Rebuilding the Industrial Revolution: Using Minecraft in Teacher Education in Social Studies

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Abstract: This article discusses how Minecraft: Education Edition (MEE) can be used as a teaching aid in social studies and as a digital learning resource to facilitate the development of generic and subject-specific competencies. The study reports from an intervention in a teacher education program where student teachers recreated historical environments of the industrial revolution along the river Aker in Norway. The rebuilding of the industrial revolution in MEE was conducted through three phases: introduction, reconstruction and transformation. These phases are illustrated with empirical data. This approach to teaching student's history emphasizes active learning by making it more engaging.

Introduction

Engagement and motivation are often cited as justifications for using computer games in teaching (Callaghan, 2016). Research on the use of digital games shows that they provide opportunities for engagement and activity among students, but the learning outcomes have also been questioned (Kluge, 2016), and computer games as a digital learning resource are met with skepticism from both teachers and parents (Dikkers, 2015; Sigurdardottir, 2016). Minecraft appeals to children because the threshold for participation is low, while the opportunities for creativity and role-playing are many, and the game allows children to build and collaborate with others (Mørch, Mifsud & Eie, 2019). Our aim is to explore how Minecraft Education Edition (MEE) can be used as a digital learning resource to create learning contexts in which generic and subject-specific competencies can be developed in interaction.

Generic competencies, often called 21st-century competencies, play an important role in fostering analytical and critical thinking, creativity, and problem-solving in children (Binkley et al., 2012). Dolan (2020) points out that 21st-century competencies should not be an end in themselves but can act as a framework for teaching. Minecraft, often referred to as digital Lego, gives participants an unlimited number of building blocks to create buildings and other visual structures. MEE is a version of this game adapted for use in schools. The basis for this article is a project that started in autumn of 2017 at a City University in Norway in which student teachers with specializations in social studies for 5th–10th grade used MEE to reconstruct historical environments. The article addresses the following research question: How can Minecraft be used in teaching social studies to develop generic and subject-specific competencies?

Enabling historical empathy

To understand the actions of the people who lived in the past, we must have some knowledge of the framework and conditions within which they acted (Lund, 2020). Hatlen (2020) refers to the English tradition of history didactics and explains the concept of "historical empathy" as "understanding how the people of the past saw their world at different times, and why they acted as they did" (p. 147). Like the concept "historical empathy" is the concept "taking [a] historical perspective," described by Seixas and Morton (2013) as:

> [...] considering the different "things" that made up their everyday living – technologies, clothing, housing, food – as well as the landscape of their communities and settlements; [...] ideas and belief systems through which they made sense of it all (p. 138).

The people of the past, like us, acted on the basis of emotions, beliefs, and ideologies, so taking a historical perspective means taking on multiple perspectives. A core element of the Norwegian curriculum is historical empathy (DoE, 2020).

According to Yilmaz (2007), historical empathy can involve elements of emotion but is mostly an intellectual exercise of reconstructing the past through the systematic study of historical contexts. Creating micro-stories about people from a period of the past provides an opportunity to take multiple perspectives and can serve

as a bridge to understanding the features of society in that period (Kvande & Naastad, 2020). Roleplaying games and simulations give students access to historical situations or, events as though they were still happening (Lund, 2020). With this roleplay, the historical actors have several possibilities for action within a structural and contextual framework. Lund claims there is "much to suggest that simulation is little used by history teachers, especially the large selection of computer simulations" (2020, p. 127). Probable reasons for this are that teachers find simulations time-consuming to use and difficult to adapt to the classroom (Lund, 2020). This paper will address this gap by using MEE for rebuilding a local context of the industrial revolution and experience it through a roleplay.

Minecraft as a digital learning resource

In the past five years, increased interest in the use of MEE in educational settings has been reported. MEE can increase motivation and creativity and provide opportunities for collaboration in the classroom (Lorence, 2015; Callaghan, 2016). Dikkers (2015) believes that Minecraft's popularity has great pedagogical potential and highlights its benefits in areas such as problem solving, motivation, and commitment in addition to learning academic topics (pp. 110–111). Jensen and Hangøj (2019) point out that MEE creates new ways of participating (p. 361) and changes teacher-centered activities to student-centered activities. Researchers have investigated the use of MEE in subject-specific competencies within language, mathematics, science, and social studies (Jensen & Hangøj, 2019; Lorence, 2015).

Games engage students in and out of school and contribute to flexible teaching, but competition and frequent trial and error approach within games can hinder reflection and learning (Kluge, 2016). Kluge (2016) states that computer games must have a high degree of pedagogical structure and give students opportunities to work with subject-specific concepts to turn commitment to play the game into learning outcomes. Gabriel (2016) points out the need to include digital game–based learning in teacher education to increase student teachers' competence in incorporating digital learning aids like games into their teaching (p. 35). Previous research has shown that few studies examine the use of MEE in teacher education (Egebert & Borysenko, 2019). Callaghan (2016) found that the teacher's active participation in the game is important for students' commitment and motivation. However, Kuhn and Stevens (2017) point out that many teachers are reluctant to use Minecraft because they know less about computer games than their students.

Common understanding through intersubjectivity

This article adopts intersubjectivity (Mead, 1910; Rommetveit, 1976) and dialectics (Vygotsky, 1986) as overarching theoretical concepts. Intersubjectivity can be described as a subprocess of collaborative learning (Stahl, Koschmann & Suthers, 2006; Fugelli, 2012). Rommetveit (1976) defined intersubjectivity as a psychological process that arises between individuals by creating a common understanding (Rommetveit, 1976). Creating a common understanding is essential for developing knowledge together (Fugelli, 2012) and is a central component of computer-supported collaborative learning, both among students and between students and teachers (Ludvigsen & Mørch, 2010). Through intersubjectivity, a group creates a common social awareness (Mead, 1910), which is developed through communication, collaboration, and negotiation (Rommetveit, 1976; Ludvigsen & Mørch, 2010). According to Mead (1910), we create history through communication with others, using a technique he referred to as reconstruction, a process that emerges in the present. Rommetveit stated that intersubjectivity is a social world temporarily shared between individuals, but which can never be completely shared because it is a generalization of different individuals' experiences (Rommetveit, 1976). The intersubjectivity partially developed in a student group needs a driving force to develop into a common knowledge object (Fugelli, 2012); for this driving force, we use the dialectical method (Vygotsky, 1986). In our case, this means setting up tensions between subject-specific and generic competencies and structuring the learning process into three steps. Mørch, Mifsud & Eie (2019) developed a model to apply processes in practice, focusing on the gradual, knowledge-based development of a common understanding (object of knowledge) through intersubjectivity. The three steps of this model are introduction, reconstruction, and transformation. In this work, we applied this model in three rounds of design-based research.

Method and case design: The industrial breakthrough in Minecraft

The main method used to organize this study was design-based research (Brown, 1992) with an emphasis on interventions over three-week periods in three semesters (autumn 2018, spring 2019 and autumn 2019). A total of 146 student teachers followed this topic during the study period. The student teachers were going to use MEE to teach in the classrooms. MEE was used to reconstruct buildings and events of the industrialization period as part of the in-depth study of the industrial breakthrough around 1840-1890, with emphasis on global history and

location-specific knowledge of the Aker river area. Based on feedback from previous iterations, the intervention was readjusted several times. Data were obtained via, screen recordings of group work, qualitative interviews, and student-produced films of the roleplay in MEE. The informants were recruited on a voluntary basis. See Table 1 below for an overview of the data we report on.

Table 1: An overview of the data reported on in this article

Data sources	Amount of data
Interviews with student teachers	Total numbers of participants = 3
Screen recording of the groups' construction in MEE	2 hours of screen recording
Student-produced films of roleplaying games	25 movies (3–4 minutes per movie)

A thematic analysis (Reichertz, 2014) was conducted of the interviews. The screen recordings show the students' screens and speech while they built. When analyzing the screen recordings, we looked especially for the use of sources, collaboration, and problem-solving abilities. When analyzing the roleplay films, we looked particularly at how subject-specific knowledge of the industrial breakthrough, such as the living conditions of this period, was expressed through context (MEE staging) and conversation between the avatars. For the thematic analysis, we used a combination of data-driven and theory-driven approaches, also referred to as the abductive approach (Reichertz, 2014). The three phases of introduction, reconstruction, and transformation describe the teaching process: first, we (the teachers) introduced the knowledge domain (subject-specific knowledge), then the students created their own reconstructions in MEE and in a written script document, and finally, they transformed the reconstruction and events into a film.

Data and analysis

The data are presented and analyzed for each of the three phases described above: We use empirical data from the Canvas Factory along the river Aker to illustrate our findings. The Canvas Factory started producing canvas for sailing ships in the early phase of industrial breakthrough in Norway.

Introduction

The first phase was to introduce subject-specific knowledge. The students spent time orienting themselves in the subject matter about the industrial buildings and the business associated with them, which had changed over the years. On campus, the students received a more detailed lecture about the buildings' architecture and the events associated with them during industrialization. The teacher then prepared an excursion along the river Aker, in which the students were given the responsibility of presenting their respective buildings to the other participants. During the excursion, the student teachers had the opportunity to take pictures and explore the building and their surroundings (Figure 1). The students gained access to historical sources that dealt with living and working conditions in addition to their own online research. The student teachers were introduced to MEE at the beginning of the intervention period. However, at least one student in each group had previous experience with MEE.
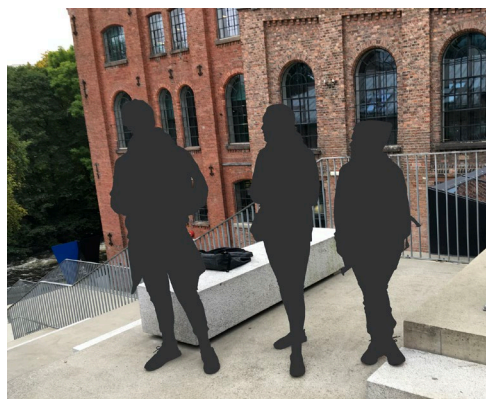

Figure 1. A picture of student teachers in front of the Canvas Factory during the excursion along the river.

The excerpt below is from an interview about how the student used different sources to learn about the Canvas Factory.

Student: We looked at old pictures and we just had to use our imagination to envision how we thought it [the Canvas Factory] was then [. . .]. We also looked in old books to get an overview. But it was difficult to find out, especially at the Canvas Factory, because it was much smaller before (in the industrial age), now it is much larger due to later extensions of the building [. . .] what it looked like in the very beginning, we found a picture that represented it quite nicely, so we got a pretty good overview [. . .]

The student elaborates on his use of different sources to gain knowledge of how the Canvas Factory looked in the industrial age. Next, the students listened to the subject teachers, searched for information on the Internet, distributed tasks among themselves, and planned the next phase. This can be understood as the beginning of the process of building intersubjectivity (common understanding); at this stage, the intersubjectivity is low or vaguely defined. We can see a parallel to Sfard's (1998) acquisition metaphor, as the students were concerned with acquiring knowledge of subject concepts, gaining knowledge of the building through historical sources, teaching, and going on the excursion. This work prepared the students for the later phases.

Reconstruction

In this phase, the student teachers were tasked with reconstructing the buildings as authentically as possible in MEE. Alongside the construction, the students developed scripts for roleplay about living and social conditions.

Reconstruction of buildings

The teachers developed an empty world (Figure 2a) with sites ready for construction along the river. Figure 2b shows how the students reconstructed and built the Canvas Factory in MEE.

Figure 2. Reconstruction of buildings in MEE: a) Empty world (site) made by the subject teachers (left) and b) the building constructed by a group of student teachers tasked with modeling Canvas Factory (right).

At the start of the reconstruction phase, an interesting pattern was revealed: group members experienced in MEE took initiative and control over the building process. The students with less experience received training from the more experienced, as revealed in the following interview excerpt:

Student: The other two I worked with had no experience with Minecraft, so it was in a way my job to teach them to play Minecraft and be leader for the construction in Minecraft and the organization of the activity. But they (the other student teachers) worked very hard to build things. I had to explain it for them, like that this area here should have this kind of stones, and you have to build using that kind of pattern, and things like that. It was very alright to work that way. During the roleplay and scriptwriting, it was the others who created the dialogue.

The students agreed on the dimensions, building materials, and design of individual elements in the building and then distributed the construction work. They often collaborated on the most complicated parts of the building, such as roofs and windows. The excerpt below illustrates the need for collaboration when reconstructing the more complex elements of historical buildings in MEE, in this case, the factory building roof.

Student: When we started building and shaping the roof, someone said: "The roof will be very high." So, we looked at it and agreed, because it got very high, so

then we flattened it [the roof]. In the game [MEE], you have stair blocks, and when you use them on top of each other, it becomes a very pointed roof. As a result, instead we used flat half blocks and a regular block [. . .], and then it became a flatter roof. [. . .] and it matched better with the picture as well.

The following excerpt is from an interview with a student who reconstructed the Canvas Factory.

Interviewer: How did you solve the task of building the Canvas Factory?
Student: We had to find out information about the Canvas Factory, and we were on an excursion along the river. We had a presentation about the factory when we walked along the river, so then we got that prior knowledge there and talked about strikes and poor working conditions and things like that. We also saw the building there. [. . .] Later, we used Google Earth to zoom in on the building to see what it looked like, but there is an extension there [in the new Google picture] and a staircase on the side that was not there before. Earlier [during the industrial age], it was just a plain [staircase].

Figure 3. Reconstruction of the staircase inside Canvas Factory.

The two previous excerpts describe the reconstruction process, highlighting two typical situations in which generic competencies and subject-specific knowledge were applied. First, the students put great effort into searching the MEE inventory for the right building blocks to use, and they regularly checked their own buildings against sources, including historical images, floor plans, and digital maps. Second, when the groups encountered problems in the construction process, they searched for more information. To figure out how the Canvas Factory looked when it was founded in 1858, the students had to search for historical pictures and drawings in books and online. The students compared different sources of information and discussed them to come to an agreement of how the building might have looked. This process parallels the process of building intersubjectivity (Rommetveit, 1978), in which students enter discussions and develop a common ground.

The reconstruction phase facilitated the development of generic competencies, such as creativity, problem solving, collaboration, and division of labor. When reconstructing the building, the students discussed the different parts of the construction process. This parallels Sfard's (1998) participation metaphor, which foregrounds participation in the collaborative building process. In the data presented above we see a tension between generic and subject-specific skills: the students worked to develop parts of the building both in parallel and together. The students contributed with their parts (walls, windows, doors, etc.) to create a whole factory building along the river, which in turn set the framework for the individual parts. This tension is linked to the lack of subject-specific knowledge. When detailing the staircase in the building, which was not shown in the original pictures, the students had to be creative. Generic competencies were therefore more dominant in this phase, contrasting with the subject-specific knowledge driving the process forward (i.e., through the need for more detailed knowledge). The development of generic and subject-specific competencies is interdependent: the whole (which is a set of relationships among parts, Figure 2b) is related to the use of domain-specific knowledge, and the parts in isolation draw on generic skills, such as creativity and information seeking (Figure 3). The two types of competencies are in a dialectical relationship (Vygotsky, 1986), which is resolved in phase 3, transformation.

Reconstruction of historical events
To reconstruct historical events and develop a realistic script, the students sought historical sources that went into depth about working conditions, power relations, and living conditions. When researching working conditions,

one student came across an interview with a former employee in one of the industrial buildings, in which the worker uses the term "black pudding on Fridays"—which the student connected to their present-day "Taco Fridays." Tacos are a typical Norwegian Friday dinner dish. The following excerpt elaborates on this connection:

Student: We refer to the present and we called it black pudding Friday instead of taco Friday. We used humor. [. . .] When it comes to problem solving, such as reconstructing a building without having the correct measurements, but at the same time getting the whole of the structure to resemble the actual building, collaboration, problem solving, and creativity are fundamental.

In the literature, this is referred to as anachronism or prolepsis. In Rommetveit's (1976) work on intersubjectivity, such formulations are considered a technique for bringing past conversations and common understandings forward in time. This linking of black pudding and taco Fridays can be seen as an anachronistic or proleptic play on words, connecting the past, the present, and an anticipated future with the aim of increased intersubjectivity.

Historical empathy is not about free imagination but about developing an understanding of a historical context via sources (Hatlen, 2020). To achieve historical empathy, the historical context must be reconstructed. The student groups based their reconstruction on sources, but several students told us they also took artistic freedom, using their own knowledge to adapt the end result. Several students expressed personal empathy for the reconstruction as they began to feel a sense of ownership of the building's history. Data from the Canvas Factory indicates that the students activated both feelings and reasoning by taking on different perspectives and life experiences in the roleplay, such as gender and class membership, which is related to historical empathy.

In the reconstruction phase, the students became participants in a community in which collaboration skills, problem-solving abilities, and creativity paid off. In using trial and error in in the building process (placing, destroying and rebuilding blocks in MEE) the students negotiated towards a shared understanding of the historical building connected to different artefacts: the MEE building and the role play script, implying that intersubjectivity gradually materializes, but partly fragmented.

Transformation

In the third phase, the students used what they had made, the building and script, to make a film showing their learning in a compact format. Two main findings emerged in the transformation phase: 1) how the students co-created a shared object of knowledge through roleplay, and 2) how the students connected the historical knowledge in the film to their own lives. These two points will be elaborated in this section.

Below are stills from a student group's film of their roleplay in the historical context of the Canvas Factory in MEE. The film shown in Figure 4 is set in 1889 and begins with a dialogue between the female workers in the factory, the director, and a representative for the workers' rights. In the opening scene, the female workers receive a scolding from a male head worker who tells them to work faster. This frustrates the women, who complain to the factory manager. He dismisses their complaint and says they are easy to replace. In the second

Female worker: Mr. Director! The men in here do nothing but scold and picking on what we do. The work we do is heavier than theirs and the air we breathe actually makes us sick.
Director: That's actually how it is here. I have done nothing but take you under my wings. You can be replaced in no time.

Agitator: Mr. Director! It is so that these women have miserable working conditions. Their wages are much worse than those of men. They are not valued for the effort they actually put in.
Director: I stand by what I have said earlier in this case and am not at all interested in negotiating. I do not need them.

Female worker: Then we go on strike. All of us! Then we'll see how your factory production goes.

Figure 4. A series of screenshots and the corresponding dialogue from a film set inside the Canvas Factory.

scene, the female workers call upon a well-known agitator for workers' rights. In the last scene, we see the female workers go on strike:

The four-minute film demonstrates subject-specific knowledge about working conditions, class relations, gender relations, and agitation for workers' rights. The roleplay dives into a limited reality, in which the actors play out written scripts and have certain options for action that depend on the level of detail in the script and creative on-the-spot adaptation. The students' roleplay in MEE has the potential for generalization of experiences to others. The factory workers and factory owners' function as representatives of "many from the same place and conditions in the relevant period" (Kvande & Naastad, 2020, p. 186). The students' roleplay enables them to get closer to historical events, take on different perspectives, and imagine how past events were happening (Seixas, 2013).

In the transformation phase, subject-specific knowledge is foregrounded, while the generic competencies of creativity and adaptation stay in the background. Both competencies can be identified in the film, as illustrated by the dialogue sequences in Figure 4. A transition occurs between the two types of competencies when an actor plays out a prolepsis (Rommetveit, 1976), which shifts the dialogue and the group's common understanding away from subject-specific topics (e.g. blood pudding for industrial workers' dinner) to a generic competency (e.g. adaptation). This shift in turn drives the intersubjectivity forward in time, resulting in a common object of knowledge. Intersubjectivity at this stage is focused, combining a verbal component (the roleplay conversation) and a visual component (the MEE building staging the roleplay). Our data indicates that through phases 1–3, the students gradually developed a common, focused object that ended with the films used in plenum presentations.

Conclusion

This article discussed how MEE can function as a digital learning resource for developing generic and subject-specific competencies in tandem. In the introduction phase, the learners received a professional introduction to subject-specific knowledge and were given access to primary and secondary sources of information. The learners were given multiple opportunities to develop their subject-specific knowledge. In the reconstruction phase, historical buildings and events were recreated in MEE and the learners were given opportunities to develop generic competencies, such as creativity, collaboration, problem solving, design, and adaptation. In the transformation phase, the students' generic competencies and subject-specific knowledge were integrated and transferred to a common knowledge object, in this case, a film of roleplay in MEE. In this phase, the subject-specific knowledge came into focus, while the generic competencies were put in the background. Tensions between the two competencies drove forward the process of creating intersubjectivity. The student teachers dialectically switched between developing generic and subject-specific competencies when using MEE to rebuild the industrial age. This was partly facilitated by the model we used for teaching, but also aided by the tensions inherent in the knowledge domain (historical knowledge) as it is reconstructed using a new digital learning resource.

The implication of this paper is that Minecraft may be explored in an educational setting as a digital learning resource that facilitates active learning processes by making history more engaging. Learners are given the opportunity to contextualize the past and imagine how historical actors lived, often under very different conditions than those under which we live today.

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