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Minecraft as a Learning and Teaching Tool - Designing integrated Game Experiences for formal and informal Learning Activities

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Faculty of Education **Thesis abstract**

Department of Educational Sciences and Teacher Education Master's Degree Programme in Education and Globalisation	Author Steinbeiß, Gregor-Jan Hermann

Title

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Abstract

Research has shown the educational benefits of using the video game Minecraft in areas such as sciences and educational purposes as a teaching tool to transfer knowledge. Most studies, however, address the issue from an external perspective, rather than a student-centred perspective by evaluation from the researchers' or teachers' perspectives. This leads to a gap of data from the participants' perspective and its usage in education. Those studies discuss how Minecraft is used as a simple teaching tool by filling it with content. Likewise, little research has studied in detail about the pedagogical designs of the virtual learning environments, or the design of the content within the game. This study aims at examining how the chosen content design and playability of the online learning environments influence the formal and informal learning outcome of a student in Minecraft. It looks at challenges faced by teachers and students by using those designs as a tool for transferring knowledge and how those challenges are dealt with during the study. In addition, the "Steinbeiß-Ruotsalainen Model for Formal, Non-Formal and Informal Learning with Minecraft" will be introduced and validated. In order to do so, a design-based research project was carried out, including six face-to-face interventions. 16 students participated in those interventions and had the opportunity to access to the online content 24 hours a day over a time period of three months. The presented data was collected through observations, video data, interviews and a survey. Based on the results of the study, the research showed that gamified designed learning environments in Minecraft benefit informal and formal learning experiences. It was observed that the designed reward-based learning environments can function as a motivational tool during the formal and informal learning phases. The introduced "teacher as an online facilitator" can support the learning outcome during formal and informal learning phases in Minecraft. It was concluded that spatially divided designs for learning environments can benefit formal learning, and that designing a learning environment by simply providing content can benefit informal learning. Designs facilitating an online society in Minecraft can create opportunities to establish social connections, and self-regulated learning benefits the learning outcome. It was observed that children need time to adapt to newly designed learning environments in Minecraft, and those with previous gaming experience do not necessarily benefit more than others. Clear rules on the Minecraft-server are needed to be implemented in order to maintain a successful learning environment. By linking theory and research results it was concluded that the "Steinbeiß-Ruotsalainen Model" can be used as a cornerstone for designing educational content in the game and for further research attempts in Minecraft based on design-based research.

Keywords computer supported collaborative learning, design-based research, digital game based learning, educational technologies, formal learning, games, gamification of education, informal learning, Minecraft, MinecraftEdu, Minecraft Edu, new media in education, problem based learning, Steinbeiß-Ruotsalainen Model,

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Thank you.
Gregor-Jan Hermann Steinbeiß

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1 INTRODUCTION

Almost every child in the westernised parts of the world knows or has at least once played video games. Computers are nowadays domesticated in the everyday life of the students and therefore, an urgent need for childhood education considering new media in education is needed (Hiltunen, 2016). Many children experience working on paper-based assignments as increasingly undesirable and would prefer an easy swift access to knowledge as a fundamental part of their education. Teachers and researchers' have to align with the steady shift in the cultural conceptions of using technologies through challenging their previously received traditional training and education. Efforts must be put towards those new increasingly complex challenges according to curriculum design and pedagogical approach (Bolanos, 2016).

Research has shown the educational benefits of using the video game Minecraft in areas such as sciences and educational purposes as a teaching tool to transfer knowledge (Nebel, Schneider, & Rey, 2016; Duncan; 2011; Schifter & Cipollone, 2013; Orlikowski, Bongartz, Reddersen, Reuter, & Pfeiffer; 2013; Smeaton, 2014; Petrov 2014; Overby & Jones, 2015; Uusi-Mäkelä, 2015 and Pihkala-Posti, 2015). Most studies, however, address the issue from an external perspective rather than a student centred perspective by evaluation from the researchers' or teachers' perspective. This leads to a gap of data from the participants' perspective and its usage in education.

Most of the above mentioned qualitative studies discuss how Minecraft is used as a simple teaching tool by filling it with content without discussing the pedagogical design of the virtual learning environments, or the design of the content within. The case studies validate the usage of Minecraft for educational purposes through simply proving the fact that it is possible to include content into the game without focusing or reflecting on it. There is a strong need for a pedagogical cornerstone to create profound learning environments within Minecraft, and it needs to be observed how different in-game designs for providing content influence the learning outcomes. In other words, the presented study will focus on gamification of learning environments within the already gamified and validated tool Minecraft. This design-based research study does not focus on the possible usage of the game as a teaching tool for different subjects through interventions, it shall outline how the design of the virtual learning environments in-game containing the content influences the learning experiences of the participants. As a framework for those design

attempts and as a general starting point for similar research about Minecraft, the "Steinbeiß-Ruotsalainen Model for Formal, Non-Formal and Informal Learning with Minecraft" will be introduced (3.5).

1.1 Aims of the Study

The general aim of this study is to observe how the commercial game of Minecraft and its additional educational add-ons (3.3) can be used to design gamified educational environments for educational purposes. The focus lies on how in-game learning environments are designed and developed by the teacher and which designs are benefiting the formal and informal learning experiences of a child (2.2.1). In addition to that, it will be investigated what challenges the new learning environment of Minecraft brings, and how they are faced and dealt with inside the classroom and online by the students and the teacher (4). Furthermore, it is expected that this research will outline specific problematic aspects and will raise questions for further research. This will be observed through classroom and online observations, by analysing video data, interviews and a survey (3.7). Aiming to investigate the above mentioned issues, the present study addresses the following research questions:

1. How does the chosen content design and playability of the online learning environments influence the formal and informal learning outcome of a student in Minecraft? (Aim 1).

2. What challenges are faced by teachers and students by using those designs as a tool for transferring knowledge in Minecraft and how are those challenges dealt with during the study? (Aim 2).

3. How functional and valid is the introduced "Steinbeiß-Ruotsalainen Model for Formal, Non-Formal and Informal Learning with Minecraft" as a pedagogical design implementation for Minecraft? (Aim 3).

2 THEORETICAL FRAMEWORK

In this chapter, the theoretical cornerstones of this thesis will be discussed. In order to create a successful design-based research it is necessary to discuss the umbrella terms (Figure 1) of this study. To begin, gamification of education (2.1) will be introduced as the mature framework of this paper. In addition to that how educational environments can be gamified (2.1.1) and how virtual worlds function as learning environments through gamification will be mentioned (2.1.2). Furthermore, the dwelled on learning theories will be introduced (2.2). Minecraft as a computer supported collaborative learning tool will be presented (2.3) and previous research in the field will be outlined (2.4).

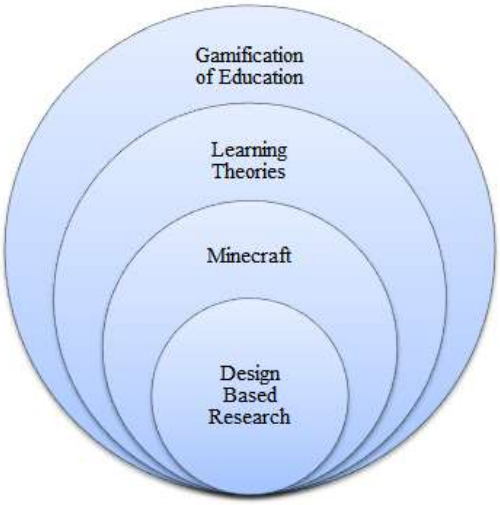


Figure 1: Umbrella Terms of the presented Study

As presented in Figure 1, in order to carry out design-based research several frameworks need to be discussed first.

2.1 Gamification of education

Caillois, (2001) introduced the concept of “paida” and “ludus” as two poles of play activity. While “paida” as playing is defined as a playful, expressional, improvisational free-form, “ludus” or game is referred as playing structured by rules and competitive strife towards goals. Instead of playing, as playing with a toy, the term gamification is characterised by explicit rule systems. Deterding et al. (2011) emphasise that the term gamification relates to games not play (or playfulness) and defines applications of game principles and game-design elements (i.e. point, scoring, rewarding, competition,

collaboration etc.) as gamification. It was introduced as a method to facilitate participation and engagement by immersing into a feeling of energised focus and enjoyment during the activity (the so called flow) as a mental state. While the phrase gamification of education nowadays is grounded on the theory that specific video game designs can be used as an educational approach, gamification was not always immediately aligned with the use of technology.

In addition to the discussed terminologies about gamification, "Learning through games", "learning with games" and "learning by making games" are in need of being defined as the three types of learning in educational games. (Egenfeldt-Nielsen, Smtih, & Tosca, 2009). Games which are usually created for educational purposes rather than for pure entertainment define themselves as games of the category "learning through games" while "learning with games" defines itself as a label for games which are not usually developed for the educational purposes, but used as a tool for learning. Those games provide the opportunity for the teacher to implement assignments and to use them in educational institutions as a tool. "Learning by making games" is defined as a framework for games which are typically game- or development environments which are used to develop games or other outcomes (Hiltunen, 2016). In general, researchers categorise Minecraft as "learning through games". Tarja, Johannesson & Backlund (2007) introduced the term "serious games" or full-fledged games for non-entertainment purposes in contradiction to gameful design for games used for purposes other mere entertainment.

While Minecraft is widely referred to as a serious game, many researchers use it nowadays as a tool to gamify educational environments (Nebel, Schneider, & Rey, 2016; Duncan; 2011; Schifter & Cipollone, 2013; Orlikowski, Bongartz, Reddersen, Reuter, & Pfeiffer; 2013, 2014; Smeaton, 2014; Petrov 2014; Overby & Jones, 2015; Uusi-Mäkelä, 2015 and Pihkala-Posti, 2015). At first introduced simply as an open sandbox toy facilitating playful design, it became a serious game by implementing a survival mode in which players had to achieve goals in order to survive, and an opportunity to beat the game was presented. On the contrary, the creative mode gives the opportunity and freedom of implementing multiple educational contents in order to use Minecraft as a teaching tool (TeacherGaming LLC, 2017). As a result, it needs to be mentioned that Minecraft in its broad spectrum fits all the above mentioned definitions depending on its use and by simply aligning it to the Deterdings et al. (2011) graph it can be illustrated for a better understanding (Figure 1).

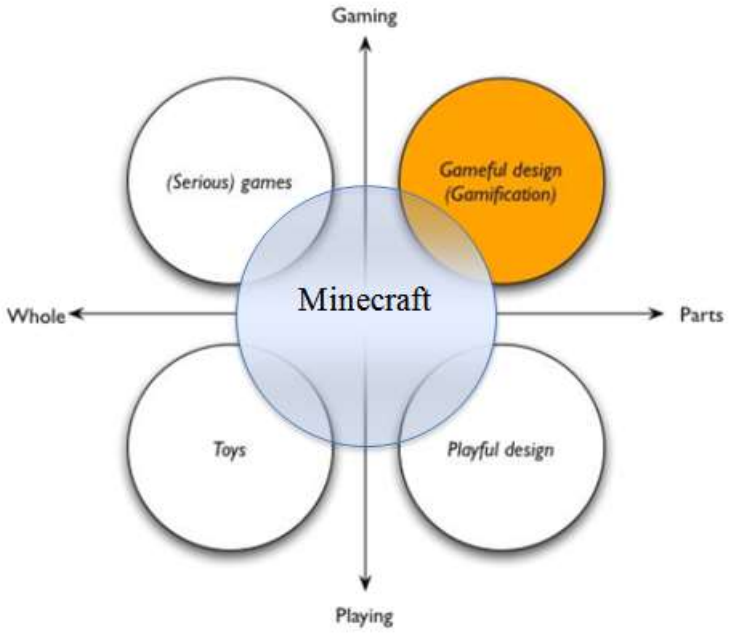


Figure 2: Aligning Minecraft to Game Definitions of Deterding et al. (2011)

2.1.1 Gamifying Educational Environments

Since this study aims to implement pedagogical content by designing gamified online learning environments within the gamified tool of Minecraft itself, it needs to be discussed how gamifying of educational environments is defined, and which cornerstones need to be addressed in order to succeed in the presented research.

Figure 3: Five Steps of the Gamification Process (Huang & Soman, 2013)

As shown in Figure 3, educational interventions can be defined through 5 steps: Understanding the target audience; defining learning objectives; structuring the experience; identifying resources and applying gamification elements (Huang & Soman, 2013)

In order to understand the target audiences, it is necessary to understand the context which surrounds the participants, and in which context the program is delivered (as

described in chapter (3.1). Through observing determined factors like learning abilities, skill-sets, age and group size etc. one can understand the needs of the design. While creating a new gamified learning environment, possible negative aspects also have to be taken in consideration, so called pain points (Huang & Soman, 2013). For example the delivery method might not fit every learner, low motivation through content and design, the inability of balancing working and playing hours can arise.

As described in chapter (3.6) the second stage of gamifying education is to set objectives for the participants. In order to successfully end a quest, or task general instructional goals are necessary for the participants. Specific learning and behaviour goal should be defined in order to understand concepts and rise performance in participation. Distractions should be minimised in order to facilitate concentration during the assignments (Deterding, Dixon, Khaled, & Nacke, 2011)

Through breaking down the learning environment and structuring, the experience stages or milestones can be generated as powerful tools for sequencing knowledge and to quantify the content to be achieved. In the present research, six stages are presented as interventions or classroom sessions (as presented in chapter 3.6). Gamified tasks offered as quests containing curricula content are given as assignments to the students, and in order to succeed and to reach a milestone all its attributes must be completed.

After defining the milestones and interventions, resources to gamify should be gathered in addition to defining a tracking mechanism, which in our case are presented as the chosen methods for data collection. Those resources might be currency (as/or rewards), specific rules of the game, achievements and an environment for feedback by the teacher Those game like elements, also called game mechanics can be classified as social-elements with a pushing or motivating aspect towards the milestones, or as self-elements working as a reward afterwards. Self-elements usually facilitate competition between the peers by recognising self-achievement through points, level achievement, trophies or badges, while social-elements support cooperation through achieving a storyline and leader boards (Huang & Soman, 2013).

2.1.2 Virtual Worlds as Learning Environments

The virtual world of Minecraft has been recently discovered as a fruitful environment for educational purposes. Through multiple research approaches, it was concluded that the game itself fits the purpose of implementing different educational subjects for gamifying

education. (Nebel, Schneider, & Rey, 2016; Duncan 2011; Schifter & Cipollone, 2013; Orlikowski, Bongartz, Reddersen, Reuter & Pfeiffer, 2013; Smeaton, 2014; Petrov 2014; Overby & Jones, 2015; Uusi-Mäkelä, 2015 and Pihkala-Posti, 2015). Aligning with the concept of gamification of education (Figure 3), one needs to identify resources in order to successfully apply gaming elements. While other research attempts mainly observed the educational usage of Minecraft as a tool itself, this study focuses primarily on the gamification opportunities within the already proven educational gamified Minecraft. In order to do so, it is necessary to identify virtual worlds in general, and onwards in relation with Minecraft. Aligning with the real life attempts in schools, moving from traditional teacher centric "teaching environments" towards student centric environments as learning environments, this study tries to address Minecraft as a learning tool and a teaching tool.

The definitions of virtual worlds (so called massively multiplayer online worlds (MMOW) adjust with Minecraft, which offers a synchronous opportunity to communicate in real time by using the chat function as a self-designed online avatar. Everything one does within a MMOW with this chosen avatar has an effect on other players as well, since all players are connected to the same world. The virtual world is persistent and hosted on an independent server without depending on a single player's presence. An action a player takes in-game has consequences and will not be erased after him or her disconnecting the server (Uusi-Mäkelä, 2015).

As a possible disadvantage of a MMOW, Warburton (2009) outlines the problem of avatars being anonymous and the almost impossible tracking of anonymous changes. While the characters in the Minecraft world will be unique for each student and noted by the teachers at least during lessons and the presence of others change can be identified (i.e. stealing items from others is still). Without other peers being online and in-game at the same location it is unfortunately possible for the participants to act undetected and inappropriately inside the virtual world of Minecraft. It is necessary to create learning environments in MMOWs which trigger a high amount of learning motivation in order to avoid boredom, which might lead to chaos, a profound understanding of learning theories is necessary.

2.2 Learning Theories related to the Study

The field of learning sciences is defined as multidisciplinary and many different approaches contribute to game-based learning. In this chapter, the main learning theories of

the presented research will be discussed and their elements will be connected within each other and the research purpose of designing learning environments. In order to understand and validate the chosen methodologies and methods and research designs (3), the principles of formal non-formal and informal learning (2.2.1), problem-based learning (2.2.2), scripting collaboration (2.2.3) and digital game based learning (2.2.4) will be explained.

2.2.1 Formal, Non-Formal and Informal Learning

Eraut, (1994) describes formal learning as a process happening in a prescribed learning framework, organised learning event or package which is offered by a facilitator acting as a teacher or trainer. Those learning environments are tightly structured and in general delivered in a systematic intentional way, usually within an environment of educational institutions towards leading to the award of qualification or credit. The generalised idea of nowadays society associating all learning with formal settings by ignoring that a certain part of gaining expertise happens outside educational environments is simply wrong (Rogers, 2008) and needs to be addressed. For example in general learning through games would be classified as informal rather than formal since playing usually happens outside of formal educational environments (Uusi-Mäkelä, 2015).

Informal learning, often referred as learning by expertise, takes place outside the dedicated learning environments and arises from the interests and activities of the individual or group. As a pervasive ongoing phenomenon of learning via participation or knowledge creation, it defines itself through not following a specific curriculum arriving sporadically. It is generally experienced as a function of everyday life and can be triggered through specific interests, peers or certain occasions (Cedefop, 2009).

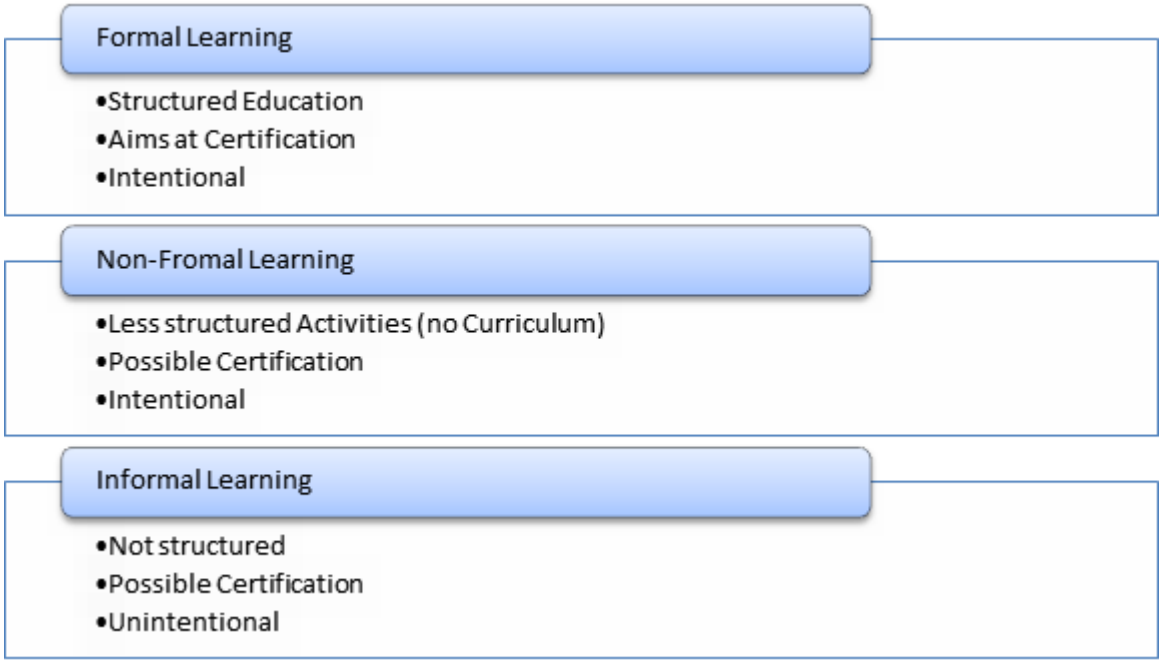


Figure 4: Formal, Non-Formal and Informal Learning (Cedefop, 2009)

The European Centre for the Development of Vocational Training argues that distinction between the two definitions is not polar since those do not cover various structured learning situations without a curriculum (Cedefop, 2009). As seen in Figure 4 non-formal learning is introduced as a definition for learning occasions which feature less structured activities without the necessity of a curriculum but triggered intentional. The Education and Training Policy Division of the OECD (2010) defines non-formal learning environments as learning resulting from daily life activities related to work, family or leisure providing examples like swimming sessions for children, community-based sports programs or boy or girl scouts.

Through the creation of a non-formal after school club about Minecraft, this research project was presented to its participants. By collaboratively designing learning environments facilitating those three definitions, the research project was carried out with formal, non-Formal and informal learning theory as cornerstones of the invented pedagogical design (3.5).

2.2.2 Problem-Based Learning

With the umbrella terms of formal, non-formal and informal learning defined, it is necessary to dig deeper into the process of knowledge gaining presented in this research.

The planned interventions are grounded on a plainly constructivist approach, beginning from the fact that children (so-called digital natives) are already aware of the use and practicality of video games, and find them fun and engaging in general. Emanating from a Piagetian perspective, conceptual acquisition comes through the realisation of a cognitive imbalance within what the children are presented with and what they already know (Vidal, 1994). A child will attempt to restore this dissonance by undergoing processes of cognitive adaptation, and subsequently learn. Problem-based learning emphasises this process rather than its outcomes. It defines itself through facing a subject through the experience of solving an open-ended problem by providing the students with independence through giving them control over their own learning and the processes involved, and emphasises the aspects of 21st century skills by developing communication skills, creative thinking, problem solving and critical thinking (Binkley, et al., 2012; Scardamalia, Bransford, Kozma, & Quellmalz, 2012).

In the case of our sessions, a child will be presented with an environment in which it has to assess authentic ill-structured issues, situations in which the problems existing and the desired state are unclear and, hence, methods of reaching the desired state need to found. Through self-directing, peers can individually and collaboratively assume responsibility for generating learning issues and processes through self-assessment and peer assessment by accessing and managing their own learning materials (Hung, Jonassen, & Liu, 2008).

2.2.3 Computer Supported Collaborative Learning

Stahl, Koschmann, & Suthers, (2006) define Computer Supported Collaborative Learning (CSCL) as how technology can support collaborative learning (CL) through facilitating, sharing and distribution of knowledge and expertise among community members using technology as their primary means of communication or as a common resource. It is a pedagogical approach which can be implemented in the classroom or online learning environments to facilitate CL and to study the use of technology in educational environments. For planning the formal in-classroom learning sessions of this research project, one contemplates the basic five components of scripting in CSCL by taking into account that our students will be most likely approach the quests as a group. The general description of the lesson section (3.6) aims at characterizing these components into the lesson plan, by specifically detailing the learning objectives of the activity and type of

activities, establishing the sequence of activities to be performed by the students, by providing an environment which supports role distribution among students, and by choosing the type of representation through which instructions are going to be presented to the participants (Kollar, Fischer, & Hesse, 2008). As the literature indicates, scripting for collaboration provides a wide array of benefits, as it may respond to traditional challenges present in collaborative working scenarios, such as free-rider effects and over-working. As Vuopala, Hyvönen & Eagle (2012) state, scripts can address the emergent needs that can arise within groups, while enhancing student activity in terms of quality, and participation. Nevertheless, special attention must be given to the extent of the effect of these scripts, as an over-scripting may lead to negative outcomes, and cognitive overload in students can distract them from the intended initial path (Dillenbourg, 2002). Therefore, we as teachers must set limits on the intended scripting presented, so as not to delve too deeply into an excessively tight script, and adopt a traditional instructional design approach.

The video game Minecraft presents a myriad of opportunities for educational design. It, along with other contemporary games, enables teaching processes to be focused on specific abilities related to concrete areas of performance at specific age intervals (Jaipal & Figg, 2009). Within the video game, by giving the children a measure of control and liberty of movement and action, they become empowered to collaboratively solve problems from their own perspective, and feel the need to solve them using their own strategies. Likewise, the children are enabled to take decisions at their own pace in a fail-safe scenario (avoiding issues related to excessive difficulty), and drill abilities facilitated by the game design, such as spatial visualization, reaction time to stimuli, and visio-motor coordination (Griffiths, 2002).

The interventions will start with a script such that minimum guidance is provided over the procedural aspects of the game and our subjects and concepts, so that they reach their own understanding based on what they already know (which will be briefly assessed at the beginning of each lesson, to ensure they are all presented with a challenge at their level). Thus, the teachers will adopt a role of introducer and facilitator (3.5.1). In that sense, one will perform a type of collaborative scripting whose level of tightness gradually becomes lower, proceeding from a tightly-scripted, instruction-oriented phase, into a free phase of experimentation. This way, one hopes to facilitate trans-activity among students, by allowing them to rely on their peer´s reasoning when the need comes, without having to employ highly intrusive teacher participation (Weinberger, 2011). Peer tutoring will be supported by the freedom of forming groups according to previous performance during the

sessions and always after the introductory phases (3.5). High-achievers will be encouraged to pair with low-achievers, and will be suggested to provide support to the peer student as needed. Likewise, those students who fared better in handling game mechanics will be encouraged to collaborate with those who did not fare as well, to ensure a swift progression and inter-peer scaffold usage.

2.2.4 Digital Game-Based Learning

We base ourselves on James Gee´s (2005) Digital Game-Based Learning (DGBL), by which video games offer a number of possibilities associated to learning and potential development in the student, by means of presenting varied levels of demand according to performance. Within Minecraft, students will get the power to define the final stages of the presented problem (considering it is an open-ended task). Open-ended tasks allow for the development of synthesis skills and exploration (in contrast to traditional close-ended tasks, like multiple-choice). Students will expectedly delve deep enough into the game to allow for learning the presented content, (rather than through teaching via abstract representations). Likewise, within Minecraft, novel ways of evaluating can be employed depending on different student learning styles. Selecting DGBL becomes almost mandatory for the present research, considering the ample opportunities a video game-based learning setting can provide.

The DGBL model is built on the fact that students are curious when it comes to acquiring information presented in a novel way as in a video game. Aligning with the theory of PBL (2.2.2) one wants to present a set of challenges to the students that enables them to interact in a constructive way with peers that might offer a different type of expertise, to jointly build on what they know and reach learning outcomes (Jonassen, Howland, Moore, & Marra, 2003). In addition to PBL, and aligning with the aspects of gamification to reach a maximum of motivation and curiosity, we designed a quest based, rewarding system and implemented in a story about the students being “Pirates” stranded on an island as an additional gaming factor (3.6.1). To escape the island and access new territories, the quests (pedagogical content) had to be solved. For those quests, the participants were able to achieve rewards which were designed to trigger the informal learning outcome and support them in order to succeed in the follow-up quests. Ronimus, Kujala, Tolvanen, & Heikki (2014) discuss that a reward system encourages the children to play longer sessions at the beginning of a training period, but that this effect might vanish

after a few sessions, it is expected that through the presented design in this research the necessity for further participation means the motivation does not decrease (Huang & Soman, 2013).

As the process goes on, students will be scaffolded during the in-classroom sessions by their peers, teachers, or in-game assisting tools, and they will be advised to rethink their currently adopted strategies to reach their goals by raising the difficulty according to the performance of the participants. One expects students will be actively engaged in reaching said goals by making new meanings by themselves within the game, based also on their previous knowledge. Ultimately, our objective is to enable meaningful learning to sprout, in terms of its five attributes featuring DGBL: being active (by observing and manipulating objects from the environment as a way to develop skills), constructive (by reflecting on activity and articulate what was known before with what is acquired), intentional (by taking motivated decisions), authentic (by acquiring skills that can be applied in multiple contexts, stimulating high-order thinking), and cooperative (by reaching socially-agreed goals) (Jonassen, Howland, Moore, & Marra, 2003).

2.3 Minecraft as a CSCL Tool

CL in general shows a lot of promise in regards to making the learning process more visible and valid. Working in collaborative learning contexts, especially in one like ME, is associated to enhancing critical thinking skills for problem solving, deeper conceptual understanding, and emerging empathic bonds among members (TeacherGaming LLC, 2017). Among the foremost theoretical treatments discussing collaborative learning, there is a distinction between different types of social interaction leading to learning as a group. Whereas there can be teamwork in which there are clearly established roles from the beginning and goals are observable and attainable by all, sometimes it might not be so. In general, the distinction made between forms of peer learning (peer tutoring, cooperative learning, and collaborative learning) has to do with dimensions of equality and mutuality of influence (Dennen & Hoadley, 2013). Those ME worlds ideally refers to a collaborative learning setting in which there is a joint discussion in setting socially agreed goals, and the task development happens following joint strategies, in such a way that not only cognitive aspects but also motivational, emotional, and social aspects are taken into consideration among peers. During the research project we worked with two main approaches: The Social-motivational approach: a highly behaviourist approach, which aims

to create interdependence by relying on the use of rewards and/or recognition by presenting group efforts, and the Social-cohesive approach: the basis of this approach is that group members collaborate with the team because they wish to see the others succeed (Fischer, et al., 2013). In both cases, a measure of interdependence should be present, and group members should understand that both goals and rewards are shared. There are both high in equality and mutuality of influence (Hmelo-Silver, Chinn, & O´Donnel, 2013).

2.4 Previous Research in the Field

Many books, sources and "articles" can be found online about the topic of Minecraft and suggestions of its pedagogical usage in schools, but only a small number of publications base their theories on profound scientific usage or focus on why the in-game structures were designed as presented. Plenty of those "guides" refer to online forums, YouTube videos, blogs and other sources where educators simply describe their work with Minecraft without conducting research about it (Nebel, Schneider, & Ray, 2016). This is a simply due to the fact that Minecraft as an educational tool is almost "new" compared to others. The game was released just six years ago for entertainment purposes (Mojang & Microsoft, 2017) and has recently found its way into the classroom, and as a result into the field of educational research (TeacherGaming LLC, 2017). Nebel, Schneider, & Rey, 2016 present in their study: *A literature review on the use of Minecraft in education and research*, several examples of usage of Minecraft as a teaching tool based on above mentioned sources. They outline that a specific need of expertise about Minecraft is needed from the researchers for successful research, and emphasise that the option of modding the game offers an infinite amount of possibilities for its use. As one of the first Duncan (2011) discussed the possible pedagogical use of Minecraft by outlining the design of Minecraft as very beneficial due to its unlimited possibilities. Out of the above mentioned "guides", the first case studies were conducted in educational institutions. For example Schifter & Cipollone (2013) present a case about a study in English lessons by discussing the engagement of students via the video game while Orlikowski, Bongartz, Reddersen, Reuter, & Pfeiffer, (2013) conduct research about the possible usage with VR-Systems with Minecraft. List & Bryant (2014) discuss in a case study usage for geographical educational purposes via using GPS units inside the game, while Smeaton (2014) and Petrov (2014) conducted quantitative studies about teachers' experiences which resulted into supporting the usefulness of Minecraft and emphasises the potential of rising the

motivation in learning as an outcome through its established popularity in schools'. Overby & Jones, (2015) showed how Minecraft based on its creative nature and possibilities can be used as a tool for arts lessons. Based on the previous mentioned studies and the case studies of Uusi-Mäkelä (2015) and Pihkala-Posti (2015) about gaining language competences by using Minecraft, the present research approach was chosen.

3 METHODOLOGY AND RESEARCH DESIGN

In this chapter, the research context and design will be elaborated in detail. At first an overview of the research participants and research environment will be given. Thereafter, methods and methodology will be defined.

3.1 Context

In order to avoid language barriers between the researcher and the participants, the lessons and the data collection were carried out at a school where the official teaching language is English. Furthermore, the facility itself especially the computer lab offered, aligning with our designs, a research friendly environment.

3.2 Subjects

The students/research participants were between the age of nine and twelve, from fourth grade to sixth grade, males and females and got the opportunity to enrol themselves for our research project if they were interested in it. The project was advertised as a non-formal after school club via a poster at the school; in addition to that online information was provided to the parents via E-mail. In total, we had space for 16 participants (limited by the amount of workspaces), but way too many applicants. In order to choose our participants, simple random sampling was used which is defined as choosing subjects out of a larger pool, with each individual chosen entirely by chance with an equal chance of being included in the sample (Fraenkel, Wallen, & Hyun, 2012).

3.3 Tools

3.3.1 Minecraft and MinecraftEdu

Minecraft belongs to the most popular and most sold video games of all time, and had in 2016 about 100 million official registered players. It is best described as an open world sandbox game taking place in a little micro society. It was officially released in 2011 for PC by a Swedish company called Mojang and is nowadays owned by Microsoft. Its world is built up on $1m^3$ textured blocks which either can be mined or used for building. The player finds himself in a randomly generated world containing several biomes simulating

night and day, weather and is populated with animals and villagers. Minecraft includes two gaming modes that the player chooses from: The “creative” allows him or her to build anything he or she desires using all of the implemented materials unlimited without the possibility of dying or the need of food. In the “survival” mode the player has to craft all mentioned items by himself in order to be able to build. In addition to that, hunting and defending against monsters is necessary in order to survive. The participants of this study will play during the survival mode in order to balance the knowledge gaining phases with the original idea of playing the game for fun “in survival” (Duncan, 2011; Mojang & Microsoft, 2017). It needs to be mentioned that it was not the vanilla version of Minecraft (original) that was chosen to conduct the presented research. A stand-alone version Called MinecraftEdu (ME) was used.

ME is an official modification of Minecraft developed by a Finnish-American company called TeacherGaming LLC and is especially designed for collaborative teaching purposes (TeacherGaming LLC, 2017). The presence of Minecraft in children’s life is beyond dispute and with ME the game slowly made its way into different educational systems. At the beginning of 2015 ME counted 300 000 users from 5000 different schools. ME is a stand-alone game, not as the usual content based add-ons (3.3.2), it works as an independent game especially designed for teaching purposes and as a result makes using Minecraft classroom friendly. It allows teachers to incorporate their own curricular content and run a custom server for each of their classes (Drzewiecki, 2014). In ME, the multiplayer mode is used to create different learning environments. In addition to that, it includes a pedagogical surface which provides the teacher with different opportunities to interact with his or her students. ME includes different worlds, and nowadays as well a huge online platform for teachers to share and discuss their work (planned lessons and online environments), 3D designs and models (Pihkala-Posti, 2015). Those models are self-designed and/or downloaded according to the subject and the topic an educator needs for further implementation into the multiplayer environment of the MinecraftEdu classroom (Drzewiecki, 2014).

3.3.2 Modifications (Mods)

Mods or Modifications are Add-Ons to the original vanilla version of Minecraft. As a matter of pedagogical use, the developers of ME implemented the same possibility of Add-ons to the teacher version (TeacherGaming LLC, 2017). Mods allow the user to modify

game rules, alter game content, redesign textures and give players new abilities - summarised with a Mod one can do basically anything to the game (Kuhn & Dikkers, 2015). In the following paragraphs, the Mods used in this study will briefly be described:

The first Mod implemented was Electrical Age. It was designed by a collective team of programmers and gamers calling themselves the “Electrical Age Team”. This mod adds a real electrical simulation model to the game and is offering the ability to perform large-scale in-game electrical simulations by adding over 150 additional items behaving similar to real life objects (Electrical Age Team, 2017).

The second Mod which was implemented was the ComputerCraft Mod. This mod was designed by the game developer and Modder Daniel Ratcliffe. It is a Mod that adds Computers, Monitors, Modems, Turtles and many more items. Those devices are pre-programmed and programmable with a visual programming language and an easy to learn LUA programming language. One can use the originally implemented materials in Minecraft and combine those with the new offered items from the Mod. This Mod offers an easy approach towards programming with children (Ratcliffe, 2016).

The last Mod to describe is WorldEdit, which is an easy-to-use Minecraft map editor and is an advanced tool for creating and changing content in a Minecraft. It was originally created by a programmer with using the synonym “sk89q” (TeacherGaming LLC, 2017) It implements commands and features to sculpt the world and perform numerous terraforming tasks, offers the opportunity to quickly create, replace or delete huge structures, to create fast basic shapes, copy and paste whole areas and save them as a file. In addition to that, the Mod lets you import files and predesigned structures of others. This tool is a must for each educator designing learning environments in Minecraft. While the vanilla version implements none of the above mentioned possibilities, ME just some, WorldEdit covers a whole spectrum of needed tools (TeacherGaming LLC, 2017).

3.4 Design-Based Research

In this chapter design-based research (DBR) will be introduced as a research method. According to Amiel and Reeves (2008) DBR has recently received considerable attention by researchers in education as an emerging framework that can guide better educational research (Van den Akker, Gravemeijer, McKenney, & Nieveen, 2006; Brown, 1992; Cobb, Confrey, diSessa, Lehrer, & Schauble, 2003; Design-Based Research Collective, 2003). In

general, this research approach is fairly new. In education, DBR has been becoming popular in the early 90s through the rise and development of digital media in education, its need for new learning designs (Brown, 1992) and through setting a new standard for educational empirical research. Researchers are encouraged to move towards more systematic and collaborative methods of investigations since technology should be recognized as a process rather than a tool (Amiel & Reeves, 2008).

In DBR, practitioners and researchers work together to produce meaningful change in contexts of practice (e.g., classrooms, after-school programs, teacher online communities) (Cobb, Confrey, DiSessa, Lehrer, & Schauble, 2003). By reflecting on the presented content, peers can evaluate the learning environment and in addition to that teachers can observe and conclude based on the learning outcome. The main purpose of those evaluation is to generate knowledge about a specific content in order to make value statements about content improvement (formative evaluation) and impact (summative evaluation) (Fitzpatrick, Sanders, & Worthen, 2011). DBR methods focus on activity structures, institutional designs, scaffolds and curricula. It goes beyond merely designing and testing particular inventions. Instead specific theoretical claims through reflection an understanding of the relationship between implemented theory, designed artefact and practice can be made.

Wang & Hannafin (2005) defined DBR as a methodology with the purpose of developing education and educational environments in real life situations through flexibility and alliteration. Over ongoing evaluation and reflection of the situation by the teachers and the peers, the learning environment shall fluidly adapt to the current needs of its participants. In this case, the product of design is an After-School-Club in the form of Minecraft lessons containing pedagogical content based on different curricula. DBR methods can compose a coherent methodology that bridges theoretical research and educational practice in cyclical processes.

Reeves (2006) outlines three cornerstone principles of this research framework:

> *"... addressing complex problems in real contexts in collaboration with practitioners; integrating known and hypothetical design principles with technological advances to render plausible solutions to these complex problems; and conducting rigorous and reflective inquiry to test and refine innovative learning environments as well as to define new design principles" (p. 58).*

DBR heads towards building a stronger connection between educational research and real world problems. With interactive research processes it systematically attempts to refine the innovation while providing design principles that can guide similar research and development endeavours (Amiel & Reeves, 2008).

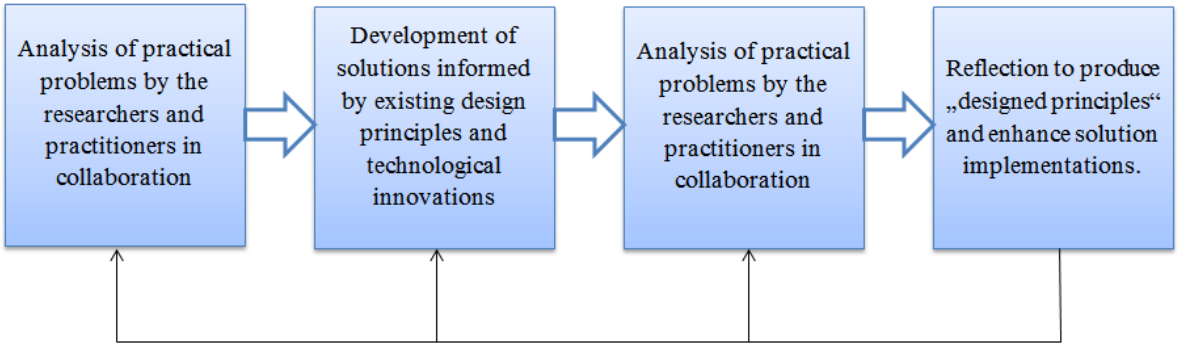


Figure 5: Design-based Research Model (Amiel & Reeves, 2008)

As shown in Figure 5, through analysis of practical problems the researchers and practitioners develop solutions informed by already existing theories, design principles and technological interventions. By analysing new practical problems faced during the new implementations, new "design principles" are concluded to enhance solution implementations (Amiel & Reeves, 2008).

Due to the presented research aim, planned environment and its participants DBR was chosen as a fitting approach. Since new pedagogical practices and learning environments were designed and introduced to students, and each session will be planned on the reflections and outcomes of the previous one, this approach perfectly fits this research (Collins et al. 2004; Pihkala-Posti 2015). Reliability and Validity of DBR will be discussed later onwards (5.1).

3.4.1 A pragmatic Approach

DBR as an applied research involves academic researchers testing theoretical understandings in natural settings (Shah, Ensminger, & Thier, 2015) or examining the application of theoretical understandings to address within educational purposes (Johnson & Christensen, 2012). One particular method to gather data does not cover a broad research approach like DBR. As a result, a pragmatic approach is suggested in order to

gather data. This pragmatic approach allows DB researchers to be methodologically (McKenney & Reeves, 2012). Depending on the immediate need of the DBR-study it employs an eclectic approach in the design and implementations of research methods by drawing on all research designs (Shah, Ensminger, & Thier, 2015). John Dewey's view of a research environment as a set of fluid and dynamic interrelationships results into a reality which is unforgivably complex. He pointed out that through the process of research not only one single "truth" can be evaluated. Dewey highlights the possibility of several multiple "truths" and in order to be able to understand those several and multiple approaches of data collections are needed (Dewey, 1958). As a result Deweyan Pragmatism and DBR acknowledge this complexity inherent in schools and in the process of learning (Shah, Ensminger, & Thier, 2015).

3.5 Pedagogical Design

The pedagogical design of the Minecraft sessions consisted of different phases designed especially for our research, purpose and lessons. According to Reeves (2008) generalised pedagogical layouts for DBR (3.4.), in the presented case the initial intervention, is in need of its own individual starting design based on theoretical grounds. Minecraft offers many opportunities to create one's own designs which fit their purpose, and in order to create a perfect environment for our research project, the researcher -based the pedagogical design for this research on the previously discussed frameworks of formal, non-formal and informal learning (2.2.1), the introduced DBR model (Figure 5) and the five steps of the gamification process (Figure 3). This model for education in Minecraft was created with the initial purpose of giving space for all learning approaches, and in addition to that, time and space for profound evaluation and reflection. For the discussed research project the following pedagogical design was implemented:

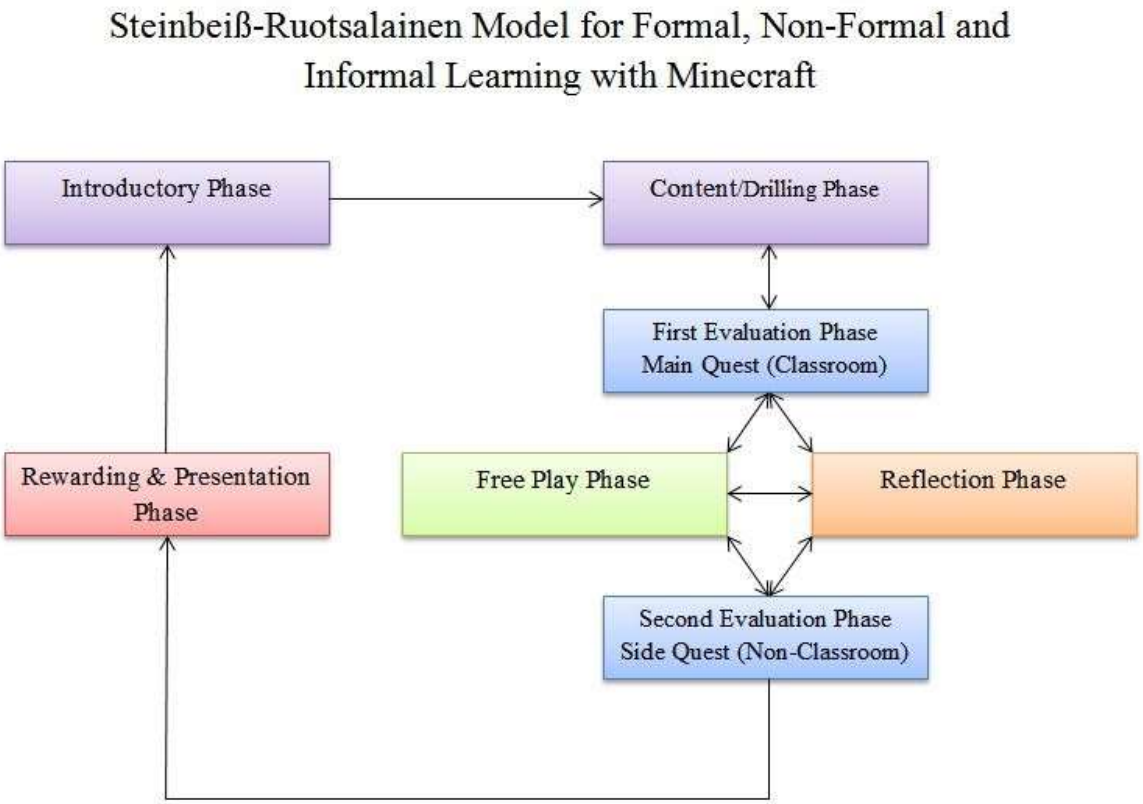


Figure 6: Steinbeiß-Ruotsalainen Model for Formal, Non-Formal and Informal Learning with Minecraft

1. The *introductory phase* includes a basic introduction into the session's topic. Students receive a small input at the beginning of each lesson so they will feel familiar enough with the content. Along this phase, one will determine student roles within dyads for each subsequent phase, to ensure clarity about the performance. After the introductory phase students will login and continue online exploring the content/drilling phase.

2. The *content/drilling phase* includes is a guided in-game tour (tightly scripted) through the targets learning concepts. Just after this, students will be provided with in-game materials (building blocks and other tools) to drill what they have acquired so far. Even though the background will contain a general summary of the concepts they have just been shown, students will be left to work on their own, withholding scripts and exclusively providing scaffolds when needed. After the students have understood the general content of the lesson they move forward to the in-classroom evaluation phase.

3. The *first evaluation phase* (in-classroom, "The Main Quest") included a challenge, where students were be asked to perform a (set of short) task(s) in which they unified what they had acquired and practiced in an open context. In-game materials were given as needed, and students performed freely. If a student was lost he or she was always been able to return to the content drilling area to gain more knowledge about the topic (Figure 6). Afterwards, the students were encouraged to continue to the in-classroom reflection phase but were also free to play since they had one whole week to fill in the diaries.

4. The *reflection phase* included a small discussion in the form of a group interview (3.7.3.) at the end of each session. The students were encouraged to bring and share their thoughts and knowledge about the lesson in a small discussion at the end of each intervention in order to sum up and reflect on the lesson design and experiences properly. The part of reflection also included a small survey (3.7.4).

5. The *free to play phase* was designed to give the students time to explore and learn on their own. The gaming servers were online 24 hours a day and students were able to connect whenever they wanted in order to either play or gain knowledge. The content area was accessible at all times and students were allowed to continue their work at home or explore new areas in order to understand new concepts and content (Figure **7**Figure **7**: Formal, Non-Formal and Informal learning Cycle through "Steinbeiß-Ruotsalainen Model").

6. The *second evaluation phase* (non-classroom, "The Captain's Quest") included an outside classroom quest, where students again will be asked to perform a (set of short) task(s), in which they can freely chose to participate, to show their gained knowledge from during the in classroom sessions.

   At this point, students were able to access all phases they needed in order to succeed in the quests. At any time in between the sessions they were able to return to the content/drilling phase, first and second evaluation phase, free to play and reflection phase. This cycling between phases (Figure 7) gave the students the opportunity to plan and structure their own learning outcomes through formal, non-formal and informal learning opportunities (Cedefop, 2009):

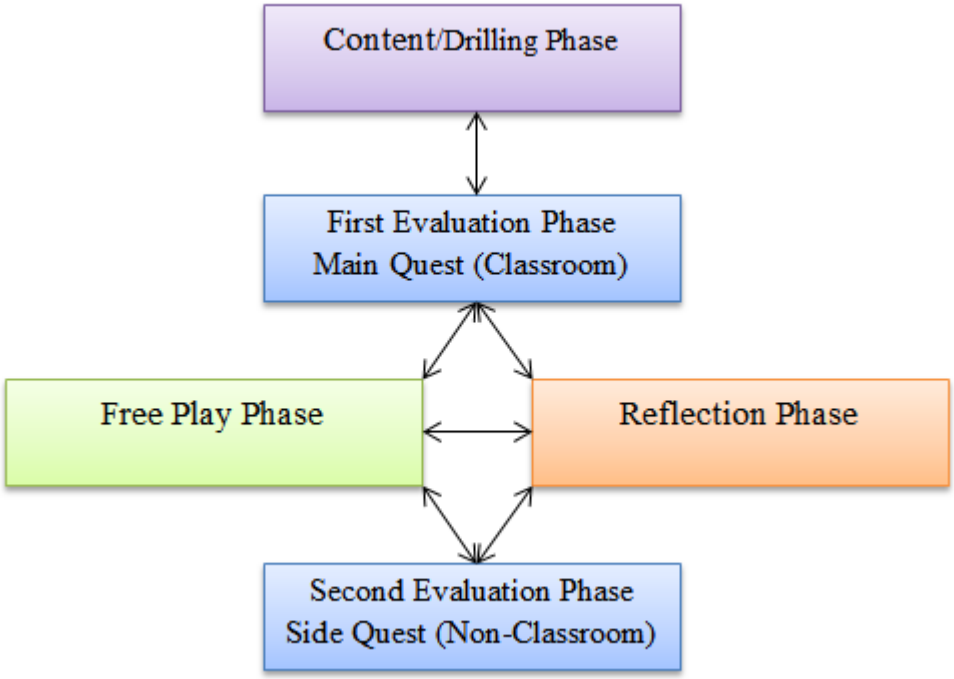


Figure 7: Formal, Non-Formal and Informal learning Cycle through "Steinbeiß-Ruotsalainen Model"

7. The *rewarding and presentation phase* included the possibility for students to show their projects and learning outcomes either to the class or to the teacher. Since rewards were given out for successfully participating in the classroom and non-classroom evaluation phases, students needed a space to prove their accomplishments. Furthermore, many other projects of students were shown to the class. After this phase, a new session was initiated.

   In addition to above, the students had full access to all content at any time content/drilling phase I-VI, first and second evaluation phase I-VI, and reflections of Sessions I-VI (Figure 8). An opportunity to explore all content (but not guided and explained) beforehand was given to the students on any occasion to provide them with a free learning environment.

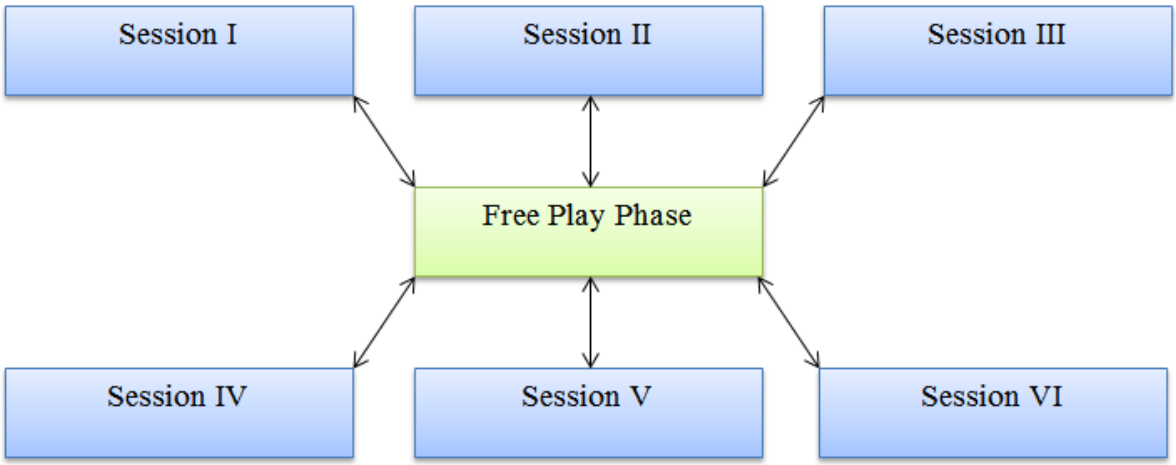


Figure 8: Full Access to all Sessions

3.5.1 Role of the Teacher

As mentioned before the teachers will adopt the role of introducer and facilitator, stepping aside after an initial instruction and allowing the children to work on their own by supervising progress and scaffolding the child when the situation requires, but otherwise providing liberty of action to the student to move within her Zone of Proximal Development, in line with Vygotskian perspectives. (Vygotsky, 1992). Teachers during the lessons will shift toward being facilitators, rather than as an instructor. This is grounded on the fact that one wants the students to learn being exclusively based on the video game and peer support, making the teacher's behaviour passive and accompanying, rather than imposing. The direct participation will be minimum, resorting instead to guiding the students to following in-game prompts, and solving any inquiry or helping them in any difficulty that emerges. Evidently, guidance and attention will be tighter toward the beginning of the lesson, since the introductory and content/drilling phases (3.5) aim at ensuring the acquisition of knowledge and skills. Nonetheless, by the third and final phase (evaluation/creative challenge phase), teacher participation will be minimum, allowing total freedom in the students and expecting high creative output. TeacherGaming (2017) emphasises that it is better to help a student inside the game rather than standing behind them and telling them how to move or taking over their computer. For that purpose, an especially designed online character called “The Captain” was introduced to the students (3.6.1).

3.6 Design of the Interventions

In this chapter, the online environments of the sessions' structures (3.5; Figure 7) will be described in more detail. The lessons, as mentioned above, were structured into multiple parts: Introductory, content/drilling, in- and non-classroom evaluation, in- and non-classroom reflection, free to play, and the rewarding and presentation phase (3.5). Over a time period of seven weeks, one 90 minutes lesson per week was held at the school in person. These lessons were structured as follows:

~ 10 minutes rewarding and presentation phase,
~ 15 minutes introductory phase,
~ 20 minutes content/drilling phase,
~ 30 minutes first evaluation phase and
~ 15 minutes reflection and free to play.

Depending on the student's performance, these times may have varied during the sessions. In addition, it needs to be mentioned that those session designs are the direct result and outcome of the presented study. Aligning with the approach of DBR (3.4) and based on the analysis of each previous session (4) the design of the next session was planned.

3.6.1 The Island and Story

Squire (2011) highlights the importance of social interactions in and around games at home, at school, and in online communities. It is mentioned that in order to sustainably learn socially and academically valuable concepts, specific social (i.e. an online society) and gaming aspects (i.e. a strong catchy narrative) can be supportive. In order to not just drop the students into a game without a story, the subjects in our research project found themselves as being "Pirates" stranded on an island (Figure 9). To be able to exit the island and expand their explorable world, several quests (pedagogical content) had to be solved. With the received rewards it was possible, to survive, create a society, explore and learn about new content and in the end escape the island and "win" the game. As an example of how the story was started, here is the introductory storyline of our first session:

> *"This is your Captain speaking! Unfortunately I made some miscalculations and now we are trapped on this island. I noticed some strange things on this reef so I*

decided to explore it on my own immediately! I left to you my entire Captain's Logbook and I hope you have already made it readable with creating yourself a secret account to access this online wiki! We need to keep it updated at all costs! Use it as your island diary and write a sailor's logbook to keep me updated about your adventures. This is a magical logbook which combines all our entries wherever we are on the island. I will continue my Captain's Logbook as well to tell you about the six secrets quests I found on the island, but unfortunately I cannot find my way back to the ship for now! We will stay in touch via the logbook, since I might have some side quests for you as well; after all I am your Captain! I found an island survival guide, someone must have lost it but it seems quite useful for staying alive on an island like this. At some places on the island you might find information blocks, I left them there to help you out with useful info's. For now this is all I can tell you. Your Captain"

Figure 9: Starting Island and Sunken Ship

The character of "The Captain" (3.5.1) was used by the teacher as an online character on the island and in the story in order to deliver information in-game, and to support students during their quests. So called "Information Blocks" (Figure 11) were placed around the island in order to keep the narrative going, provide input, guidance and links to the an online wiki containing detailed descriptions of the quests, story and the online diaries.

3.6.2 Hall of Quests and Science Centre

In order to differentiate more easily between the free to play area and a learning environment the “Science Centre” was created (Figure 10). This differential design was implemented during the research process since it emphasised the learning outcome of the students (4). Also MinecraftEdu separates environments besides the normal playing areas with implementing a possibility to teleport (TeacherGaming LLC, 2017). It simplified the access to the content without getting lost on the island, and the subject dividing learning areas in the “Science Centre” gave simple access to all the provided content during the free-play phases.

Figure 10: The "Science Centre"

Inside the “Science Centre”, a “Hall of Quests” was built with the possibility to walk or teleport into all subject areas. In addition, the students were able to open the wiki and access all additional non in-game information and their reflections. For that purpose, the above mentioned “Information Blocks” were used, which offer the possibility to include links into the game. The students were able to teleport from the town hall (Figure 21; 4.1.2) on their island into the “Hall of Quests” in order to freely move around and explore all the provided content.

Figure 11: Hall of Quests and Information Blocks

3.6.3 Session I - Introduction, Collaboration and Society

Session one was initially designed for one week but since some students needed more time to either acclimatise to the new learning environment, or to just learn basic gaming skills, the time was expanded to two weeks (equals two weeks of free to play in combination with fulfilling the quests in combination with 180 minutes in-classroom time)

The main subject of this session was to give the participants time and space to learn how to play the game, to show them the possibilities of how to interact with each other and how to collaborate. Furthermore, it was emphasised to create a village, a society on the island (Figure 9) in order to support the learning outcome of the participants (Uusi-Mäkelä, 2015). Several opportunities were given to understand the basics of Minecraft and the content was differentiated according to different skill levels.

During the introductory phase (3.5) the game was shown and explained to the students with a general overview and supportive comments from other students which were already familiar with the software. In addition to that it was discussed why the video game Minecraft is used at school. It was explained that the experience of playing Minecraft in school would be different from playing at home, that specific assignments would be given and that inappropriate things one might do at home would not be tolerated in the school environment without consequences. Furthermore, ground rules were set as a group; for

example, the “golden rule”: Treat others as you want to be treated (Microsoft & TeacherGaming, 2016)

During the content/drilling phase students had to go through a tutorial world before proceeding to the island (Figure 9) to work on their quests and join the storyline after the introduction phase (3.5). Students who have never had played the game before were in addition guided by the teacher in-game through a tutorial world (TeacherGaming LLC, 2017).

Figure 12: Start Tutorial World

The tutorial world (Figure 12) partly followed our pedagogical model, and provided a lot of in-game tools and practicing opportunities which were needed to get used to in order to succeed in our world as well. It was delivered with the in-game content of MinecraftEdu and is structured in six different zones where children learn step by step how to use the game properly by following signs and instructions. In zone number one, the subjects learned basic movement by following hints, afterwards in zone two they reach a parkour where they had to use the acquired skillset. In zone 3, they face a task which inquires about their problem solving abilities and if achieved collaboratively the subjects were able to continue to the next zone. In zones 4 and 5, the students learned about using items, placing blocks and different materials before they reach zone 6 which would have been a free to play area. Instead of continuing in the tutorial world, the students switched to the world which was designed for the research (TeacherGaming LLC, 2017).

During the first evaluation phase (3.5) of this session, the children faced several main quests for which they need the previously acquired skills from the tutorial world. An additional intention was to form an online society in combination with the story in order to build a profound gaming experience in combination with the pedagogical content. For that reason, the size of the island was chosen according to the number of players so it was unavoidable for them to play alone and not to interact with the others. The main quests of the first session were defined as follows:

1. **Explore the island** together with a buddy! Never go alone it is dangerous out there!
2. **Build a house!** Try to survive, protect yourselves, and build a shelter.
3. **Find a place for your house!** Mark your place with torches and a sign and start building, do not take place away from others!
4. **Build a bed!** Build a bed for every person living in the house!
5. **Build a chest!** You need a place for your material!
6. **Put a sign in front of your house** with your name on**!**
7. **Start living in your new Village!**

The rewards for this session were chosen in order to give the participants enough material to succeed in the second evaluation phase (3.5). 64 cobblestones, 64 oak wood planks, 32 panes of glass, six chests and one item of choice were offered (general building materials for houses).

During the second evaluation phase (3.5), the students had to build a town hall with the material of the destroyed ship (Figure 9). The quest was delivered by the "Captain" online during the week with an "Information Block" placed on the island. Since this was designed as a collaborative task, a group reward was chosen to be access to the "Nether" (a second dimension in the game; Mojang & Microsoft, 2017), ten pieces of gold for each player participating, and the opportunity of teleporting to the "Science Centre" (3.6.2).

3.6.4 Session II - Physics: Electricity

The subject to be taught in this session was physics and within that, electricity, the concept of basic circuits, the flow of energy and how energy is produced. The idea was to give the students an opportunity to experience electricity according to real life physics and for that purpose the Mod Electrical Age was used (3.3.2; Electrical Age Team, 2017, MediaWiki,

2017). The newly created learning environment - the Electricity Museum - included a broad spectrum of the topic provided in a project based learning environment which aligns with the teaching approach of the Finnish national curriculum (OPS, 2016). Many more things than actually needed were included, i.e. block circuits which can be crafted into a number of logic gates similar to real life digital electronics, or signal cables connected with in-game screens. Additional material was placed in order to trigger the motivation of the participants to return and continue exploring on their own (Short, 2012).

During the introductory phase (3.5), the students gathered their previous knowledge about electricity and in addition to that several Mod related tools were introduced which the students needed in order to succeed in the quests. Since the learning environment was huge, it was emphasized that the students should not explore everything at once during the content/drilling phase, but focus on the quest related areas.

During the content/drilling phase (3.5) the students explored the museum in the "Science Centre" (Figure 10) and were guided with signs and information beacons through the interactive museum. At first, cable and its purpose were introduced, how a circuit works and how energy flows. Simple interactive examples were shown. In the second part of the museum, it was explained how energy is produced and how those circuits could be combined with a power source. The third part of the museum included a fully functional self-powered house that the students were able to explore, and in the fourth part, signals and signal cables (irrelevant for the quests) were introduced.

After the participants went through the museum, they ended up in the first evaluation phase (3.5) which included a set of simple quests. After following the guided tour through the museum, the participants should be able to succeed in all the quests working in the "Science Labs" (Figure 12). Each student was provided with several items (cables, lamps, lamp sockets…) and arrived at his or her own individual working place to pursue the following quests:

1. **Pick up your building materials** - Grab the materials you need to work at your science lab.
2. **Find yourself an unoccupied science lab -** Look around and find yourself a free place, remember your laboratory number.
3. **Connect your Lamp to the main power circuit** - Use the provided power source to lighten up your lamp.

4. **Connect the machines to the main power circuit -** Use the provided power source to turn on the machines.
5. **Produce your own energy with a water turbine** - Use the water and dirt blocks to build a small river and get the blades turning.
6. **Power your machine and lamp with your own energy -** Before disconnect your circuit from the provided power source.

Figure 13: Science Labs for Electrical Age Mod

Again the rewards for this session were chosen in order to give the participants enough material to succeed in the second evaluation phase. A starter kit was given in order to motivate the participants to explore the Electrical Age Mod (3.3.2). A water turbine, a 50 V plate machine, an electrical furnace, two flat lamp sockets, one Redstone to voltage and voltage to Redstone converter, one 50 V turbine and one e-coal chest plate were the rewards (Electrical Age Team, 2017; MediaWiki, 2017).

During the second evaluation phase (3.5), the students faced the task to produce energy for their own houses, lighten up lamps and power their own machines. Six cost oriented batteries for their houses, five diamonds, ten gold pieces and ten iron pieces were the rewards for this quest. In addition, the opportunity of teleporting to the "Hall of Quests" (3.6.2) was given.

3.6.5 Session III - Mathematics: Area and Volume Calculations

Since MinecraftEdu offers several new blocks and opportunities which support mathematics (TeacherGaming LLC, 2017), the next subjects to be taught in a session were arithmetic and basic geometry. The basic cube shaped blocks give the opportunity to explore within geometry the concepts of area in quadrilaterals, volume in cubes and rectangular prisms, along with basic hands-on calculation algorithms for building solids (excluding the positive mathematical aspect by taking advantage of the digital tool) (Gilbert & Dikkers, 2015). By the end of the session, students should have acquired a basic overview of the definition of area and volume calculations.

At the beginning of the session, during the introductory phase (3.5) the participants were asked to gather all previous knowledge about volume and area calculations. With a brainstorming in groups, they brought their memories on paper and shared their ideas with other participants in order to ensure the success of every classmate. Furthermore the new learning environment (Figure 14) was officially introduced and hints how to start and find guidelines were given.

During the content/drilling phase (3.5) the students were guided through two main areas where signs indicated how to solve the mathematical equations. Both spaces focused on calculating areas or volumes, and introduced the students step by step to the main concepts of the formulas.

Figure 14: Mathematics Learning Environment

In the first evaluation phase (3.5), the students showed their progress in-game by solving a simple set of tasks in the new learning environment (Figure 14) that requires them to apply skills practiced and obtained throughout the lesson:

1. **Complete area calculating room**: Read and follow the signs in the area calculating room and build at least one figure in the working area.
2. **Complete Volume calculating room**: Read and follow the signs in the volume calculating room and build at least one object in the working area
3. **Calculate your house's area**: Calculate the area of your house in square meters and place a sign with the result in front of the door.
4. **What is the volume of your house**: Calculate the volume of your house in square meters and place a sign with the result in front of the door.

Through this, one expected them to be able to grasp and understand the concept of fractions away from a paper-and-pen traditional approach. Likewise, in terms of geometry, students would have acquired basic definitions of area in quadrilaterals and volume in cubes and rectangular prisms (Figure 29).

Since there were no special items necessary for the second evaluation phase the rewards for this quest were villagers which are in-game AIs (artificial intelligence; characters or animals controlled by the computer; TeacherGaming LLC, 2017).
During the second evaluation phase (3.5), the students were encouraged to build a room or an additional room to their houses with at least ten square meters in order to host a Villager (in-game AI) who has the ability to trade items for emeralds (Mojang & Microsoft, 2017). Concluding from that fact the reward for this quest was fifteen emeralds.

3.6.6 Session IV - Creative Writing: Stories about a Zombie Apocalypse

The subject of this session was creative writing. Previous research has shown that the game itself can be used to develop language competences, especially in the field of second language competences (Pihkala-Posti, 2015; Uusi-Mäkelä, 2015). The idea in this session was not to focus on the language development but to elaborate on how the game could be used in order to write stories, and on how encouraging the online environment of Minecraft was in order to succeed. For this approach, it was decided to stay on the island (Figure 15; 3.6.1) instead of the “Science Centre” (Figure 10; 3.6.2) which was usually the place for

content/drilling and evaluation. “The Captain” introduced an upcoming zombie apocalypse, and, based on the survival of the participants, a creative writing phase was initiated since it might be one of the most exciting and inspiring occasions one could (Kuhn & Dikkers, 2015).

Figure 15: Island Overview

During the introductory phase (3.5), the “Book and Quill” item was introduced to the students, a tool which gives the writer the opportunity to form paragraphs in-game and save them as an item for further reading or writing (Figure 16; Mojang & Microsoft, 2017). In addition, the quests and tasks were explained carefully since the students were not working in the familiar, usually more scaffolded learning environment - the “Science Centre” (Figure 10; 3.6.2).

The content/drilling phase (3.5) was split up into two parts: The preparation and the invasion. During the preparation part, the students had time to collaboratively prepare against the upcoming zombie invasion. They were offered several books from “The Captain” (3.5.1) on how to protect themselves, on how to build shelters and how to avoid getting harmed. Furthermore, they were introduced to how to use weapons and armour against the AIs (zombies and skeletons). During the second part, the participants faced several waves of monsters and were in need to form and adapt strategies in order to survive individually or as a group. Additionally, they were encouraged to take notes in between the waves on how they managed to survive.

Figure 16: A Zombie and a Book

The quest outline of Session IV was as follows:

1. **Read the Captains Preparation Guide -** Read the guide and try to prepare yourself for the upcoming zombie invasion
2. **Survive and take notes -** Try to stay alive and support your classmates, write down your experiences in a "Book and Quill".
3. **Write a survival guide** - After the invasion, take your notes and write a book about your experiences. Afterwards hand the book over to the Captain in the town hall.

At the time of the first evaluation phase (4.3) all monsters disappeared and the students, after having successfully survived, received another empty "Book and Quill" which has proven itself as a good in-game writing tool since the students are able to edit their stories at any time and export the data into a word document (Dikkers, 2015). They were encouraged to write a story about their own experiences during the zombie invasion, about their collaboration with others, how they supported each other and which strategies they used in order to stay alive (Figure 34). Since there were no special items needed for the next evaluation phase, wolves, ocelots and horses spawned as a group reward. Those are also in-game AIs (artificial intelligence; characters or animals controlled by the computer) (TeacherGaming LLC, 2017).

During the second evaluation phase (3.5), the students were encouraged to write their own stories about their in-game life in Minecraft. As a continuation they present them to their classmates during the next rewarding/presentation phase (3.5). Therefore a group reward in the form of a second island connected to the first one was provided.

3.6.7 Session V - Geography: Nations of the E.U.

The subject to be taught in this session was geography. Minecraft offers several opportunities to start with, i.e. the automatically created landscape including different biomes, beaches, forests, oceans and lakes, and the opportunity to create maps and coordinates, or the fact that plenty of minerals and layers are present as well (Short, 2012). In addition to that, the creative aspect of Minecraft offers the opportunity to design flags, which was also shown during Session III (Figure 29) where a student remodelled the Finnish flag during the area calculation quest. As a result of this, the topic: The European Union was chosen. We decided to design this session following the most common aspects of the European curricula prescribed: Students should learn about the physical geography of the E.U. so they can identify the countries on the map; what it means to be a member state; why the E.U. was established in the first place and what role the E.U. plays on an international level. (Dunne, Ulicna, & Oberheit, 2013).

During the introduction phase (3.5), the students gathered all their previous knowledge about the E.U. in groups, and shared them afterwards with the class. In addition to that, the new learning environment was introduced and items containing the basic information about the European Union were provided to the student according to the above mentioned aspects.

While the students were reading the material in the content/drilling phase (3.5), they were able to walk around in a new learning environment to find even more useful information about the member states. Links to several web pages about the countries of the member states could be found, general information about the tasks of the Union and its history were provided. During this phase the participants were introduced to the following quests:

1. **Gather more information about the E.U.** - Follow the in-game instructions and find links and material about the topic - Take notes.
2. **Choose a country and build its flag** - Use the provided “wool blocks” to design the flag.
3. **Place a sign with official language, square kilometres and population** - Gather the information either via the in-game links or use google.com and wikipedia.org.
4. **Write a small tourist guide about your county in a “Book and Quill”**

In the first evaluation phase (3.5), the students were encouraged to choose a member state and built its flag inside a creative designing area (Figure 17) with “Wool Blocks” (blocks in various colours, usually designed in Minecraft for artistic purposes; Mojang & Microsoft, 2017). After they had finished the creative part, the participants had to gather and write down various pieces of information about the country on a sign and in a “Book and Quill” (as mentioned above). The reward for this session was an unlimited amount of coloured “wool blocks” in order to succeed in the following phase.

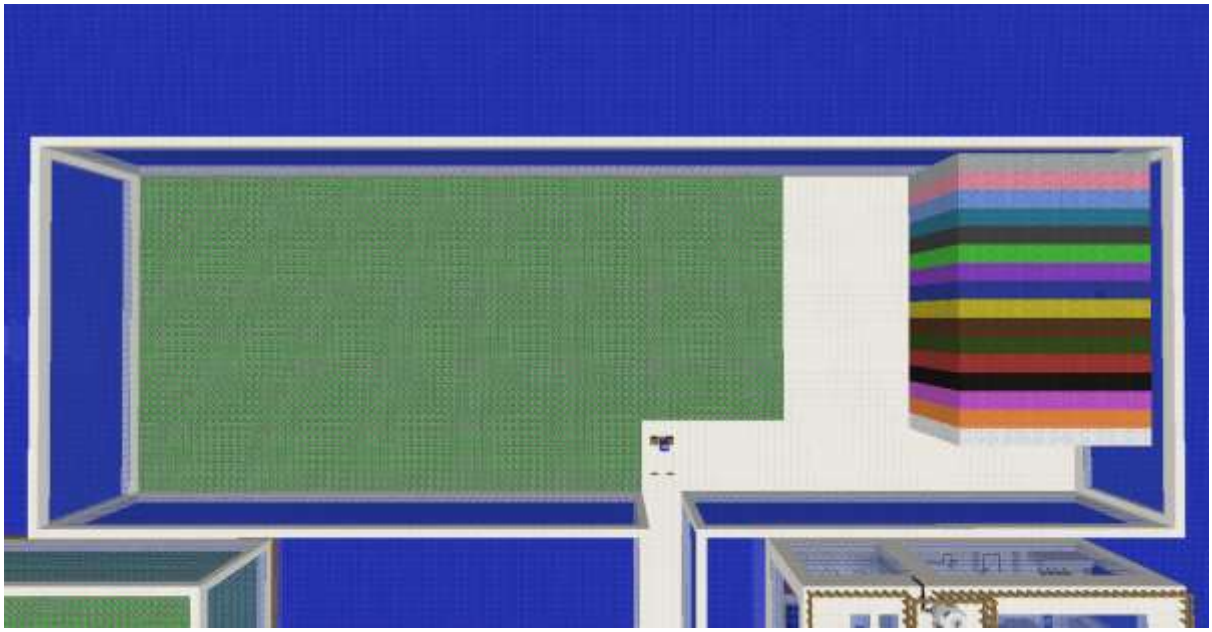


Figure 17: Flag building Zone

The second evaluation phase (3.5) contained the task of collaboratively building a flag for the island at the top of the island's volcano. The rewards for this quest were items of the ComputerCraft Mod: A turtle and its remote controller (in-game robot) and a computer (both programmable via different languages; TeacherGaming LLC, 2017). Those items were chosen in order to trigger the motivation for Session VI.

3.6.8 Session VI – Programming

As mentioned before (3.3), Minecraft gives the opportunity of adding Mods which can add in-game content in order to explore new learning material and worlds especially designed for one subject or field. For this session, the chosen topic was programming and computing and for that purpose the mod ComputerCraft was used (TeacherGaming LLC, 2017). It

aligns with the Finnish national curriculum introduced in 2014 and applied in 2016 in which a new competence area was introduced called Information and Communication Technology (ICT). The curriculum does not use the word "code", it rather talks about computational thinking and programming, where programming is seen as a way to achieve computational thinking, but also to foster creative expression, increase motivation in general and to develop problem solving and logical thinking skills (Finnish National Agency for Education, 2016).

Coding in compulsory schools in Finland is not a separate subject area, not a specific course but is mandatory in both primary and lower secondary education. Some example requirements are:

1. ICT competences in grades 1-2: "Pupils receive and share experiences in working with digital media as well as age-suitable programming." (OPS, 2016, p. 101)
2. ICT competences in grades 3-6: "While experimenting with programming, pupils gain experiences on how the functioning of technology depends on human made decisions." (OPS, 2016, p. 157)

From grade 1 to 6, it is the class teachers who will be mainly responsible for bringing coding into school work as the curriculum recommends. Since all teaching (with the exception of some arts and foreign language studies) in primary education in Finland is handled by a class teacher who teaches a class for several years, following the children, new learning tools like Minecraft were introduced (TeacherGaming LLC, 2017; OPS, 2016).

During the introductory phase (3.5) the students were introduced to the learning environment (Figure 19) and how to interact with the "Turtles" (programmable in-game robots). Furthermore, the programming surface was explained as well in order to be able to code. This code editor (Figure 18) implemented in the "Turtles" includes many commands which give the opportunity to simulate all doings which a participant as a character is able to do as well (Ratcliffe, 2016). During Session VI, it was decided that just the basic commands such as: Movements, digging and placing were going to be introduced. Students who are already familiar with the topic or finish faster were to be provided additional input.

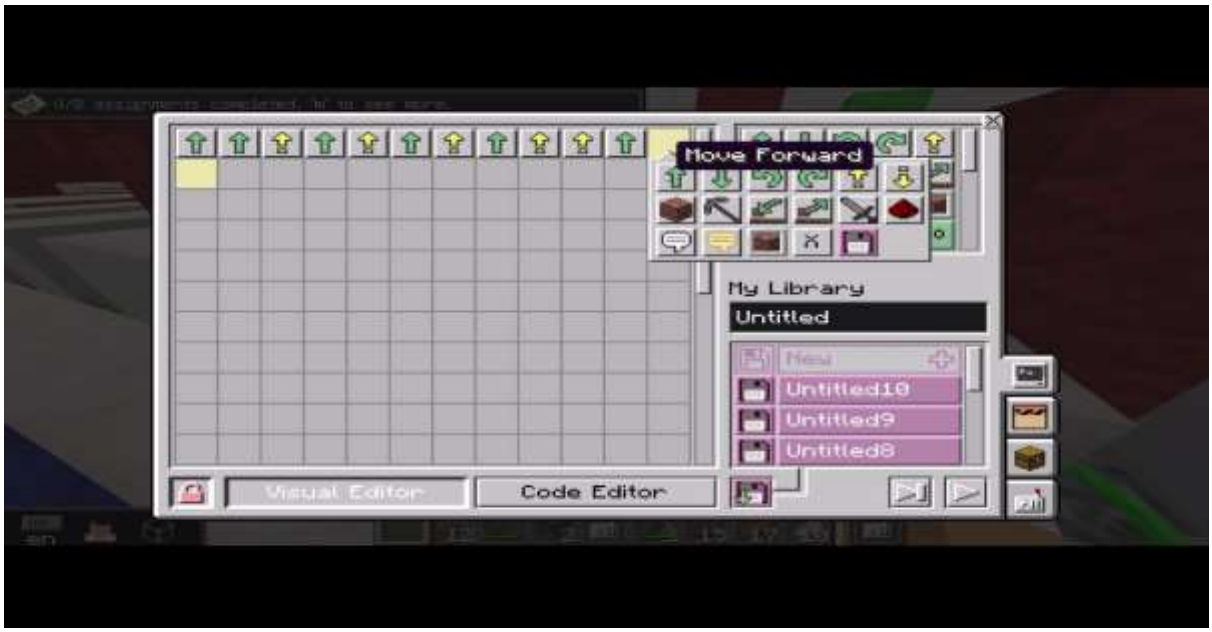


Figure 18: Programming Surface

In the content/drilling phase (3.5), the students found themselves in a new learning environment especially designed and scaffolded in order to gain a profound basic understanding of programming. The quests/rooms (Figure 19) were differentiated step by step from easy to average programming, and students with previous knowledge were allowed to start on a later stage. After designing the "turtles", the students followed in-game instructions in order to understand how to program the turtles correctly. Links and YouTube tutorials were provided in-game in order to provide support with additional material.

1. **Design your "Turtle" -** Place your "Turtle" on the prepared block and chose your own personal design for your "Turtle".
2. **Complete assignments in room 1 -** Program your "Turtle" to move from the starting area to the green blocks. Afterwards upgrade your program in order to make the turtle return to the starting position.
3. **Complete assignments in room 2 -** Program your "Turtle" to reach the green block and then return to the starting position.
4. **Complete assignments in room 3** - Program your "Turtle" to reach the green block. Be aware of the fact that vertical movements are needed as well.
5. **Complete the final room -** Program your "Turtle" to reach the green block and solve the maze.

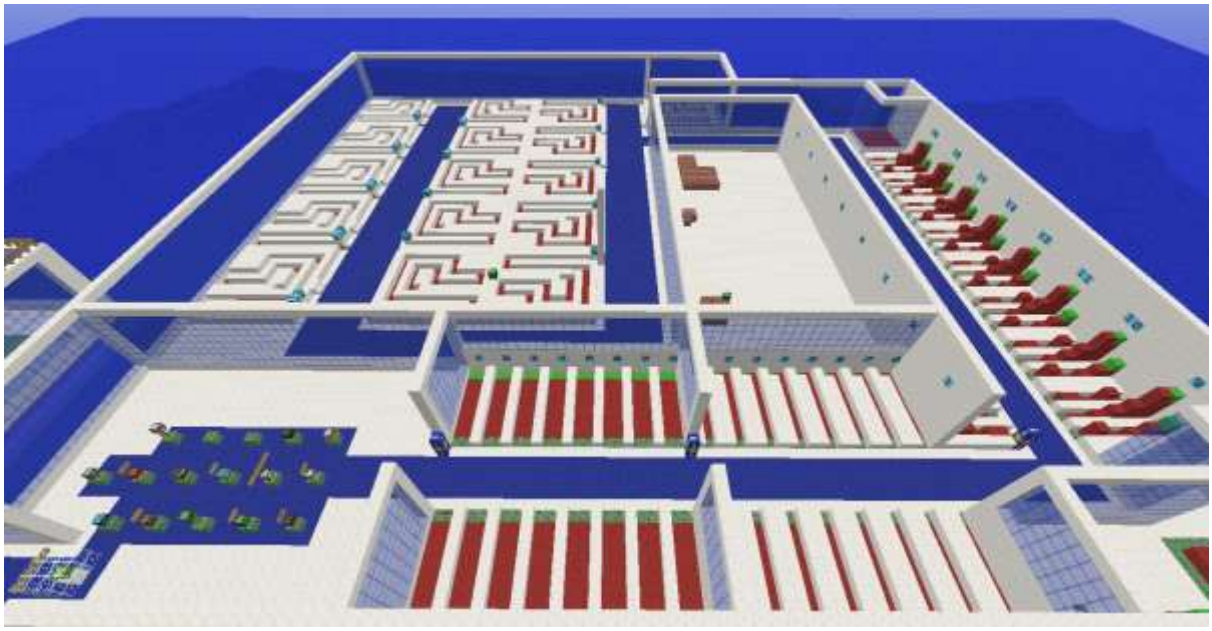


Figure 19: Programming Environment

As mentioned above, the final stage, the first evaluation phase (3.5), was a maze where the students had to show their gained programming skills in order to find their way through the maze. A comparatively complex and long program was necessary in order to succeed in this phase (Figure 39). As a reward, building material and several “turtles” for different usage were handed out.

During the second evaluation phase (3.5), the students had to self-program a “Turtle” in order to automatically build a bridge to a small island in front of the town hall (Figure 20). From this island, the participants were able to finally escape the restricted playing area and use the whole world as a reward over the Christmas holiday for free playing. The storyline ended here as well, and the students as “Pirates” were officially beating the game and escaped.

Figure 20: Escape Island

3.7 Data Collection

3.7.1 Classroom Observation

In general, observation as a method is divided into two main approaches: A direct and indirect approach. While the indirect approach excludes the researcher from the data gathering process, the direct approach offers the options to collect data in person (Shaughnessy, Zechmeister, & Zechmeister, 2012). Both approaches were used during this research to collect data.

Direct observational methods (as taking field notes during the classroom) are described as participatory and can be structured into observations with or without interventions. This thesis talks about DBR (3.4) by creating interventions (sessions) including designs in order to observe and collect data. The observational method including interventions is again separated into two approaches: The structured and unstructured approach (Uusi-Mäkelä, 2015). While structured observation provides a specific set up to understand a specific problem, unstructured observation through interventions provides an open uninfluenced environment though minimum influence on the participants by the researcher (Shaughnessy, Zechmeister, & Zechmeister, 2012). The observer has the freedom to note down what he or she feels is correct and relevant to the point of study, and

as a result this approach of observation is very suitable for exploratory research. As a fitting function of unstructured observation through interventions we chose simple field notes as a data collection tool during our classroom (sessions). Those handwritten notes were later organised into categories and in combination with other collected data interpreted in order to design the interventions (3.6). Since direct observation might influence the participants, it was just mentioned to the parents that field notes during the classroom session will be taken. In addition, to validate the data output an indirect approach, the recording of gameplay videos (3.7.2), was added to create a reliable balance.

3.7.2 Gameplay Videos

As an indirect observational tool, gameplay videos were set up as an addition to the direct classroom observations. This unobtrusive observation method did not influence the learning atmosphere during the classroom sessions and reduced the effect that the observer's presence may have on the subjects. In addition to that, video data collection was necessary since the learning environments were very complex and the group size of the participants was hardly comprehensible and as a result an additional source of data was needed to be implemented. Wood, Griffiths, & Eatough (2004) embrace the benefit of recording additional gameplay and the opportunity of reviewing the data afterwards in the end emphasises the research outcome. By having several additional viewpoints, it was possible to observe each student individually and during the classroom session it took the pressure off the teachers/researcher.

Three camera views were implemented during the evaluation phases (3.5) in order to cover the whole learning environment and to include all possibilities of further observational interpretations. Camera one was positioned from an aerial or bird's eye perspective. The video material of this camera was mainly used for an understanding of students' movement through the environment, and to differentiate the working speed and outcome of the participants. Camera two was filming a student's perspective, and his or her learning experience during the classroom session. This material (including voice comments) gave an understanding of how the student him or herself has experienced the learning environment, and which strategies were used in order to succeed in the quests. In addition to that, with Camera three a free moving recording of the teachers' perspective was collected. This free moving source was used in order to be able to film current events and occasions happening in the classroom, when students wanted to show something

special, or during in-game disturbances in the classroom sessions. In total around 35 hours of video material was gathered and reviewed.

3.7.3 Group Interviews – Reflections

Interviews as a research tool for data collection encourage the participants to speak up and share their personal experiences and feelings (Hiltunen, 2016). Sharing those thoughts immediately after the interventions established a connection between the students and the researchers and created a general feeling of being heard. The given opportunity to implement changes and verbalise criticism was beneficial to the interview situation and created a participatory motivation between the students. In addition to that, the interviews gave an opportunity to immediately reflect on the observations made during the classroom sessions.

Myers & Newman (2007) define interview questions as open and closed questions. While closed questions have numerical answers which are easy to measure, open questions are much more complicated from the scientific point of view. An interviewer has to identify the relevant issues during the interview and based on the observation, in combination with keeping the research aims in his or her mind, either closed or open questions are formed. The questions formed have to be compact, without subjective opportunity and double meanings (Hiltunen, 2016).

Seidmann (2013) structures interviews into four different categorisations: Informal conversational interviews; a general guided interview approach; a standardised open ended interview; and closed fixed-response interviews. Closed fixed-response interviews are defined as structured interviews where all participants are asked the same questions and to choose answers from among the same set of alternatives. In comparison to that, the main features of a standardised open ended interview are prepared structured questionnaires with open-ended questions. This approach offers a strictly guided questionnaire with the opportunity to answer freely. The informal conversational interviews are defined by no predetermined questions or ideas in order to offer an open and adaptable environment for the interviewee´s nature and issues. For the purpose of this research, the general interview guide approach was chosen. Its features are prepared general ideas and directions about the interview without limiting itself to any structure or prepared questions. An example would be having a general research aim in mind, but forming the questions based on previous taken observations as well. Aligning with the desired function of the classroom session

group reflections, this approach focused on a conversational approach, but still allows a degree of freedom and adaptability.

3.7.4 Survey

After each session, in addition to the interviews, a survey (9.1) in the form of a google document was linked in-game for the students. In general, surveys in the form of questionnaires are economical and easy to arrange and supply answers in a standardised form. Denscombe (2010) describes them as economical in the sense of not requiring plenty of time to administer, but producing relatively large amounts of data. Compared to writing a reflective diary on one's own, answering a survey also takes less time off the student, and involves less effort to organise and conclude afterwards, since all participants answer the same questions. In addition, responding to the same format for example in multiple choice questions also ensures an easier data analysis (Uusi-Mäkelä, 2015).

The first part of the questionnaire, the quantitative part of the survey in this study, included a set of closed-ended questions. It was used to identify which students had participated in which quests, if they have been online between the sessions, and how each individual has rated and experienced the interventions. Data was collected in form of yes or no questions, and Likert-scales which are a psychometric tool giving an opportunity to decide from whether to disagree strongly, disagree, neither agree nor disagree, agree, or strongly agree (Denscombe, 2010). This data is presented as diagrams with an additional interpretation in the analysis part (4.7). In addition, the quantitative data of the survey provided indicators on where to look and how to find conclusions in the qualitative data sets (Denzin, 2012). For example, if a student has answered while being online, but not participating in any quests in combination with a bad rating of the tasks, a closer look at his or her personal reflections was necessary in order to understand the problem of non-participation. In addition, one could review the video data focusing on the mentioned student in order to observe what happened online and what the student did instead.

In the initial design, it was planned to use an online-wiki as a tool to collect the outcome of a weekly reflective writing task. After the first session and the first week of collecting reflective data, it came to the researcher’s attention, that not all students were able to sustainably reflect in written form on their gaming experiences. Writing support was given in the online-wiki, but it was decided to implement a set of open questions to the

survey instead. Those open-ended questions provided a qualitative outcome. Those reflective questions gave the students an idea how and what to write about.

3.8 Data Analysis

The present study employs a mix of qualitative and quantitative approaches, instead of just relying on a single, specific method to gather data, multiple outlets were employed (gameplay videos, observations, reflective interviews and a small survey). This material and method triangulation (Uusi-Mäkelä, 2015) aims to improve the confidence in the findings.

During the discussion of his paper, Uusi-Mäkelä (2015) outlined that even with his two chosen methods of data collection not all questions of his research about Minecraft could be concluded:

> *"....Surveys, while productive and efficient, lack the dynamic interactivity of, say, interviews. If there are interesting trends or discrepancies in the responses there is no way to investigate them further. This point acknowledged when designing the study setting observation data was collected to facilitate interpretation of data. In hindsight, more structured observation (cf. freeform note-taking) may have benefited the accuracy of the study. However observation did prove useful and provides necessary context for many of the survey items. Methods such as individual interviews might have provided broader data but given the specificity of the topic survey items were deemed more practical. Indeed, researching informal learning that is often unconscious, a more open approach might have yielded less accurate data. Still given the opportunity, follow up interviews could have provided clarification to some of the question left open in the analysis...."* (Uusi-Mäkelä, 2015, p. 77)

As a result of those findings, four approaches of data collection were chosen. The gameplay videos and interviews are additional sources in order to support the conclusions made during the classroom and online observation. If the researcher is unsure of the interpretation of a situation, a second source of data can be used as a validation of a conclusion (Denzin, 2012). Likewise, the survey functions as a backup tool for the reflections based on the children and vice versa. In addition to that, the chat log was used

as well to re-evaluate the conclusions. It needs to be mentioned that in the data analysis part (4), the focus lies more on the observation and reflections which were backed up with the additional quantitative tools of the survey, the chat logs (Figure 32) and the video data. According to Collins et al. (2004), ethnographic this chosen pool of mixed methods fit DBR in which quantitative and qualitative research methods usually are mixed. All data sets are complementing each other and create a summarised outcome.

4 RESULTS

In this chapter, the detailed outcomes of the videos, observations, surveys and reflections (3.7) will be presented. The relationship between the data and the research questions (Aim 1, 2, 3) will be outlined by focusing on observed and mentioned details and patterns in the data. The analysis will be structured into DBR cycles, and within into classroom observations, online and video observations and survey interpretations. Aligning with the DBR research model (Figure 5), the implementations for the redesign of the next session will be concluded and presented at the end of each cycle. In addition, the small quantitative dataset of the survey will be shown and connected to the qualitative data outcome. The results of this study will be aligned and discussed with other research findings in chapter (5).

4.1 Cycle I – Session I (3.6.3)

4.1.1 Classroom Observation

It seemed that most of the students were already familiar with the game mechanics, and as a result have started working immediately on their tasks. During the observation of the less skilled players one could see that some of them were lost and did not know what to do next. After 20 minutes of in-game time some students were already creating structures for their houses and fulfilling their first quests (3.6.3). At that stage of the lesson, the students have split into three different groups: The “Explorers” who were ignoring the quests at the start and wandered through the environment, the “Builders” who were eager with creating and fulfilling the quests, and the “Newbies” whom the teacher joined with his character “The Captain” (3.5.1) in order to support them in gaining gaming experience. It was observed that the teacher's presence is not necessary needed next to the child in the classroom, rather than guiding the player in-game via voice and an online character (Aim 1). At first, there was an unnecessary concern that the “explorers” might forget about their task, but it turned out that the task itself was so easy that they could afford running off at the beginning.

It was observed that if students are aware of their skills in Minecraft, and have a specific set of tasks within a timeframe, independent time management can be an opportunity during the gameplay (Aim 1, 3).

The introduction of the rewards for the quest was held back until the middle of the lecture, since we tried to avoid influencing the starting motivation and its observation. As described above, students had different approaches at the beginning of the game. After the rewarding system was introduced many “explorers” returned from the free to play phase (3.5) and started focusing on the task as well which can be concluded that reward based (Aim 3). As a result, it was observed that rewards do influence the motivation of a learner in-game (Aim 1). In addition, it was clarified that rewards for the sessions always will be handed out at the beginning of the next one.

An emergent nature of collaboration was developing; initiated by the students, houses were created together, materials were collected in order to support each other and trading of useful materials were made. This result might be the outcome of the original collaborative nature of the game itself, and that students were used to collaboration in Minecraft (Mojang & Microsoft, 2017; TeacherGaming LLC, 2017).

After minute 40, all students were finally starting to build houses and were working on their quests. During the first session, the students were encouraged to finish their tasks, but if they ever felt they would not, they were informed that they had time during the week as well since they were able to connect and play from home.

During the first session, one could observe that the students had problems in focusing on the pedagogical content. This might be the result of the excitement about the new learning and teaching tool, and the fact that they are not used to this foreign environment in school. The fact of transferring the gameplay from the home environment to the school environment needed adjustment from the students (Aim 2). It could be concluded that it might be beneficial for the students to have a clear separation between the learning environments and free to play area.

In addition, one could observe that all the chests which were providing the starting items for all players were looted unequally, and faster players were taking all the materials instead of sharing them with others. Furthermore, the starting area (which was on the bottom of the ship) was flooded through the destroying of the ship's walls. This fact lead to a movement barrier of other children and made it harder for them to continue with their task. It lead to the conclusion that some areas need to be protected from possible destruction in order to protect less skilled students, and that especially at the beginning more scaffolding might be needed (Aim 2).

Cursing was a big issue during the gaming session. Before initiating a discussion about that, further observations are required. At this point one came to the conclusion that

cursing was a part of a student's everyday gaming life (Aim 2). It was not directed towards anybody, but happened from time to time. Instead of freezing the game and influencing or stopping the learning process, such non-targeted cursing was tolerated for now until further observation was made.

4.1.2 Online and Video Interpretation

During the process of building the town hall (Figure 21), one could observe that the students were discussion a lot via the in-game chat about the design of the structure. Since more experienced students have had already a clear plan about the design, less experienced ones were guided by their peers to collect building materials and to plan the field. Several different attempts at building the town hall were made till the final design was pleasing for everyone.

Figure 21: The Town Hall

Students have started to continue their work on quest one from home, since they were allowed to connect to the server during their leisure time. One could observe that in addition to the original task (building the town hall), many have added a lot of aspects which were not required. The more experienced children were already playing frequently, and have built huge structures and underground complexes, and at this stage observations lead to the assumption that all students will succeed in quest one.

Figure 22: A Farm on the Beach

Since there was no collaboration mentioned in the house building tasks it was fascinating to observe that many students connected from their homes and built almost all their structures in groups (Aim 1). Even if the students had just a small island, instead of spreading evenly, they just inhabited half of the island and stuck together as a community without the teacher implying anything.

Some students have already started to experiment with the Electrical Age Mod and Computer Craft (3.3.2) items. As shown in Figure 23, some students were already crafting and experimenting with “Turtles” (in-game programmable robots; TeacherGaming LLC, 2017). Despite the fact that the students were allowed to just play for fun, curiosity and in-game hints and material lead to an informal learning outcome which triggered the curiosity of other students as well (Aim 3). Many participants watched when other students were exploring new content, and afterwards tried to copy and develop their own ideas. It was observed that small input can trigger informal learning phases, and in addition to that learning through peers is a possible strategy of designing learning environments and gaining knowledge (Aim 1).

Figure 23: Remote controlled Turtle creating Fireworks

4.1.3 Survey and Interview Interpretation

Most of the reflective writing aligned with our observations and according to the students the general feeling about the introductory session was quite positive. One main issue mentioned was that the reward items were too special, and needed to be changed from long term crafting items to causal ones.

> *"All my items were stolen during the week, but I can't prove who it was. First you give us stuff which is rare, like an endgame item, but then people steal it anyways even if they already have it."*

The fact that some items were stolen during the week was mentioned, and that it would be necessary to talk about that in the upcoming session. It was mentioned that clear rules are needed in order to maintain a working on online society. Aligning with the observations, it was shown that without rules for the non-learning part the in-game behaviour might influence the classroom harmony and as a consequence the learning outcome of the students (Aim 1).

Those students who were already experimenting with the Electrical Age Mod by exploring the formal learning areas (Aim 3) were complaining about circuit explosions and demanded support and more information about electricity and the Mod itself.

"There is electricity like in real life. Everything explodes if you make one little stupid mistake! "

It was mentioned many times how the students were surprised that the current flow, voltage and power actually followed real physics. In addition, it was mentioned that the process of building a town hall was partly tricky since the discussion about the design took too long, and the building part itself was slowed down by that and by students who were still figuring out the game mechanics. As a result, a request for more time in order to learn the game mechanics was requested. Furthermore, it was mentioned that there was a problem of being trapped on an island without having the opportunity to explore the whole world from the beginning.

4.1.4 Implementations for Session II (3.6.4)

Focusing on equal distribution of items is necessary and needs to be ensured by the teacher from the beginning of the lesson in order to avoid confusion. In addition, more time will be given between session one and two in order to support less experienced players to gain skills and to give the students' time for adjustment to the new learning environment. Essential buildings needed to be protected in order to avoid their destruction by students, less skilled students need a safe environment in order to proceed successfully through the tasks. The cursing during the gameplay needs to be observed during the next lesson. In order to support the students' informal learning during the outside classroom experiences, more hints, links and information about the Mods should be provided. The rewards will be partly chosen by the students from now on, since apparently they were over-rewarded and the issue of stealing items from others needs to be discussed at the beginning of the next lecture. In addition to that, an extension of the explorable territory will be given as a future reward in order to keep the students motivated. Based on the observation mentioned above, a separated environment the "Science Centre" (3.6.2) will be introduced to the participants in order to separate free to play area learning environments (Aim 3).

4.2 Cycle II - Session II (3.6.4)

4.2.1 Classroom Observation

As described before the lesson started with a discussion about the issue of crime and stealing on the server. During the analysis of the online survey and interview notes, one could observe that some particular students tended to commit crimes against others and during our discussion we found several ways to resolve these issues. Some students agreed on “paying back”, and some students were forgiven, depending on the victim's decision. Summarized at that stage of the session everyone agreed to stop harming others gameplay experience.

During the introduction phase (3.5), the students were eager to gain knowledge about electricity and one could observe that they have studied the previously given hints and material on the island about the topics very carefully, leading to the conclusion that the informal learning outcome of the two weeks was much higher than one has expected (Aim 1,3).

After introduction to the new environment itself for the content/drilling phase (3.5) the students showed a high amount of motivation triggered by the design of the learning environment (Aim 1). The fact that a building was provided and a museum was built triggered their exploration motivation. The students were eager to find out about the information which was provided, and seemed to be very happy to finally have the opportunity to learn about electricity, which they have explored on their own beforehand. The main attraction for the students was the self-powering eco-friendly house. Since all the participants seemed to be eager to build on their own land, they really studied our exhibit very closely. It was observed that the created learning environment highly motivated the students to participate in this session, in addition a rotation between the free to play area and “Science Centre” (3.6.2) was observed (Aim 1, 3).

As described before (3.3.1), it was decided that the game mode will be kept on survival since the playing aspect of the original game was highly encouraged. In order to survive, the students successfully prepared food for the museum trip for themselves, and shared it with those who could not because they were not able to connect or play from home. After exploring the environment of the museum it was necessary to teleport the students to the starting area of the experiment stations. Some students got lost in the big

structure and in order to keep the session running it was necessary to unite them at this point (Figure 24).

Figure 24: Teleporting to improvised Chests

One necessary thing to mention is that even if there was an experiment station for each student to work alone, some students decided to work together on one station. Even if one scaffolded a self-regulated learning environment, collaboration was happening. Since this fact was observed already many times before, it leads to the conclusion that in Minecraft collaborative learning is one major design factor in order to support the learning outcome of the students (Aim 1; TeacherGaming LLC et. al., 2017; Uusi-Mäkelä, 2015; Pihkala-Posti, 2015; Dikkers, 2015, Duncan, 2011)

Through the first evaluation phase (3.5), a lot of material and machines blew up (Figure 25) and in order to get things done the students successfully managed to return to the museum part in order to observe and understand how they had to improve things in the right way. In addition, “The Captain” (3.5.1) had to repair a lot of the destroyed environment in order to ensure the working progress of the students. The fact that the teacher was participating online gave the children a new way of addressing the teacher in-game. They asked about the tasks mainly online and if they could receive help from the online character to fulfil their assignment which is aligning with the already observed fact that the teacher's presence online was accepted (Aim 1).

Figure 25: Explosions in the Science Labs

What came to our attention was that many of the students ignored signs and information stands during the content/drilling phase (3.5) of the session, and without reading the material they started to explore the electrical devices empirically. This lead to small explosions which sometimes distracted the students, but also lead to the conclusion to return and start reading the information more carefully (Figure 25).

Unfortunately the "Item/Block to Give" function of MinecraftEdu (3.3.1) did not support the Electrical Age Mod, so the teachers had to improvise on distributing the materials manually via chests. This lead to the conclusion that not all Mods might work perfectly, and one always should be prepared for eventual failures (Aim 2).

This session was highly scaffolded, a lot of the additional features like border blocks and built allow/disallow blocks (in-game blocks with specific restriction purposes; TeacherGaming LLC, 2017) were used in order to prevent destruction and confusion again, but even though one had planned everything very carefully, students tried to explore and to break out of the environment (Figure 26). In order to prevent breaking out and destruction, it was decided to put more effort on the design of the next session (Aim 2).

Figure 26: Breakout of Science Labs

4.2.2 Online and Video Interpretation

During the week, one could observe that many students had started to work on their own small power plants. It was observed that through revisiting the exhibition and observing other students many of them were able to succeed in the quest (3.6.4) of generating power for their own houses (Figure 27). The expected behaviour after the classroom session was achieved. It was concluded that the students were learning from each other during the non-classroom playing, and after one student achieved the first production of energy many were motivated to follow. This observation supports the fact of the already mentioned learning through peers and collaboration as a knowledge gaining strategy, and that a separated "Science Centre" (3.6.2) with easy accessible content supports the overall learning outcome.

Figure 27: Powering a House

During this week also one of the first fully programmed self-working "Turtle" came to attention. Since programming was not introduced yet, it was marvellous to see those learning process happening independently. It aligns with the concluding idea that hints trigger informal learning, and in addition the students mainly used sources outside of the game (YouTube, Online-Wiki) to continue their work (Aim 1).

Figure 28: Fully programmed Turtle

4.2.3 Survey and Interview Interpretation

One main issue mentioned was that the environment itself was very big, and that there was not enough time to explore and learn about everything. It was a big problem that there were so many signs and readings, and they were overwhelmed by the amount of provided material.

> "*We got lost a lot, several times! There were so many signs and things to look at and not enough time to read everything. Also stuff blew up all the time and it was hard to focus on the quest, I need to come back later to figure out stuff.*"

They understood that they have the opportunity to return during their private gaming time, but in combination with our observation, we agreed that "less might be more". It was concluded that overstimulation through too much provided content harms the learning outcome (Aim 1). Aligning with the students opinions that if they wanted to find out more, they could use the internet as a source, it was decided to change the design during the next session towards less content.

The second main complaints were about being in survival mode during the working period. Students suggested being put into the MinecraftEdu mode (no possibility of dying) in order not to have to focus on their food supply during the time they have to learn about new material. Aligning to our observation, it was mentioned that the material providing was perplexing for the students.

It also needs to mention that some students have already explored the content on their own during their free play time and were not too excited about the session:

> *"For me all that was kinda boring, I have already electricity on my house since last week, with the online wiki it is not a big deal right now we are working in my friend's house to get him lights too."*

The fact that students were already way ahead of using the educational Mods than had been expected by the teachers showed the enormous efforts of exploring during the leisure time and gave an idea about how informal learning was happening outside the classroom (Aim 1).

4.2.4 Implementations for Session III (3.6.5)

It was concluded that the MinecraftEdu mode will be used during the next sessions in order to simplify the process if playing during the teaching sessions, since many students blew themselves up various times. In addition to that, the return to the learning environment occupied too much time as a result a “Hall of Quests” shall be introduced in order to give the participants easy access to all content at all times (Aim 3). Furthermore there was a need for a smaller and simpler environment, but with an improvement on being indestructible. Inaccessible areas should be inaccessible.

Too much information and learning material was given, and the students were overwhelmed by the amount of knowledge provided for them during the lecture. For private playing, the museum was useful since they could and did return to learn more on their own, for the in-classroom session of 90 minutes it was definitely too much.
Unfortunately the material distribution went wrong again and needs to be improved as well. “Command Blocks” (programmable by the teacher for various purposes; Mojang & Microsoft, 2017) shall be introduced in order to distribute material by pressing an in-game button.

4.3 Cycle III - Session III (3.6.5)

4.3.1 Classroom Observation

After our reward distribution and the introductory phase, which went very well, since a lot of the older students were already familiar with this content, it then came to our attention that our online server was not working. This created a small delay during our session and the students got a little bit nervous about their playing time. It is necessary to mention here that a backup USB stick with all your server files is mandatory at all times since you cannot rely on the technology (Aim 2).

During the working period, one could observe that older students were helping out younger students in order to support them to succeed. It took the younger students more time to participate in that session, especially with the right labelling of the signs, but without the teacher's engagement older students were starting to support younger ones in order for everybody to succeed, which aligned with the aspects of collaboration and learning through peers (Aim 1).

The implementation of less signs during this session made it easier for the students to follow the tasks. All students were participating at the area calculation task, but when it came to the volume calculations, some children started to exclude themselves from the working assignments for a while, while others were eager to finish early being able to play free afterwards. This could be related to the fact that some of the participants lack the gaming aspect too much during the classroom sessions. It was concluded that the game itself might not be enough motivation to work if the stimulus of gamification is not presented well enough in-game (Aim 1).

A lot of creativity (Figure 29) was observed during the creations of the volume and area structures, but many students forgot to label their work with their names.

Figure 29: Creative but nameless Area-Calculation

During the area calculation part, students were building houses and different other structures for their calculations, nevertheless towers were made to try to escape out of our new learning environment. Despite the creative attempts to escape (Figure 30), our new design implementations for the learning environment worked.

Figure 30: Attempt to Escape

4.3.2 Online and Video Interpretation

During the non-classroom quest it was observed that students had no difficulties to succeed in the quest of building houses for the “Villagers”. Many students let their creativity flow and built huge complexes to host the new arrivals, but forgot that afterwards they had to do calculations based on their created structure. After that realisation, smaller buildings were built in order to keep the calculations easier in the end. One particularly nice structure was a shop (Figure 31) built collaboratively by four students. The idea was to put those “Villagers” who have the ability to trade into the shop as shopkeepers.

Figure 31: A Shop as House for the Villagers

4.3.3 Survey and Interview Interpretation

The students elaborated this quest very carefully and mentioned that it was too easy, but they had fun during the gameplay and appreciated the support of others:

> *"It was pretty fun. I liked the questions and stuff; but also boring; I feel quite bored since I already knew all of this stuff. But it was fun to play with my classmates anyway; my friends give me staff sometimes they helped me build my volume stuff"*

One very important statement needs to be mentioned as well:

> *"I spoke with people or played with people I never thought I would talk or play with."*

There were several mentions of the fact that new friendships through playing were found, or as mentioned above, new connection were made which might have not been possible to develop at all, and this lead to the conclusion that the collaborative aspect of the game in combination with the lesson designs for our sessions offers a new way of connecting between peers (Aim 1).

The students developed a deeper social understanding, observed and appreciated the good work and support of others, and came to the conclusion that they have to respect

other's properties and buildings. It was mentioned that they were continuing on working with the electrical machines in their homes, and that they would like to have more information on how to proceed with that topic.

In addition it was mentioned that the fun aspect of playing was a little bit missing, and many students agreed on the fact that it would be nice to have a fun session in between once in a while (Aim 1).

4.3.4 Implementations for Session IV (3.6.6)

For the next session, the fun aspect of the game should stand in a healthy relation to the learning part. The learning environment we have created so far perfectly scaffolds the student during the introduction/drilling phase (3.5) for learning new material, but decreases the enjoyment of playing. Although the students have had time to play free after the main quest was completed, it was concluded to test a different approach for the next session. Furthermore, the content was already known by many students, which should not always be the case in order to avoid boredom.

4.4 Cycle IV - Session IV (3.6.6)

4.4.1 Classroom Observation

The excitement at the beginning of the session was great, after we announced the topic and what was about to happen, the students seemed to be highly motivated to survive and to write about their progress. The fun factor we had implemented seemed to be well received, which leads to the conclusion that there is a necessary balance in between the knowledge gaining phases and casual fun phases including the teacher (Aim 1, 3).

As mentioned, all children were starting from the town hall together, so left with the option to either stick together and collaborate, or trying it on their own. During the first minutes the group stuck together, and defended the building. One could observe great efforts of communication and creativity in order to survive. One student found out that the hall of quest (to which one can teleport from the town hall) was safe and shared this information in the chat (Figure 32). A lot of the students saved themselves to the hall of quest at the start to figure out a more detailed strategy.

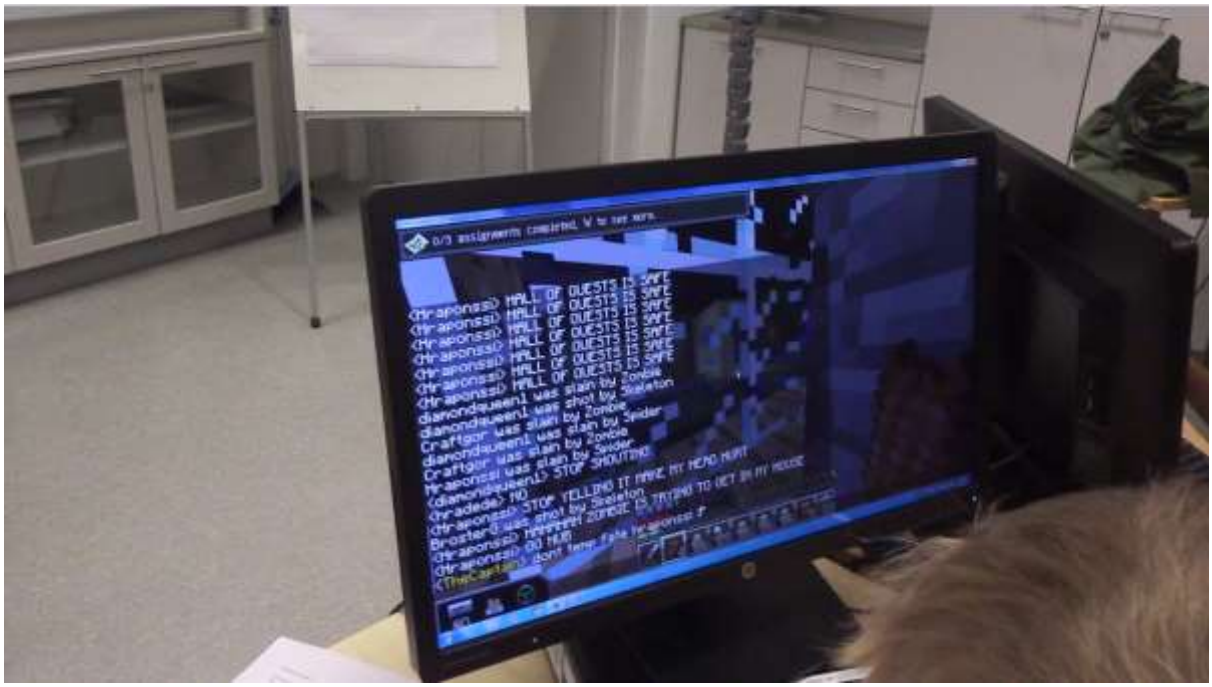


Figure 32: “Hall of Quest” is Safe in Chat Log

Two students went to the island together, while the rest of the group was in the safe “Hall of Quest” (3.6.2) to build up strategies together. None of that was indicated by the teacher. The students used the chat and communicated in the classroom about how to address the situation. Through critical thinking and creativity, they managed to conclude in a collaborative strategy in order to secure the town hall.

Back at the town hall (Figure 21) the students with a higher skill level protected the weaker students which had the task to build walls around the environment and to strengthen the windows and doors with material. The children were singing during the class: *“This is so fun, this is so fun!”*

After the first wave of zombies, one could observe that teams were immediately formed after the stressful situation. The students tried to bunker themselves together and/or tried to create small safe houses for others. One could observe that students were politely asking others if they could use their houses for shelter. Despite of the questionable language during the sessions, in time of emergency they remained polite.

Children provided material, armour and weaponry to each other and formed shelters and safe houses together, two big groups were formed. During the second wave, one could observe even a better coordination and improvement in their team building processes and collaboration. At this point, despite the fact that they could hear each other in the classroom, the students manly were using the chat function for several purposes.

During the third wave, all students gathered at a big ship that one student has built during her free time. At this point, the caretaking and the split up tasks were amazingly well coordinated between the students. A huge process of collaboration was recognized during this first part of the session and aligned with other observations of collaboration as a cornerstone of designing learning environments in Minecraft (Aim 1).

Figure 33: Airship on the Island

During the creative writing part, the students started to reflect on their previous actions and were able to fill in their booklets. Students were taking notes during the zombie invasion in order to have some orientation afterwards. At this point, the group split up and the students were returning to their individual homes to relax and write. For some students, it was hard to return from the "fun part" back into the evaluation phase. This might be the reason for being on the island and not in the usual learning environment. It was concluded that for the next session a return to the "Science Centre" (3.6.2) is necessary in order to support the success of all participants (Aim 1, 3).

Figure 34: Student Journal about “Zombie Apocalypse”

4.4.2 Online and Video Interpretation

During the online observation, it was difficult to observe the approaches of how the students managed to succeed in their tasks. On the contrary the outcome of the quest (3.6.6) was delivered to the teacher and if wanted presented to the class. Several students shared their stories in between beforehand and triggered each other's writing motivations through different stories which supports the previous observations of motivation through peers (Aim 1).

One example of a story written by a student outside the classroom sessions:

> *“The madness of the keys - Long ago there was a girl looking for five keys that she would be happy until she dies. But she did not know of the consequences. As she went from place to place for each key she grew happier but the people around her grew sad and with each key she got the more people would suffer. As she saw the last key before her eyes she went to grab it, but when she did all the suffering peoples pane came to her in one big rush and then she went mad and she ran around with all the keys laughing at everyone. In time she went so mad she jumped off a cliff side and die… the end”*

4.4.3 Survey and Interview Interpretation

The feedback after this session was highly positive. The combination of the gaming aspects of Minecraft and the educational aspect of creative writing was very well accepted.

> *"We all came together at the "hall of quests", it was safe and we had time to make up a plan together since there were no zombies. All players were here and we discussed what to do to survive. Most of my friends helped me and I helped them to survive. We had to trust each other to survive you do teamwork."*

The student elaborated that teamwork, trust and good planning were necessary in order to succeed as a group.
It was mentioned that is was a little bit hard for some students to return into work-mode after the gaming aspect, but since the rewards were designed as group rewards they had to work in order to make the whole class succeed.

> *"Group reward was great, but we had to help others to write so we don't fail, some of my mates did not want to write first but we helped, maybe next time no group reward anymore please. We stayed at my friends' ship it was safe to write."*

Through our observations in combination with the outcome of the reflections, it was concluded that group rewards can have either a positive motivational aspect, or on the other hand a negative pressuring outcome in order to succeed in the quest (Aim 1).

4.4.4 Implementations for Session V (3.6.7)

Out of the observation, the reflection and survey data it was concluded that the working part should be ahead of the playing aspect in order to not lose the motivation towards the end of the session. It came to our attention that a creative part was desired by the students since the building aspect seemed to be very supporting towards the students learning and motivational process. As observed before at the area calculation session, students were building flags (Figure 29) so it was decided to focus on a geographical topic at the next session. Furthermore, to support students who needed more scaffolding, the already familiar "Science Centre" (3.6.2) should be implemented again (Aim 1). Many students needed their familiar learning environment back in order to be able to distinguish between the playing time and the learning time during the session (Aim 3).

4.5 Cycle V - Session V (3.6.7)

4.5.1 Classroom Observation

During session five the students found themselves back in the “Science centre” (3.6.2), and after opening the tasks, the students started to work immediately on going through the provided content and materials. No unexpected issues were taking place during the content/drilling phase (3.5.) since students seemed to work perfectly in the already familiar learning environment. It could be observed that the clear structure of the “Science Centre” (3.6.2.) was very well adapted and this offers support to the conclusion of the necessity of a separated learning environment (Aim 1, 3). Many students followed the instructions and succeeded in the quests, but two students used their creative freedom to design an ISIS flag and a Swastika.

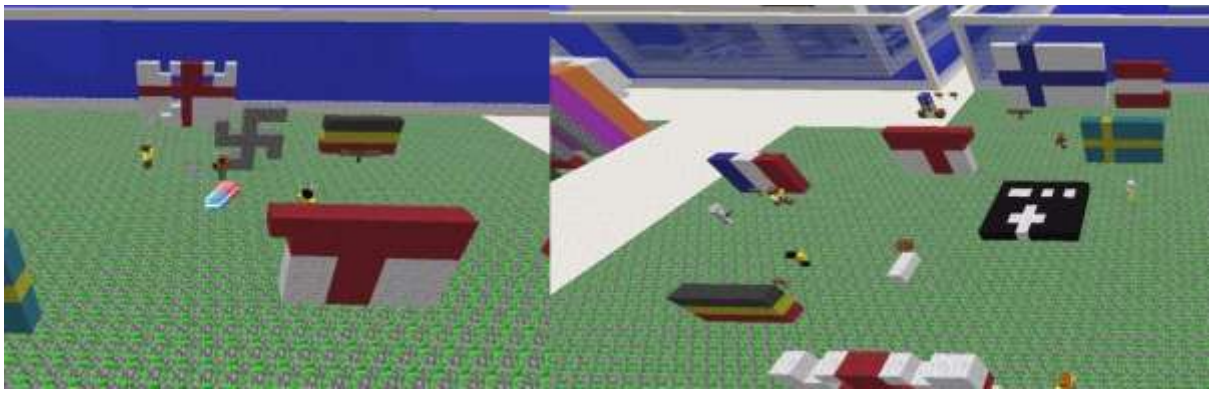


Figure 35: Isis and Swastika Flag during Session V

Regarding the age of the children in combination with the current global situation that was not surprising, but still needed to be discussed in order to support them in succeeding with the task.

Many questionable figures and structures were observed during the free to play phases (3.5), and this was addressed via the online character of the teacher “The Captain” (3.5.1). Since this was the first occasion during a classroom session it was decided to talk about this incident in person. To avoid disturbing the working flow of the other students to a greater extent, the teacher had a small conversation with the two students causing the disturbance. As the other students were getting all their needed information in-game through the scaffolded learning environment (3.6.7) there was enough time for a short intervention. After a talk between the students and the teacher, it was clear that the given

creative freedom in combination with the simple task of building a flag were decisive factors and lead to this specific outcome (Aim 2). It was mentioned that the given time was way too much and that it still was easily possible to succeed in the quest (it needs to be mentioned that those two players were the most experienced Minecrafters in class). It was discussed and observed in class that a learning environment cannot fulfil all the diverse levels and demands of every student (Aim 1). It was emphasised and later observed that if students decide to plan their own working time during the classroom session, they should leave the learning environment into the free to play zone (Aim 2, 3).

It does need to be mentioned that there were no attempts of breaking out of the "Science Centre" (3.6.2) and after the above mentioned incident, students built their flags and succeeded in the quests (Figure 36). It was concluded that the students, after a specific time or a specific number of sessions, will acclimatise to the learning environment (Aim 1).

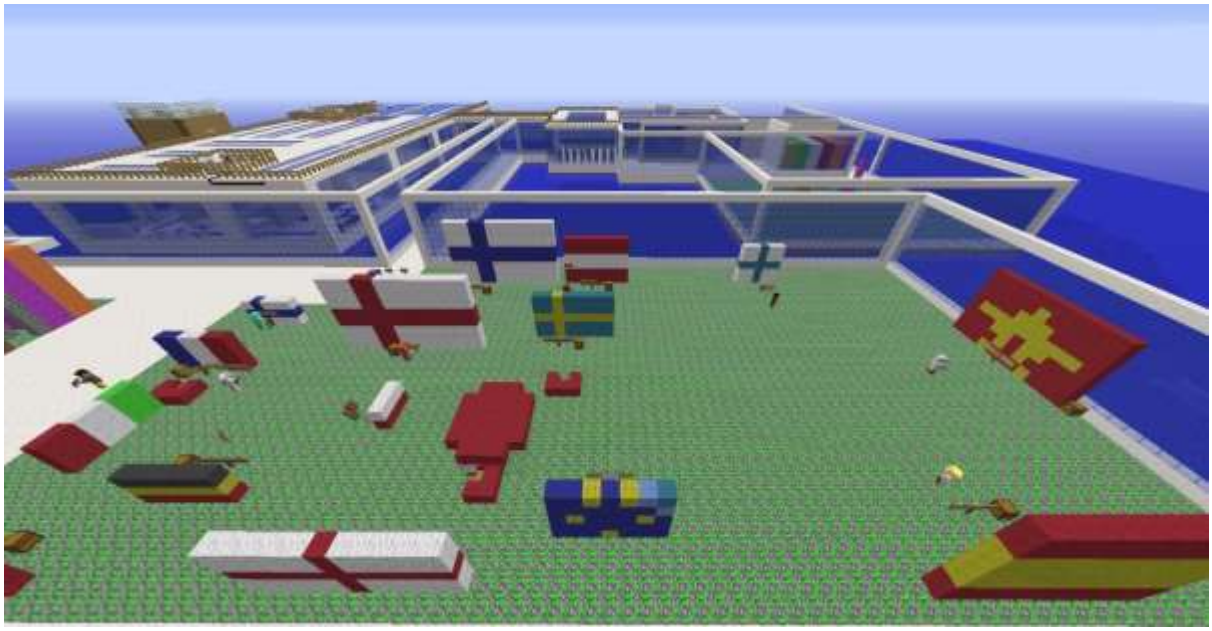


Figure 36: Flags of Europe

4.5.2 Online and Video Interpretation

During the non-classroom quest (building a flag for the island, 3.6.7) similar observations as during the building of the town hall were made (4.1.2). The students gathered and a leading group was immediately starting to build without considering the opinions of other players. While building, a discussion was started about the design and if all players who

were online at that time would be fine with the chosen outcome. Since the previously less skilled players were able to contribute equally well, more ideas were in need to be aligned to create an outcome which pleases everyone's idea of a flag. Several attempts were needed in order to find the final design but in the end it was democratically via voting decided which design fits the best. Those decisions were made without the guidance of the teacher. The participants gathered in the town hall and used the environment of their online society and discussion. It was concluded that the idea of building up a society on the island with clear rules and structures benefited the outcome of decision making and in the end the success of the quest (Aim 1).

Two students were exploring the ComputerCraft Mod almost on a daily basis without any guidance. They reached a skill level way beyond the planned outcome of Session VI (3.6.8) which was originally just visual based programming. In order to successfully evaluate their informal learning outcome, a special task based on an advanced level, written programming language was hidden on the island. To access the treasure behind a door the students had to solve a riddle hidden in the written program. Just with finding the mistake, they were able to open the door and access the next room (Figure 37). It was observed that it took them almost one hour of researching and trying before being able to open the door. It was concluded that the additional added Mods with minimal guidance triggered an exceptionally outstanding informal learning outcome. It was not necessarily needed to introduce a new topic or content, just its presence was enough to create knowledge (Aim 1, 3).

Figure 37: Solving a Programming Problem

4.5.3 Survey and Interview Interpretation

It seemed that the students in general enjoyed the lesson, its content and structure. It was mentioned that the creative flag building part was a great idea, and that it balanced the fun of building with the reading about a new country.

> *"It felt really good to work on something I could chose myself, always wanted to go to Paris, I love France."*

Besides the generally positive feedback, it was mentioned that the freedom and opportunity of choosing a smaller topic inside of a greater issue like the European Union benefited the motivation of the learner (Aim 1, 3). The issue of students building non-topic related flags was mentioned and that it was experienced as kind of funny at the beginning, but in the end as stupid and annoying.

> *"I was building other flags since the European ones are boring, there was nothing hard in this Session and I thought I had enough time to do other stuff."*
> *"Seeing my classmate building a Nazi flag was pretty funny so I decided to make an IsIs flag because it's funnier"*

The builders themselves defended their behaviour as mentioned above by pinpointing the fact that the learning environment did not stimulate their motivation, and that the topic itself was not that interesting as well. It was observed that Minecraft as a learning tool does not fit everyone's learning approach all time, on the one hand children with pre-gaming experience benefit more than others at during the informal learning phases, but on the other hand they might get bored during the formal parts (Aim 2).

4.5.4 Implementations for Session VI (3.6.8)

There occurred no problem related to the design of the "Science Centre" (3.6.2). It seemed that the students were accepting and adapting to the environment perfectly, and as a result it was decided to continue the knowledge gaining phases separated from the free to play area. In addition it was decided to either provide extra tasks, or an opportunity of free play

for faster and more experienced students in order to maintain an undisturbed learning environment for others.

4.6 Cycle VI - Session VI (3.6.8)

4.6.1 Classroom Observation

At our last session, the desired programming content was finally implemented. Many students were already familiar with the “Turtles” from their informal learning experiences; one could observe that the combination of the scaffolded well adapted “Science Centre” (3.6.2) and the previous informal learning experiences resulted in a very fruitful lesson (Aim 1). No bad behaviour was observed, and the session went as planned. In addition to that the more experienced programmers were allowed to skip the *c*ontent/drilling phase to proceed directly to the first and second evaluation phase (3.5) in order to avoid disturbance and boredom. Those students were encouraged to present their outcomes to the classroom at the end of the session in order to trigger further learning processes of others. The implemented personal design phase at the beginning gained the interest of the students and motivated them to continue since the personalisation of the tool created excitement and a positive attitude (Figure 38).

Figure 38: “Turtle” Design

One could observe that the step by step scaffolded learning environment lead the children to a fruitful learning outcome (Aim 1). Just two students were in need of additional guidance from the online character "The Captain" (3.5.1) and in the end succeeded as well in the quest of programming the "Turtles" (3.6.8). Even complex programming structures like While-Do functions were implemented by the students (Figure 39), which lead to the conclusion of an unexpected higher informal learning outcome than previously assumed (Aim 1,3).

Figure 39: Finalised Program including While-Do Function

4.6.2 Online and Video Interpretation

During the online observation of the second evaluation phase (3.5), one could monitor that students were eager to finally escape the island by reaching the escape platform. The motivation of being able to enjoy the whole Minecraft world/experience on the server during the upcoming holidays for free playing lead to a rapid success in building a bridge (Figure 40) and in beating the game and our story. It was mentioned (screamed) many times during the classroom session that the participants were already looking forward to the next semester and the next storylines and quests. The generated happiness by achieving this success lead to the conclusion by the teachers that the implemented storyline and

quests highly benefited the motivation of the students and definitely supported a better learning outcome (Aim 1).

Figure 40: Bridge automatically built by Turtles

4.6.3 Survey and Interview Interpretation

In keeping with previous observations it was mentioned that the students were relieved that they finally received a session about programming. Especially students who were less successful in their informal learning experience about programming were delighted that a possibility of catching up was presented.

> *"Finally after so long time of exploring on my own we do a lesson about programming, I thought it would never happen at all."*
> *"We should have done a Club just about programming, I would have like that a lot."*

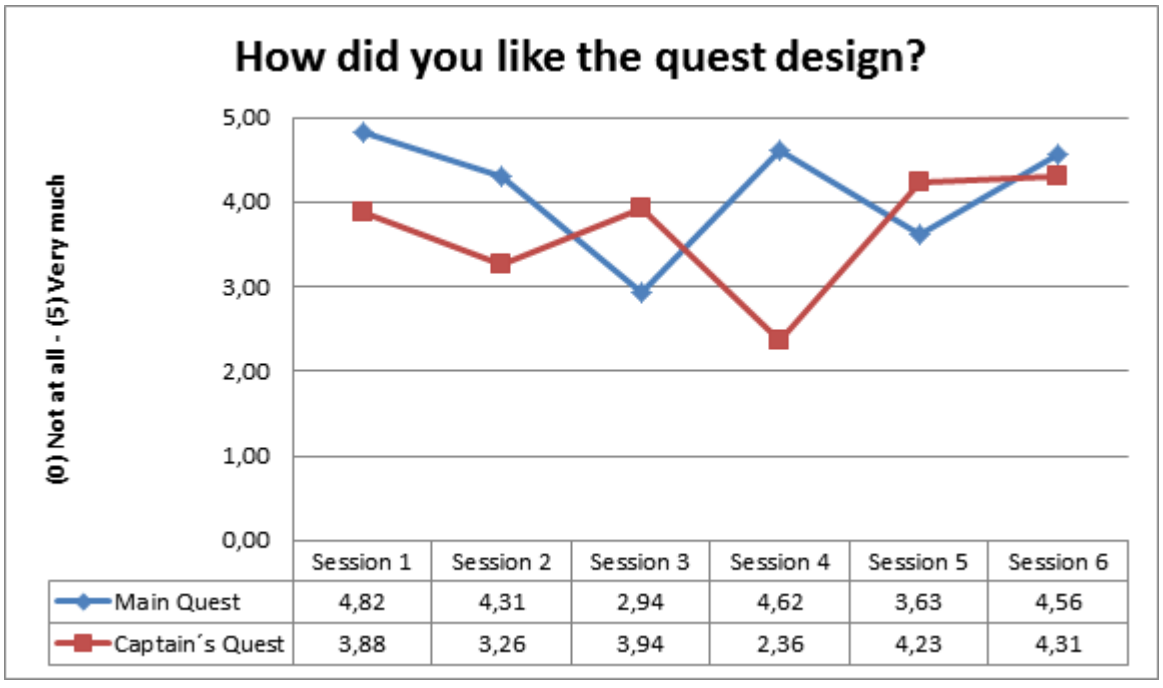
In addition, the final outbreak off the island(s) to be able to free-play as a reward was mentioned many times. One could read the happiness of the final success of the team efforts of the previous weeks created motivation towards new projects.

"I usually do not really like these guys, but I am kind of sad that this experiment is over. I´m gonna miss our village and society a lot. I am pretty sure I won't speak to half of the players anymore."

Furthermore many students mentioned that they will miss playing in the class and that they were also afraid of not "seeing" each other again. One statement of a girl (quote above) was addressing the fact that the online friendships might not result in friendships outside the classroom. It was observed that Minecraft and the playing aspect itself provided an opportunity to create an online society, and from and build up social bounding, but it does not support or guarantee the continuation in real life (Aim 1).

4.7 Additional quantitative Interpretation

After carefully analysing the qualitative data, the small quantitative part of the survey needs to be discussed and linked towards already made observations. In order to give an understanding about the results and conclusions, the data is presented through simple graphs.



	Session 1	Session 2	Session 3	Session 4	Session 5	Session 6
Main Quest	4,82	4,31	2,94	4,62	3,63	4,56
Captain´s Quest	3,88	3,26	3,94	2,36	4,23	4,31

Figure 41: General feeling about the Quest Design

Figure 41 above visualises the general feeling of the participants about the quest design. Through a Likert-scale (Denscombe, 2010) it was determined how the content was experienced during the project by the participants. It can be assumed that the question about the game design covers pedagogical content, session design and rewards. According to the game design, it was discussed earlier that the separation of the learning environments was beneficial (4.). In Session II (4,31), Session III (2,94), Session V (3,63) and Session VI (4,65) the same design was used to transfer knowledge while in Session I (4,82) and Session IV (4,62) were held outside the learning environment. Since both environments show high results in the numbers aligning with the qualitative results, it can be concluded that the learning environment is not the main indicator of enjoyment for the participants (Aim1).

It was not observed that the motivational effect of rewards as discussed before (3.6.2) vanished during the project (Ronimus, Kujala, Tolvanen, & Heikki, 2014), which leads to the assumption that by excluding design and rewards as an indicator for this graph, the pedagogical content most likely is represented. It shows that after the peak of Session I (4,82), a possible result of the starting-motivation, the general motivation dropped after implementing pedagogical content. Aligning with the observations by the researchers and comments of the participants (4.4.3) a more playful attempt towards knowledge gaining was needed after the drop in Session III (2,94) By comparing the results afterwards, Session V (3,63) and Session VI (4,56) (a positive feedback in a scaffolded content based environment) it can be concluded that a balance between joy facilitating and knowledge gaining phases needs to be found in order to keep a successful learning outcome (Aim 1,3).

The generally lower ratings of the Captain's Quest may be the result of the fact that the second evaluation phase (3.5) was always containing a similarity, through the previous Sessions' experienced topic. Always conducted in the non-learning environment the respondents to those quests, also more likely reflect the topic itself rather than the design. While ratings in general are average it can be observed that after the highly enjoyed main quests of Session VI (4,56) the results of the free to play captains quest of Session IV (2,36) dropped dramatically. It can be assumed that without a highly emotional trigger ("Zombie Apocalypse", 3.6.6), creative writing did not seem to be appealing (Aim 1).

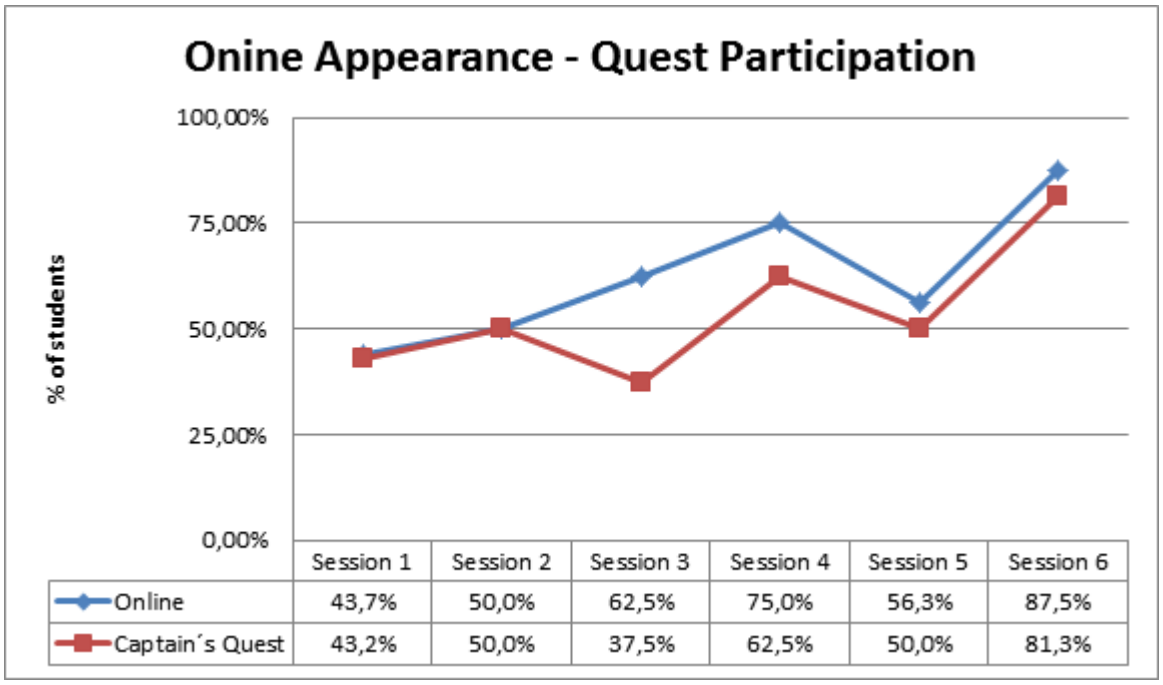


Figure 42: Online Appearance and Quest Participation Rate

Figure 42 shows the online appearance between the interventions compared with the percentage of students participating in the Captain's Quest. Discussing the online appearance itself, the graph shows a continuous rise towards the end. Aligning with the observations made, this is a simple result coming from, the fact that students have needed time in order to connect from home. Almost half of the class had problems after Session I (43.7%) with playing from home and it took the last participant almost 3 weeks to eliminate all installation errors. In addition to that not all parents allowed their offspring to participate from home as well. It can be argued that the online presence is a direct result between the previous experienced session and the attractiveness of the Captain's Quest (Aim 2). During the period of the first two weeks, the online rates of (43.7% and 50%) almost align with the participation (43.2% and 50%) rate of the quest leading to the previously mentioned idea of starting-motivation as influence. The already discussed motivational drop at Session III (4.3.3) might have an impact on the participation of the Captain's Quest III, yet it seemed that the online presence due to its rise was not influenced. In addition, this observation can lead to the conclusion that students were busy with exploring and learning about other content, supporting the assumption of informal learning (Aim 1, 3). Summarised, it can be concluded that, besides the drop of Session III, almost always all students who have been online, participated as well in the second evaluation phase (3.5).

5 DISCUSSION

In this chapter, the implications of the above shown results to the research aims will be discussed and the validity and reliability of the research methodology and its methods will be addressed. The ethical guidelines of the study will be outlined and the correctness according to the Finnish standards will be demonstrated. Thirdly, the conclusions made during the data analysis will be discussed and aligned with the research aims.

1. How does the chosen content design and playability of the online learning environments influence the formal and informal learning outcome of a student in Minecraft? (Aim 1).

Gamified designed learning environments in Minecraft benefit informal and formal learning experiences - Aligning with the gaming aspects originally coming with Minecraft (Mojang & Microsoft, 2017) it was observed that the creation of a society around a story about pirates and an island (3.6.1) created a fruitful framework for implementing and designing quests including pedagogical content. Huang & Soman (2013) conclude as well that experiencing communities around or in the game do an incredible amount of intellectual work by providing a framework which gives the opportunity to communicate, reflect and explain. While participating in the online society emphasised collaboration and motivation, the goal of escaping the island (Figure 9) by fulfilling educational quests (3.6.) highly motivated the participants. Likewise the aspect of being rewarded highly inspired the participants and emphasised participation.

Designed reward-based learning environments in Minecraft can function as a motivational tool during the formal and informal learning phases - Ronimus, Kujala, Tolvanen, & Heikki (2014) discuss that a reward system encourages the children to play longer sessions at the beginning of a training period, but that this effect might vanish after a few sessions. This vanishing was avoided in the presented study due the importance of the items. It was observed that the motivation in relation to the rewards stayed at the same level since the rewards were necessary in order to succeed in the follow up quests. In addition they generally started low in value and were raised during the project. It needs to be mentioned that not only positive aspects of rewarding were monitored. Group rewards could lead to negative aspects by generating tensions between the participants, which might put pressure on the individual and decrease the learning motivation (4.3.3).

The teacher as an online facilitator can support the learning outcome during formal and informal learning phases in Minecraft -Without the presence of a teacher during the formal classroom session as a person, offering Minecraft as a learning tool is simply not possible, at least not if the students do not have pre-existing knowledge about the game (TeacherGaming LLC, 2017) . The implementations of "The Captain" (3.5.1) as an online character resulted in a fruitful relationship between students during the informal learning phases. Aligning with the observations made by TeacherGaming LLC and Uusi-Mäkelä (2015) it offers the students a solid opportunity to address the teacher online which adapted to the their needs risen during the informal learning part and provided information to support the learning process.

Spatially divided designs for learning environments can benefit formal learning - It was observed multiple times (4.1.4; 4.2.1; 4.5.1; 4.6.1) that a clear distinction of the playing area from the learning environments by creating the "Hall of quests" and the "Science Centre" (3.6.2) resulted in higher motivation and a better learning outcome. Returning to a slightly scripted environment after already being used to the scaffolded one, lead to problems like confusion between the peers and to a weaker learning outcome (4.4.). In comparison, by returning to the scaffolded environment at the last intervention, none of the mentioned problems were observed (4.6). This argument can be underlined with comparing to school or classroom management. Different learning zones feature different learning outcomes. With giving the students a clear understanding about the separate purposes of the environments it is easier for them to adapt faster and start gaining knowledge (Samaras, 2002).

Designing a learning environment by simply providing content can trigger informal learning in Minecraft - It was observed that the participants joined the interventions with previously gained knowledge gathered during the free to play phase (4.2.1; 4.6.1). At the end of the research, students showed profound knowledge about electricity and programming. The topic of electricity was introduced with a huge area containing all content for the students to discover and was also covered at the beginning in Session II (3.6.4). In comparison to that the content of programming was neither provided in a learning environment nor explained anyhow before the end of Session VI (3.6.8). This lead to the conclusion that hints given, and material provided during the free to play phase benefit and trigger the informal learning outcome but are not necessarily a must in order to create knowledge. It was concluded that:

Too much provided content in the designed environment can decrease the formal but increase the informal learning outcome in Minecraft - Csíkszentmihályi's (1975) widely cited notion of "flow." describes the positive psychological notion of experiencing a heightened, optimal state during an activity, with flow states being balanced between two competing states of "boredom" and "anxiety," resting in neither. While the presented research tried to achieve this mentioned balanced it was observed that in Session II (4.2.) the given opportunity of exploring almost all content of a topic or a mod at once lead to slight overstimulation. It needs to be argued that the students were limited in time and that the design approach was too complex for the formal learning phase. On the contrary, the offered content was reviewed a lot during the free to play phase and lead to self-regulated learning with a successful completion of the quest and also lead to further experiments with electricity.

Collaborative learning experiences are naturally facilitated by the game Minecraft - It was observed that without scripting collaboration in the first place, many tasks were solved collaboratively (4.1.1; 4.1.2; 4.2.1. 4.2.2; 4.4.1) and peer learning was noticed during those processes, which is in agreement with Dennen & Hoadley's (2013) statement of peer learning as a concept of collaborative learning. Aligning with the observation of others (Pihkala-Posti, 2015; TeacherGaming LLC, 2017; Uusi-Mäkelä, 2015) and the game design itself (Mojang & Microsoft, 2017) it needs no further argumentation that Minecraft is a collaborative tool. On the contrary it needs to be mentioned that it was observed during the presented research that:

Self-regulated learning designs can benefit formal and informal learning in Minecraft - Despite the in common research mainly used collaborative aspects of the game Nebel, Schneider, & Rey (2016) emphasise as a benefit of Minecraft that active knowledge construction in the game can either happen through cooperation approaches or through self- regulation.. Similarly it was observed and mentioned (4.1.1) that the freedom to choose between self-regulation including personal time management and collaboration in the presented research environment resulted into a beneficial learning experience (4.3.3; 4.5.1). It was observed that the opportunity to choose when and what to learn inspired and gave the participants responsibility about their own learning outcome during both learning phases.

Designs facilitating an online society in Minecraft can create opportunities to establish social connections - It was outlined by the students that the opportunity of participating in this online environment gave plenty of possibilities to connect to new peers

which might not have been encountered otherwise. In contradiction to that it was mentioned that those are not necessarily kept afterwards without the usage of the game (4.3.3), since the advantages of the online communities in the game that provide a framework which gives the opportunity to communicate online are not provided anymore (Huang & Soman, 2013).

2. What challenges are faced by teachers and students by using those designs as a tool for transferring knowledge in Minecraft and how are those challenges dealt with during the study? (Aim 2)

Clear rules on the Minecraft-server are needed to be implemented in order to maintain a successful learning environment - Cursing was one main issue during the research. When asked why the students sometimes use "curse words" during the classroom session they simply stated the fact that they do not even realise it. As with Rassin & Van Der Heijden (2007) and Johnson & Lewis (2010) in combination with the results of our data analysis it was concluded that a healthy amount of cursing can be tolerated if not directed against others. Psycholinguists have simply remarked that "taboo words communicate emotional information more effectively than non-taboo words" and allow us to vent anger without getting physical (Jay & Janschewitz, 2010). In addition to that destruction of the learning environments was observed leading to confusion and slowing down others in their workflow. (Figure 26, Figure 30). This leads to the need of mentioning that:

Children need time to adapt to new designed learning environments in Minecraft- the above mentioned destructions lead to confusion and slowed others in their work. After reflecting on the issue with the participants it turned out that it was mainly for the sake of exploring a mistake in the design implemented by the teachers. Based on the fact that over the time it was shown that this behaviour decreased itself, and at the last session no harm was done to the environment at all it was concluded that after a specific time the students accept a learning environment (4.6.1; Samaras, 2002)

Children with pre gaming experience about Minecraft do not necessarily benefit more than others - Unlike Uusi-Mäkelä (2015) and Pihkala-Posti, (2015) in their research this study concluded that as a result of the diverse gaming skills not all students were always entertained and motivated equally. In keeping with Dahlskog´s (2012) observation that experienced players may fall back into their previous actions, through having more experience with the game and are less triggered by new content, it was observed as well

that skilled players got bored easier than non-skilled players (Figure 26, 4.2.1; 4.2.3; Figure 30, 4.3.1; Figure 35, 4.5.1). In other words, skilled students' balance between "boredom" and "anxiety," was way more complex than the one of inexperienced players (Csíkszentmihályi's, 1975). This created boredom, held them back and decreased the focus on the actual topic (i.e. creating different flags, 4.5.1) while inexperienced players simply stayed excited and motivated.

Always have a backup file due to possible technical issues with the Minecraft-server - During this study it happened several times that the online server was not accessible because of connection errors (4.3.1). Since the server was hosted outside the school environment it was necessary to always carry a backup file in order to emergency host a server at a school computer. In addition to that, mods may cause server crashes or do not function as planned since many of them are beta versions in the trial phase (Mojang & Microsoft, 2017, TeacherGaming LLC, 2017).

Preparation hours as a newcomer to Minecraft can be long - When this research project was started both researchers were already familiar with the gameplay since both were experienced Minecraft players. There was however little experience on how to design fast structures, copy and paste material, import other material and how to handle the WorldEdit Mods (2.4.2). It can be argued that there is no need for scaffolding, no need to implement a story and no need to design learning environments, just join the game and start using Mods to teach. Based on our DBR cycles (Figure 5) this learning environment has evolved depending on the actions and reflections of the students observed and interpreted by the researchers. Due to this fact it can be validated that in this case with these participants this online environment and working hours were necessary (Reeves, 2006).

3. How functional and valid is the introduced "Steinbeiß-Ruotsalainen Model for Formal, Non-Formal and Informal Learning with Minecraft" as a pedagogical design implementation for Minecraft? (Aim 3)

The designed pedagogical "Steinbeiß-Ruotsalainen Model" can be used for further research attempts in Minecraft based on DBR (3.4; Figure 5) - In order to validate this statement it is necessary to link theory and research results of the presented study. According to Fitzpatrick, Sanders, & Worthen, (2011) outline of DBR as a method of focusing on activity structures, institutional designs, scaffolds and curricula this study

presents a new pedagogical design approach towards DBR with Minecraft. By going beyond merely designing and testing particular inventions, this model is validated by specifying theoretical claims through reflection, an understanding of the relationship among implemented theory, designed artefact and practice. During plenty occasions of observation and data analysis it was noticed that the implementation of the "Steinbeiß-Ruotsalainen Model" benefited the cycle of DBR to collect data and implement resulted design, in addition to that it benefited the research outcome and facilitated the learning outcome of the participants (4.1.1-4; 4.2.1;4.2.4; 4.5.1-2; 4.6.1; 4.7). Through the model's benefits students developed and individual time management and self-regulation, rotated between learning environments during the educational phases (4.5.1), and gained profound knowledge through exploring the learning environments freely on their own (4.1.3; 4.2.1; 4.2.4. 4.5.1). It was observed that without initiating additional content through Mods was explored during the informal learning phases (4.2.2). Through the possibility of circling between learning environments and free to play areas, motivation was triggered which lead to an unexpected high learning outcome as a result of informal learning experiences (4.2.1; 4.6.1). The "Steinbeiß-Ruotsalainen Model" validates itself through the presented research outcome and aligns with the idea of Wang & Hannafin (2005) which define DBR as a methodology with the purpose of developing education and educational environments in real life situations through flexibility and alliteration. In addition, the validation already mentioned the model justifies itself through the usage of standardised tools from multiple sources through method triangulation (3.8) which presented similar data. By comparing the qualitative and quantitative results it was shown that the provided balance of the "Steinbeiß-Ruotsalainen Model" between joy facilitating and knowledge gaining phases is needed in order to keep a successful learning outcome. Several indicators were found in the graphs, which aligning with the qualitative data sets, lead to the conclusion that the structure of the model benefited the fact that students were in general continuously busy with exploring and learning about other content through the informal learning phases (4.7).

It needs to be mentioned that the "Steinbeiß-Ruotsalainen Model" as a tool for DBR cannot be generalised and functional towards all future Minecraft research. Aligning with the DBR this publication allows readers to understand how the model benefited the presented research in order to validate its design. In addition to that, we emphasise that the context for further application has to be similar to that of this study (Denscombe, 2010). It needs to be mentioned that by testing the "Steinbeiß-Ruotsalainen Model" in such a small environment, this study cannot offer definitive results in its usage. The role of this model is

to pilot novel approaches towards using Minecraft as a learning and teaching tool by acting as a cornerstone for designing learning environments for formal and informal learning purposes.

5.1 Validity and Reliability

Validity is defined as the measurement of how the chosen research approach and its methods succeed in the process of creating results towards the research aims. It assesses how well the methods measure and how data represents what it should measure and represent (Newman & Benz, 1998). In order to prove the validity of this study DBR (3.4) and the chosen methods (3.7) need to be evaluated.

DBR can raise questions of concern about validity of its findings through the tweaking of innovations that occurs in it. It requires researchers to focus on being transparent, reflexive, and critical of their study (Shah, Ensminger, & Thier, 2015). Due to this given transparency, objectivity and validity are addressed (Collins, Joseph, & Bielaczyc, 2004) and in addition, promoting consensus among stakeholders serves as a defence of validity of DBR results (O'Donnell, 2004; Shah, Ensminger, & Thier, 2015). Researchers in general legitimise their studies by employing established qualitative and quantitative validity practices. These practices are based on the design of the study, and validated more specifically by re-evaluating at each cycle level. The usage of standardised tools from multiple sources (in this case observation through field notes and video data collection, reflective interviews and survey) is called material and method triangulation (3.8). DBR typically triangulates multiple sources and kinds of data to connect the intended and unintended outcomes to processes of enactment. In order to assess the validity of the research approach in this study, the validity of the chosen method triangulation has to be evaluated.

The unstructured observation through interventions as a naturalistic approach excludes the Hawthorne-effect which is based on the theory that if the participants know they are being watched they may act differently. As mentioned (3.7.1), the students were not aware of the fact that besides the video data collection, field notes were taken as well during the sessions. Since two researchers were present at all times, one always had time and space to gather valid data about the events while the other one was handling the lesson as a teacher and online character (3.5.1). In addition, naturalistic approaches are less reliable as variables cannot be controlled and through the fact of being conducted on a

micro scale, the findings are lacking the ability to be generalized to a wider society. Furthermore, the decision on what is important and worth noting requires a profound understanding of the research and its topic. The researcher needs to be trained to be able to recognise aspects of a situation that are psychologically significant and worth further attention. This makes it difficult for another researcher to repeat the study in exactly the same way (McCarney, et al., 2007).

In order to add additional value to the process of taking field notes which face the above mentioned problems, video data collection (3.7.2) was added to the data pool. This data simply records all in-game happenings and gives other researchers the opportunity to re-watch and to understand the conclusions made in this research. It is argued that the different placing of the recording device influences the end result since, depending on how one places the camera, it distorts reality in different ways (Jewitt, 2012). In order to avoid adulterates and distortions, three different angles of recording were chosen (3.2.2). The overall bird's eye perspective which recorded the whole area, the students' perspective which focused on the participation during the quests, and the teachers' perspective as a fluid moving camera. Furthermore, the field notes as a backbone of recorded reality eliminate the possibility of false interpretations. Again, the Hawthorne-effect can be an argued as well, since the participants knew that they were filmed. Lomax & Casey (1998) argue that even if one is recorded, after a specific time the participations forget about the presence of a recording device and continue uninfluenced. This state is referred to as an *"active state of not paying attention"* rather than not noticing. During the observation in the classroom, the same feeling was present which aligns with the theory of Lomax and Casey.

Complying with Reeves (2006) design of collaborative DBR, two more methods were implemented to add value to the data set. The first addition to the observational tools was a group reflection in from of a group interview after each session. As mentioned above, the observational collected data depends on the decision of the researcher about what he or she might think is useful for further usage. Since the students explore the whole research project from the perspective of a learner it was necessary to include the feedback of the participants as well. Through interviewing, the depth of detail from the interviewee can be understood. Through voice, intonation and body language, the interviewer has access to plenty of extra information if recognised. This leads to a possible weakness with general guided interviews (3.7.3): The possibility of missing some information. This can arise from the immense multitasking that the interviewer must do in combination with the

creation of follow up questions and questions based on the observation (Seidmann, 2013). Furthermore Seidmann (2013) argues that researchers report more missing data in interview research than survey research.

To backbone the interviews, a survey (3.7.4) was added as a tool for collection of individual data from the participants. While the interview covers the disadvantages of the survey, the survey copes with missing valid data during the interview part. By producing fast and efficient data sets, the survey lacks the dynamic interactivity of an interview, but gives the students time to sustainably reflect, and to answer in a relaxed environment. The quantitative part of the survey gave the opportunity for useful visual data to support the conclusions made during the analysis part, but is influenced by the number of students taking the surveys. It was emphasised that everyone should participate in the survey, and by visualising the data sets it was shown that most of the students did follow this suggestion.

Through choosing a triangulation of the above mentioned methods, misinterpretation of the data sets was kept to a minimum, and as a result design based approach appears to be valid since the internal validity (the successful link between methods and its purpose) is given. All chosen methods backed each other up and eliminated the disadvantages within each other. In addition to that, the external validity (the generalisation to other context) is assessed by the above mentioned promoting consensus among stakeholders (O'Donnell, 2004; Shah, Ensminger, & Thier, 2015). DBR publications allow readers to understand how conclusions are reached in order to validate the approach. In addition, one must emphasise that the context for further application has to be similar to that of this study (Denscombe, 2010). It needs to be mentioned that within such a small environment, this study cannot offer definitive results which can be generalised to every context. The role of this study is to pilot novel approaches towards using Minecraft as a learning and teaching tool by designing learning environments for formal and informal learning purposes.

5.2 Ethics of the Study

The current research has been conducted to comply with the ethical principles of social studies which, according to Denscombe (2010), need to ensure that the interests of the participants are protected, that its participation is voluntarily and based on informed consent, it avoids deception, operates with scientific integrity and complies with the law of the land.

These principles align with the Finnish Advisory Board on Research Integrity and align with previous research attempts made with Minecraft in Finland (i.e. Uusi-Mäkelä, 2015; Pihkala-Posti, 2015). This research did neither harm the participants in real life, nor were the participants able to be harmed inside the game, since the option of dying was excluded from the beginning of the study. In addition, the data collection approaches were participant friendly and were well adapted by the students. No personal information was handed to second or third parties, and all information was kept anonymous in this thesis. The participants signed up for this study freely via registering to an after school club. The lessons were neither graded, nor was there an opportunity to fail and provided an additional to guarantee validity of the data. The parents were informed beforehand about the study and via signing an agreement they agreed on the collection of data about their offspring. The participants and their parents had the opportunity to contact the researchers at any time. In addition to that, all content and data was kept transparent to them at a current state. By discussing and reflecting on the research on a weekly basis, the students had a clear idea about its goal and current status. Due to above outlined facts it can be concluded that the research took place in an ethically and morally correct framework.

6 CONCLUSION

The general aim of this study was to observe how the commercial game of Minecraft and its additional educational add-ons (2.4) could be used to design gamified educational environments for educational purposes. The focus laid on how the in-game learning environments were designed and developed by the teacher, and which designs were of benefit to the formal and informal learning experiences of a child (3.3). In addition, it was investigated what challenges the new learning environment of Minecraft brings, and how they were faced and dealt with inside the classroom and online by the students and the teacher (4). The "Steinbeiß-Ruotsalainen Model for Formal, Non-Formal and Informal Learning with Minecraft" (3.5) was introduced, and its functionality was validated. The results of this study have yielded several interesting findings:

First, it has been shown that gamified designed learning environments in Minecraft benefit informal and formal learning experiences. It was observed that the designed reward-based learning areas can function as a motivational tool during the formal and informal learning phases, and that the introduced "teacher as an online facilitator" can support the learning outcome. It was concluded that spatially divided designs for learning environments can benefit formal learning, and by designing a learning environment through simply providing content, informal learning was triggered. In addition, designs facilitating an online society in Minecraft can create opportunities to establish social connections, and self-regulated learning environments benefit the learning outcome.

Second, it was observed that children needed time to adapt to newly designed learning environments in Minecraft, and that those with previous gaming experience do not necessarily benefit more than others. Clear rules on the Minecraft-server were needed to be implemented in order to maintain a successful learning environment. Possible technical errors can always occur, and a backup data file of the server should be kept at all times.

Finally, from linking theory and the research results it was concluded that the "Steinbeiß-Ruotsalainen Model" can be used as a cornerstone for designing educational content in the game. It has proven itself to be a good design for teaching and researching purposes, and it can be used for further research attempts in Minecraft based on design-based research.

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8 TABLE OF FIGURES

9 APPENDICES

9.1 Appendix I – Survey

Sailor's Log Week 6

Fill in this form and collect your reward afterwards!

Enter your name (real life):

Enter your age:

Enter your grade/class:

Have you been online from home since the last meeting?

- ☐ Yes
- ☐ No

Have you participated in the Captain's Quest Week 5?
(Building and creating a flag for the island and on top of the mountain)

- ☐ Yes
- ☐ No

How did you like or dislike the Captain's Quest Week 5?
(Building and creating a flag for the island and on top of the mountain)

	1	2	3	4	5	
Did not like it at all.	○	○	○	○	○	I liked it very much.

Let's talk about Quest 6!

It is really important that you answer with more than just one or two sentences! Write a small paragraph to each question and describe in detail what you have experienced!

Have you done all Quests of Week 6?

(Programming turtles)

- ☐ Yes
- ☐ No

How did you like or dislike Quest 6?

(If you haven´t been in class leave the following questions empty)

	1	2	3	4	5	
I did not like it at all.	○	○	○	○	○	I liked it very much.

What has happened?

How did you feel?

What did you observe in others?

What did the exercise mean to you in relation to others?

What did you learn?

What would you do differently if you could change something?

How do we go on now? What needs to be done next?