

e. Strongly agree

11) What subject(s) do you teach?

12) What grades do you teach?

a. K

b. 1

c. 2

d. 3

e. 4

f. 5

g. 6

h. 7

i. 8

j. 9

k. 10

l. 11

m. 12

n. Adults

13) Where do you source your Minecraft Education Edition lesson plans? Please check ALL that apply.

a. I use readymade lesson plans

b. I redesign existing lesson plans

c. I create original lesson plans

d. Other:

14) Whom do you work with when creating lessons plans for Minecraft EDU? Please check ALL that apply.

a. Design everything by myself

b. Co-design with other teachers

c. Co-design with my students

d. Other:

Appendix C – Interview Protocol (study 3)

Introduction and consent to record

Thank you for meeting with me today.

A bit about myself. I am a 6th year PhD candidate in Learning Sciences at Northwestern University. In my research, I explore Digital Game-Based Learning, and I am specifically interested in how teachers use games like Minecraft as an educational tool.

Before we continue, I want to remind you that this interview will be recorded for analytical purposes. If you agree to participate in the research, please indicate that you consent for Zoom to record this session.

*** Start Zoom Recording***

Start Screen Sharing

Lesson Examination Task

In this next task, I will share on my screen, two lesson plans from the Minecraft Education Edition lesson library.

As we go through the three lesson plans sequentially, I want you to think aloud about the lesson designs.

Specifically, I want you to imagine that you are commenting on a lesson plan as you judge whether you would use it in your classroom.

In your critique, feel free to narrate your thoughts, your impressions of the lesson plans, and share any ideas about them that come to mind.

Stop Screen Sharing

Curriculum Materials Sharing Task

In this next task, I would like you to share your screen and take me through some curricular materials such as lesson plans that you have developed for Minecraft Education Edition.

Ask Participant to Start Screen Sharing

- Describe the content and topic(s) for the lesson.
- Describe the student learning goals/objectives addressed in the lesson.
- Describe your students (e.g. grade level, and specific learning needs/preferences).
- Walk me through the lesson/project as it unfolded in the classroom.
- How did you use Minecraft Education Edition in this lesson?
- How and why does Minecraft Education Edition "fit" the content/process goals?
- How and why does Minecraft Education Edition "fit" the instructional strategies you used?
- What other educational technologies (digital and non-digital) did you use and how did you and/or your students use them?
- Describe any contextual information (e.g. access to a computer lab, materials and resources available; particular departmental/school-wide initiatives) that influenced the design or implementation of the lesson/project.

Participant Stops Screen Sharing

Conclusion and final questions

Thank you again for your time today.

As you know, this study and my research in general aim to shed light on the knowledge, processes, and stories of teachers who teach with games and Minecraft Education Edition in particular.

I will share the findings of this study in a few months via Social Media and likely through the Minecraft Global Mentors channels.

If you have any questions about this interview or my research, in general we can use the remaining time for that.