Mapping the Landscape of Digital Game-Based Learning in Swedish Compulsory and Upper Secondary Schools

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Opportunities and Challenges for Teachers

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Abstract

Interest in the use of digital games in education has been increasing over the past few decades. Advocates argue that digital games are powerful learning tools with the potential to support increased motivational, cognitive, behavioural, affective, physiological and social outcomes. However, empirical evidence for their effectiveness is mixed. Research has focused primarily on measuring the effect of games on learning in researcher-controlled experiments, whilst relatively less attention has been paid to the role of teachers. The thesis addresses the research gap by investigating how teachers in Swedish compulsory and upper secondary schools use digital games on their own initiative and how they develop their competencies. It also considers the challenges they face.

Data from in-depth qualitative interviews and a mixed method survey are used to investigate the research questions. Both the data collection and analysis have been informed by activity theory. This is also used to problematise the adaptation of digital games as teaching and learning tools. In addition, the analysis explores teachers´ self-reported activities in relation to their disposition towards digital games.

The findings show that a diversity of digital games and gamification tools have found a foothold in Swedish classrooms. The participating teachers are interested in introducing and further developing digital game-based approaches, though there are limitations in their use of gaming resources and the extent to which they can leverage these to achieve educational outcomes. The research identifies and discusses four general categories of teachers: non-game users, sceptics, curious adopters and advanced adopters. Results indicate that the more positive disposition of game-using teachers tends to be related to a higher level of pedagogical integration, a greater variety of game use, and a wider range of educational outcomes, as well as an interest in professional development. Digital game-based learning is often understood as the use of gamification tools in the form of quizzes, whereas complex games and longer gameplay are less typical. Whilst most teachers agree on the motivational benefits of digital games, not as many perceive them as effective in teaching new knowledge and cognitive skills. The introduction of digital games is hampered by the lack of access to relevant and good-quality products, financial resources, preparation time and adequate technology, as well as contextualised and flexible forms of professional development. These

challenges hint at deeper issues with preexisting education structures. Future research should have a twofold focus: the development of adequate game resources that can support collaborative forms of learning and higher-level skills, and flexible and contextualised competence-development solutions for teachers which are relevant to their needs.

The thesis contributes to the current literature by mapping the landscape of digital game-based learning in Swedish compulsory and upper secondary schools. It provides a nuanced understanding of the perspectives of teachers on digital game use and the opportunities and challenges presented by digital game-based learning.

Keywords: digital game-based learning, digital game-based teaching, digital games, education and games

Sammanfattning

Intresset för användningen av digitala spel inom utbildning har ökat under de senaste decennierna. Förespråkare hävdar att digitala spel är kraftfulla inlärningsverktyg med potential att främja ökade motivationsmässiga, kognitiva, beteendemässiga, affektiva, fysiologiska och sociala resultat. Dock är de empiriska beläggen för deras effektivitet blandade. Forskningen har främst fokuserat på att mäta spelens effekt på lärande i forskarstyrda experiment, medan mindre uppmärksamhet relativt sett har ägnats åt lärarnas roll. Avhandlingen behandlar forskningsgapet genom att undersöka hur lärare i svenska grundskolor och gymnasieskolor använder digitala spel på eget initiativ och hur de utvecklar sin kompetens. Den beaktar också de utmaningar de står inför.

Data från djupgående kvalitativa intervjuer och en multimetodologisk undersökning används för att undersöka forskningsfrågorna. Både insamlingen och analysen av data har informerats av aktivitetsteori. Denna används också för att problematisera användningen av digitala spel som undervisnings- och inlärningsverktyg. Dessutom undersöker analysen lärarnas självrapporterade aktiviteter i relation till deras inställning till digitala spel.

Resultaten visar att en mångfald av digitala spel och spelverktyg har fått fotfäste i svenska klassrum. De deltagande lärarna är intresserade av att införa och vidareutveckla metoder baserade på digitala spel, även om det finns begränsningar i deras användning av spelresurser och i vilken utsträckning de kan utnyttja dessa för att uppnå utbildningsresultat. Forskningen identifierar och diskuterar fyra allmänna kategorier av lärare: icke-spelanvändare, skeptiker, nyfikna adoptanter och avancerade adoptanter. Resultaten indikerar att den mer positiva inställningen hos lärare som använder spel tenderar att vara relaterad till en högre nivå av pedagogisk integrering, en mer varierad spelanvändning och ett bredare omfång av utbildningsresultat, samt ett intresse för professionell utveckling. Digitalt spelbaserat lärande uppfattas ofta som spelifiering i form av frågesport, medan komplexa eller längre spel är mindre vanliga. Medan de flesta lärare är överens om de digitala spelens fördelar avseende motivation är det inte lika många som uppfattar dem som effektiva för att lära ut ny kunskap och kognitiva förmågor. Införandet av digitala spel hämmas av bristen på tillgång till relevanta produkter av god kvalitet, ekonomiska resurser, förberedelsetid och tillräcklig teknologi, samt

kontextualiserade och flexibla former av professionell utveckling. Dessa utmaningar antyder djupare problem med befintliga utbildningsstrukturer. Framtida forskning bör ha ett tvåfaldigt fokus: utvecklingen av adekvata spelresurser som kan främja samarbetsformer för lärande och färdigheter, samt flexibla och kontextualiserade lösningar för kompetensutveckling som är relevanta för lärarnas behov.

Avhandlingen bidrar till den aktuella litteraturen genom att kartlägga landskapet för digitalt spelbaserat lärande i svenska grundskolor och gymnasieskolor. Den ger en nyanserad förståelse av lärarnas perspektiv på användningen av digitala spel samt de möjligheter och utmaningar som digitalt spelbaserat lärande medför.

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Acronyms and initialisms

AT Activity theory

DGBL Digital game-based learning

DGBT Digital game-based teaching

GUT Game-using teacher

NGUT Non-game-using teacher

OECD Organisation for Economic Co-operation and Development

1. Introduction

Educators have been long fascinated with the question of how to facilitate and enhance learning through play (Gee 2007), and the quest continues in our current digital environment (Plass et al., 2019). Today, most children and adolescents play games across a wide range of devices such as computers, game consoles, mobile phones and other mobile devices. In Sweden, 79% of children between the ages of nine and 12 play digital games, with most of them playing for five to seven hours per week (Statens Medieråd 2017; Statista 2016). Gaming has grown into an essential form of entertainment and has redefined the way young people consume entertainment as teenage e-sports competitors have become more popular than professional athletes. Gaming today is a ubiquitous part of culture and society and a booming multibillion USD business (Swedish Games Industry 2019).

The growing use of digital devices and the popularity of games have sparked researchers' and educators' interest in the use of digital games in education. Advocates argue that games are powerful learning tools (Gee 2003, 2007); well-designed games can fully engage and immerse players in interactive and challenging game worlds and create an intense sense of intrinsic motivation (Malone and Lepper 1987; Prensky 2001). Players can learn new concepts, understand complex processes and events, and discuss and engage in collaborative problem solving with others while playing (Gee 2003). For education it means that games have the potential to develop skills and knowledge, engage students in complex forms of thinking (Kafai and Burke 2016a, b) and support the understanding of how various systems of relationships operate in relation to each other (Bogost 2007). They can be powerful tools for supporting the development of identity and values through activities that simulate professions such as historians, engineers and mathematicians (Shaffer 2006). Games may provide building blocks that can be manipulated and recombined, for example when learning computer programming (Kafai and Burke 2016a,b; Ito 2009), and support socially and culturally situated learning (Squire 2012) and literacy development, and promote active learning and multimodality (Gee 2003, 2007).

Hence, various generations and types of digital games have been introduced into education since the 1980s paralleled by shifts in our understanding of how humans learn (Egenfeldt-Nielsen 2007). Digital games were found to be part of teachers' toolbox across schools in Denmark, Finland, Norway, Portugal and the US, mostly in lower grades (Egenfeldt-Nielsen 2011). In a study with 684 K-8 teachers in the US, 74% of the teachers say that they teach with digital games and one out of five teachers say they use games at least on a monthly basis (Takeuchi and Vaala 2014). In a recent study from the Nordics, including Iceland, Denmark and Norway, 66% of schoolteachers say they use digital games (Brooks et al. 2019).

However, findings indicate that few teachers use games that allow for exploration and complex decision-making. Games are typically short and mainly used to motivate and reward students rather than to teach or assess (Takeuchi and Vaala 2014). Similar findings have emerged from a Norwegian study indicating that the most popular tools are quizzes to drill students' knowledge (Brooks et al. 2019). The game researcher Elizabeth Gee stressed that gaming in schools may run the risk that it *"will be viewed as a dumbed-down learning activity for problem students, rather than as a means of providing richer and more productive learning opportunities for all students"* (Takeuchi and Vaala 2014, p.56). Teachers who do not use games both in the US and across the Nordics say that they are unsure how to integrate games in their teaching (Brooks et al. 2019; Takeuchi and Vaala 2014). Teachers who use games more frequently report greater improvements in their students' skills than those who use games less. These teachers tend to be younger teachers or game players themselves (Takeuchi and Vaala 2014). Findings from the studies point towards differences among teachers in terms of their gaming background, competences in using games in their teaching, and access to support and resources. While digital games may hold the promise of a powerful learning tool, what becomes possible for individual teachers with the available games in the complex reality of their classrooms may be a different story.

Despite the fact that for most Swedish children, games are an integral part of life, little is understood as yet about the role of digital games and how teachers use them in Swedish schools. To leverage the potentials of digital games in the reality of Swedish schools, first it is important to understand why and how teachers themselves implement digital games and the challenges they face. A better understanding of teachers' use of digital games and their challenges as they arise in classroom contexts will help in the design of games and support for teachers.

1.1 The research problem and motivation

Much of the research about the use of digital games in education has been conducted with a particular game as a starting point. This typically means that a researcher chooses a game that is relatively inexpensive, applies it to the curriculum under study or appropriate age level or other convenience. Thus, the classroom experiences are built around the game first and then educational objectives are selected based on what is possible to achieve with that particular game to study whether games can teach. These researcher-led experiments (Boyle et al. 2016) often assume that educational outcomes can be attributed solely to the game effect (Nousiainen et al. 2018) while disconnecting from real contexts and practices of teachers and their influence on the outcomes.

Several recent studies have highlighted that in student learning teachers play a critical role (Huizenga et al. 2017; Kangas et al. 2016) as they have the most significant impact on student achievement (Hattie, 2003). Therefore, digital games as stand-alone educational solutions cannot do the job on their own (Becker, 2017). Navigating a variety of game designs and implementing games in the classroom is not an easy task as it requires not only adequate resources but also a careful coordination of various knowledge domains (Bourgonjon et al. 2013). Selecting, planning, implementing and assessing the learning around and in games can be daunting for teachers. Nonetheless, teachers have been under-represented in game-based learning literature and teachers' practice-based use of digital games has been a less explored area (Kangas et al. 2016).

Despite the fact that for most Swedish children games are an integral part of life, the role of digital games and how teachers use them in Swedish schools are as yet little understood. To leverage the potentials of digital games in the reality of Swedish schools, first we need to understand why and how teachers themselves implement digital games.

1.2 Aim and research questions

The studies in this thesis address the research gaps described and investigate how teachers use digital games on their own initiative across Swedish compulsory and higher secondary schools and the challenges they face. More precisely, the thesis addresses the following research questions:

RQ: How do teachers in Swedish compulsory and upper secondary schools…

1. understand and implement digital games?
2. engage in professional development about the use of digital games in teaching?
3. perceive challenges of, and barriers to, using digital games in teaching?

1.3 The research approach

In approaching the research questions, a sequential mixed-research methodology was applied. Accordingly, the research questions formulated have been empirically approached by using a combination of qualitative and quantitative research approaches in two studies. These are referred to throughout the thesis as Study 1 and Study 2A and 2B. The studies were conducted from 2018 to 2019 in Sweden and involved teachers from compulsory and upper secondary

schools from grade 1 to grade 12. The three articles in this thesis are based on these two conducted studies. See Figure 1 for an overview.

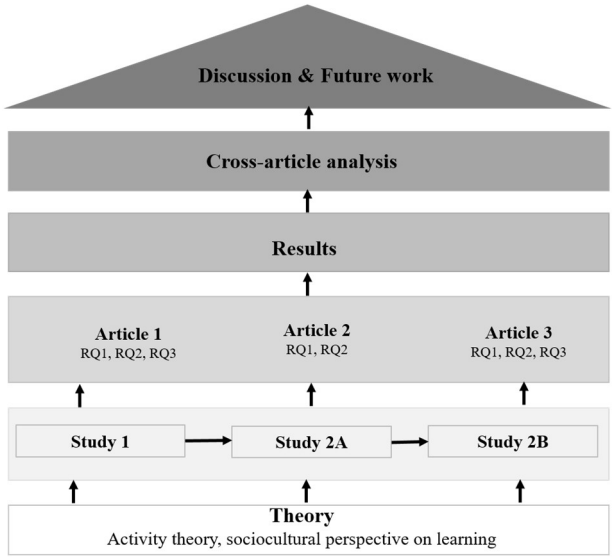

Figure 1 Research design

1.4 Delimitations

Firstly, this thesis considers any types of games that are played entirely or partially on any digital devices. However, it does not consider analogue games. Secondly, the findings obtained in this study are not generalizable to all teachers in Sweden as teachers selected for Study 1 and those who voluntarily opted in to Study 2 are not necessarily representative of all teachers in Sweden. Thirdly, the studies focus solely on the self-reported activities of teachers and did not collect data on 1) the teachers' actual use of digital games in classrooms, and 2) students' actual use of digital games in classrooms.

1.5 Articles in this thesis

The following articles have been included in this thesis:

1. Mathe, M., Verhagen, H. and Wiklund, M., 2018. Digital games in education: exploring teachers´ practices and challenges from play to co-design. In M. Ciussi (Ed), *Proceedings of the 12th European Conference on Game Based Learning,* SKEMA Business School, Sophia Antipolis, France, 4-5 October 2018, pp. 388-395.
   My contribution to this article was 75%

2. Mathe, M., Verhagen, H. and Wiklund, M., 2019a. Digital games-based teaching in Swedish compulsory and upper secondary schools. In L. Elbæk, G. Majgaard, A.Valente and Md. S. Khalid (Eds), *Proceedings of the 13th European Conference on Game Based Learning*, Odense, Denmark, 3-4 October 2019, pp. 503-511.
   My contribution to this article was 75%

3. Mathe, M., Verhagen, H. & Wiklund, M., 2019b. From skeptics to advanced adopters: investigating digital game adoption practices, challenges and needs of teachers in Swedish school. In A. Liapis, G.N.Yannakakis, M. Gentile and M. Ninaus (Eds)*, Games and Learning Alliance 2019: 8th International Conference,* Athens, Greece, 27-29 November 2019, pp. 73-82.
   My contribution to this article was 75%

1.6 Overview of the research articles

The thesis is based on a collection and overview of three articles stemming from the two research studies. Study 1 is a multiple-case, interview study that explored different teaching approaches and challenges of *game-using teachers* in Sweden. Studies 2A and 2B comprise a mixed-method survey study that expanded data collection across the country and included both *game-using* and *non-game-using teachers*. The studies are explorative and descriptive in terms of the nature of research. Article 1 stems from Study 1, while Articles 2 and 3 stem from Studies 2A and 2B, respectively.

Article 1 – Digital games in education: exploring teachers' practices and challenges from play to co-design

This article explores teachers' self-reported DGBT activities and challenges in Swedish compulsory and upper secondary schools. To this end, semi-structured interviews were conducted with eight participating teachers from an activity theory perspective. The teachers had already implemented digital games in their teaching on their own initiative. The analysis identified different approaches to digital game-based teaching (DGBT) and a set of challenges that teachers have faced.

Article 2 – Digital games-based teaching in Swedish compulsory and upper secondary schools

This article further investigates the DGBT activities and challenges of 181 teachers across Swedish schools and expands the scope to both *game-using* teachers (GUTs) and *non-game using* teachers (NGUTs). It takes a closer look at teacher characteristics such as age, gender and teaching experience and ex-

amines gaming interest and experience, DGBT activities and perceived challenges of teachers. The article discusses the similarities and differences of NGUTs and GUTs.

Article 3 – From skeptics to advanced adopters: investigating digital game adoption practices, challenges and needs of teachers in Swedish schools
In this article, the 123 *game-using* teachers from Study 2B were further investigated. First, the respondents were classified based on their disposition towards the use of digital games in their teaching. The analysis identified a set of clusters which that were further examined in terms of game use, challenges and professional development activities and needs. The article examines the differences in the game use approaches, perceived effects, challenges and needs of GUTs. Table 1 summarizes how the articles address the research questions.

Table 1. Research questions in articles

Research Question		**Article**
How do teachers in Swedish compulsory and upper secondary schools… 1. understand and implement digital games?		Article 1 Article 2 Article 3
2. engage in professional development?		Article 1 Article 3
3. perceive challenges of, and barriers to, DGBT?		Article 1 Article 2 Article 3

1.7 Contributions

This thesis contributes to the body of research in the following ways:

- It addresses the important stakeholder group of teachers largely overlooked in the context of digital game-based learning (DGBL);
- It provides an insight into how teachers in Swedish compulsory and upper secondary schools use digital games;
- It analyses both game-using and non-game-using teachers;
- It provides insight into the reasons why teachers in Sweden may or may not use digital games in their teaching;
- It proposes possible future pathways of DGBL in Swedish schools.

1.8 Thesis structure

Chapter 1 Introduction, presents the research area and the scope of the research, and includes an overview of the published articles that are the foundation of the present research.
Chapter 2 presents the background of digital games-based teaching and learning.
Chapter 3 describes the ontological and epistemological perspectives and theoretical positioning of the research.
Chapter 4 presents the methodologies used in the research studies.
Chapter 5 discusses the results and analysis of the empirical studies.
Chapter 6 discusses the conclusions and contributions of this thesis and recommendations for future work.

2. Background

2.1 From children's playthings to digital games

While the history of digital games dates back to the 1950s, children have played with self-made and improvised "playthings" since ancient times. Prior to the eighteenth century, playthings specifically manufactured for children were rare and only accessible to the privileged elite. The English word *toy* itself stood for "petty commodity", a thing of no greater value. Originally it denoted inexpensive objects and had nothing to do specifically with children (Sutton-Smith 1986). Prior to the eighteenth century, play was condemned as sinful, idle pursuit as children were expected to contribute to the family economy at an early age. They were seen as inherently sinful individuals who had to be broken through discipline and their play was perceived as a potential obstruction to learning (Brandow-Faller 2018).

However, with the onset of the Enlightenment in the eighteenth century, the perfectibility of humans through knowledge and reason became important. The previous notion of the *sinful child* was opposed by Locke's theory of *tabula rasa*, in which the *innocent child* was seen as a blank slate and shaped by its environment and education (Brandow-Faller 2018). Locke saw *play* as a tool to be used by the child to learn under a teacher's supervision. Playing gained educative and moralistic functions in moulding children's ability to reason and in teaching them important lessons for adulthood. Thus, it was the first time that the idea of the modern educational toy had been conceived (ibid.). Consequently, the first educational toys had a solitary, supervised intention (Sutton-Smith 1986). By the end of the 1700s there was a wide array of educational toys and games available that used packs of cards to teach geography, history, spelling and astronomy. Board games were transformed into games about morality. Jigsaws were invented for calculation, patience and solitary concentration. The manufacturers of the day advertised their wares as "improving toys" that combined entertainment and amusement with instruction (Sutton-Smith 1986). The birth of toys marked a point when an individualistic ethic became dominant in the middle and upper classes. Educational toys gradually became toys of solitariness and personal possessions of children. Children were coming to be recognized as individuals (Sutton-Smith 1986). Giving children toys for them to possess also signalled a shift from discipline to a notion of control through gifts and rewards.

By the 1900s, children had been removed from wage labour and introduced to compulsory schooling, and the age of minority had been extended as well. In the Western world, children were by then seen as productively useless but emotionally priceless, while play was seen as the work of the child that re-

quired specific objects. This period is characterized by the expansion of factory production. In the twentieth century, with the notion of the *priceless child*, toys become a form of caring and a substitute for family socialization and the discourse was often divided between perspectives of the *exploited child* and the *empowered child* (Brandow-Faller 2018). Toys were adopted for educational use in schools, mostly under the profound influence of the German educator Fröbel. He argued that for children's development, external objects or play objects were necessary. To this end, he designed objects (i.e. a ball, cube, sphere, cylinder and blocks) that he called "gifts from God" that were given to children in a specific sequence. Fröbel saw *play as a divine occupation* accompanied by play objects (Sutton-Smith 1986).

His notion that particular toys have specific educational effects was taken up by Maria Montessori. Children were allowed to practise with different materials in a prescribed manner to learn about colour, form, shape and texture, but they were not allowed to play with these objects in their own fashion. The Russian psychologist Lev Vygotsky also related specific effects to specific toys, while John Dewey emphasized that children may use whatever objects are at hand in order to develop their own understanding (Sutton-Smith 1986).

The early twentieth century was also a period of intense technological development, including radio and television. The first attempt to use educational media in schools started with instructional films in the 1910s. However, there was scepticism over combining entertainment, commercial interest and education, instructional films were considered low culture, and producers tended to aim for fast profit, which then alienated the educators. Later, educational television was introduced into education as a form of one-way communication (Egenfeldt-Nielsen 2005). In 1958, Skinner built his drill and practice machine, a forerunner of early games built on ideas of behaviourism (Egenfeldt-Nielsen 2006). The 1960s was the period when the first computers entered education. Computer-assisted learning sparked much enthusiasm and emphasized the need for computer literacy and the benefits of computer-assisted instruction focused on drill and curriculum-based instruction systems. These were stand-alone activities with only limited guidance from teachers built on behaviourism (Egenfeldt-Nielsen 2005).

In 1973, largely in response, and as an alternative, to the drill-based instruction systems, the Plato project was established in the US. The project attempted to teach maths through everyday examples rather than abstract algebra. The inspiration for the project was not behaviourism but rather the cognitivism of Jean Piaget and the educational philosopher John Dewey's ideas (Egenfeldt-Nielsen 2005). Evaluation studies showed positive effects on maths achievement (Olive and Lobato , 2001), and from the late 1970s and early 1980s educators and technology makers started to build software products for children. Educational computer games were released in large numbers and computer games started to emerge in classrooms (Egenfeldt-Nielsen 2005). While it took several millennia for games to evolve into a virtual world,

the progress from simple games with dots and lines to three-dimensional avatars playable on the World Wide Web has taken a couple of decades. In the 1970s, games were played in video arcades. Today, digital games are played on computers, game consoles, mobile phones and other mobile devices. There is a wide variety of different digital games that are outpacing most other media formats in terms of their complexity, content, usability and desirability. Mobile gaming, online games and a widening of the demographics of game players make the case for using digital games in education compelling (Kirriemuir 2006; Gee 2003, 2007).

Modern ideas of play contain laminations from the various historical periods that diversely entered into the modern view. There is a plurality of conceptualizations of play with paradoxical and amorphous definitions (Sutton-Smith 1986). In his influential book *Homo Ludens*, Johan Huizinga (1949) argued that play cannot be described purely from a behavioural or biological perspective. He argues that play is one of the "driving forces in culture". He describes play as a free activity, standing quite consciously outside "ordinary" life and "beyond the immediate needs of life". Play has meaning, a sense and, most importantly, it is fun (Huizinga 1949, p.13).

2.2 What is a game?

There are many different forms of games and interpretations thereof. Researchers, theorists and philosophers have spent years crafting a definition of games. Salen and Zimmermann (2006) for example discuss eight different definitions.

There are many different types of games: simple games of chance, games of skill, role play or scenario planning and mimetic play. They are different in how they use chance and strategy, repetitiveness, linearity or, for example, the perspective from which the player views the events in digital games. Games can be played individually or in a group, and sometimes thousands of players connect remotely in massively multiplayer online games (Selwyn 2014). While discussing a range of definitions would be difficult and lengthy in this thesis, all games can be said to share some common characteristics. Waern (2012) suggests that games can be seen either from the perspective of *systems* or *human activity*. Next, these perspectives are explored in more detail.

From the **systems perspective**, games are a "system in which players engage in an artificial conflict, defined by rules, that results in a quantifiable outcome" (Salen and Zimmermann 2003). A game is a goal-directed activity conducted within a framework of agreed rules (Lindley 2003). The rules of the game influence what actions a player can or cannot do, and what consequences those actions may have within the world of the game. From this perspective, games can offer a structured context where playing is voluntary, internally motivated, enjoyable and requires active participation. Becker (2017)

argues that a game is interactive, has rules, has one or more goals, and has a quantifiable measure of progress and usually a recognizable ending.

Thinking beyond the system of the games, Selwyn (2014) also discusses the narratology of games. From this perspective, games can be seen as a form of interactive storytelling with a focus on events, settings, characters and perspectives (Selwyn 2014), and positions games as a story and text, similar to films, books and television. Carr et al. (2006) suggest that role-playing games or action adventure games can be particularly interesting from this perspective due to their connection to other media forms such as cinema or comics, as well as their complex worlds, characters and narratives.

Another notion of **games as activity** refers to games as acts of play that are exploratory and not bound to the rules of a system (Selwyn 2014). From this perspective, it is not the game that is primarily interesting but rather the activity of playing (Kangas et al. 2016). In the context of learning, play means stimulating and promoting creativity and knowledge co-creation through hands-on playful and physical activities. This may include curriculum-based learning that is enriched with play, games and technological affordances that provide new locations beyond the classroom. In a playful environment, students are seen as active participants, become game content creators and may be involved in activities both in- and outdoors (Kangas et al. 2016).

These perspectives correspond to Caillois' classification of play described in his seminal book *Man, Play and Games* (2001). For him, games and play can be placed on a sliding scale from structure- and rule-heavy ludus (game) to free-flowing paidia (play). He suggests that play is an activity that is free and voluntary, separate and defined in space and time and has an uncertain outcome. Paidiac play is spontaneous, and unscripted, open-ended role playing or fantasy play. On the other hand, ludic play (game) is based on rules and upon "the pleasure experienced in solving a problem arbitrarily designed for this purpose" (Caillois 2001, p.28).

2.3 Digital games and learning

The concept of digital game-based learning (DGBL) started when Malone (1981) published his work "Toward a theory of intrinsically motivating instruction taxonomy" on why digital games are engaging and motivating. He argued that for games to be fun, the right amount of challenge, curiosity, fantasy and control is necessary. At the same time, Seymour Papert (1980) published his seminal book called *Mindstorms*, which outlined the potentials of computers for education. One of the first persons to use the term "DGBL" was Marc Prensky (2001). In his book *Digital Game-Based Learning* he argued for the great potential in the use of digital games for student motivation and learning in what he described as the "digital game-based learning revolution".

He argued that the days of sitting in boring classrooms in front of boring computer training systems are soon to be over (Ito, 2009).

Further impetus for DGBL came from James Paul Gee (2003) when he published *What Video Games Have to Teach Us about Learning and Literacy.* He argued that well-designed video games are powerful learning tools as they have the capacity to engage learners in complex forms of thinking and problem solving. Children and adolescents can spend several hours per day on navigating game environments, learning and mastering new concepts, understanding complex processes and events, and discussing and engaging in collaborative problem solving with others in a way that involves reflection. They develop mastery within specific domains in order to progress in the game and achieve the goals presented in the game. He argued that successful video games can be interactive and challenging environments that support socially and culturally situated learning and literacy development, promote active learning, multimodality and development of learner identity (Gee 2003, 2007). Complementing his work, others argued that games encourage the development of particular literacies. Ian Bogost (2007) suggested that games are well equipped to educate players on *procedural literacy*. This involves understanding how various systems of relationships operate in relation to each other. He argued that computer games can provide building blocks that can be manipulated and recombined, for example when learning computer programming, tinkering with a simulation of a city or civilization, or building a virtual house (Ito 2009). Shaffer (2006) argued that games are particularly powerful tools for developing skills, knowledge, identity and values. He focused on what he calls *epistemic games* where players take part in activities that simulate professions such as historians, engineers and mathematicians.

Several research studies discuss the positive effects of introducing digital games into learning contexts and argue that games can help to increase the motivation and engagement of students in learning and enhance educational processes (Connolly et al. 2012; Hainey et al. 2016). Games have been successfully used for knowledge and skill acquisition, affective and perceptual goals, behavioural change, and cognitive and physiological outcomes (Boyle et al. 2016).

Despite the positive accounts and potentials of digital games, solid empirical evidence of digital games as an effective teaching tool is mixed. Research on games in education has primarily focused on measuring learning outcomes of game-based learning or identifying the learning potential of particular game designs (Hanghøj 2013). These are often single teaching experiments in which a game has been tested on students without the pedagogical approaches and solutions being elaborated. Such experiments controlled by researchers often assume that effectiveness can be attributed merely to the game effect. Challenges relate also to ambiguities regarding taxonomies of digital games, and the different design considerations of how digital games might support learning (Kangas et al. 2016).

Research generally discusses three digital game-based approaches to learning: the use of educational games, entertainment games and learning by making games. All three approaches are based on Van Eck's (2006) typology of game-based learning. A more recent, separate concept is gamification (Deterding et al. 2011). Next, these four design approaches are explored in more detail.

2.3.1 Educational games

Educational games are designed while trying to address specific learning objectives and help learners to reach these objectives. However, they can be diverse in terms of their design.

Egenfeldt-Nielsen (2007) outlines three generations of educational games paralleled by shifts in our understanding of how humans learn. The first generation of educational games dates back to the 1970s and 1980s and included simple computer games that delivered straight-forward information to players; these were also called "edutainment games". The term signals the underlying assumption that children should not play solely for the sake of playing but to develop other skills in the process. Parents appreciate the combination of entertainment and education, thus their wish to rationalize play was used to create a new market. These games were typically inspired by behaviourism, which claims that people learn by practising skills and content through reinforcement and conditioning and assumes that learning occurs when people practise a skill enough times (Egenfeldt-Nielsen 2007). This theory focuses on Skinner, Pavlov and Thorndike's observation that learning happens by reinforcing, substituting or removing external conditions and stimuli (Phillips & Soltis 2009). The evidence of learning here is directly observable behaviours. These games tend to focus on extrinsic motivation, which is when learners get some kind of a reward, for example points, for engaging in an activity rather than being motivated by themselves, for example by the feeling of mastery from completing a game level. Usually, these titles lacked integration of playing and learning experience, while information in general was fed to players separately from the game itself. An example is the Swedish game Chefren's Pyramid (Egenfeldt-Nielsen 2007). The game is supposed to teach players about Egyptian culture and contains a large amount of facts that players have to scroll through and sometimes read. The game features different puzzles and small games, but without any connection to the Egyptian culture. Another criticized feature of edutainment games was that they supported superficial construction of what learning is. Critics pointed out that students need to be able to endure frustration during learning, despite facing problems, which was rare in edutainment titles. The ease of use became the dominating feature as limited budgets led to mediocre contents. Consequently, edutainment games gradually lost their appeal (Egenfeldt-Nielsen 2007).

In the 1990s, however, a second generation of games started to emerge, in parallel with a shift in learning theories. These games focused on the learners themselves and acknowledged that they bring different knowledge bases when they enter the gameplay. The focus was on delivering content in a cognitively appropriate format, and to this end they incorporated cognitive constructivist learning concepts such as scaffolding, chunking of information and facilitation (Egenfeldt-Nielsen 2007). Games such as Playing History and Immune Attack are examples of this generation of games.

The early 2000s saw the emergence of third-generation games across the US, the UK and Nordic countries based on the idea of a close integration of gameplay and learning experience. An example is Quest Atlantis. There was also a view that games do not exist in a social vacuum. The educational experience around the games that promoted creative, socioculturally interactive learning activities, problem solving and collaboration became important. These games were building on concepts from constructivism and situated learning theory based on Vygotsky's work on the social aspects of learning (Egenfeldt-Nielsen 2005). The learning experience is not limited to the interaction between the players and the game as discussed by Gee (2003) but teachers are seen as a central facilitator whose role is to adapt the games to classroom teaching and engage the students in hands-on activities.

Egenfeldt-Nielsen (2007) argues that each generation of games is carried forward to the next, meaning, for example, that behaviourism is still at play, but considered in a broader overall frame.

Educational games today may still carry the legacy of edutainment. Many educational game titles on the market today are often short experiences and used to practise specific learning objectives based on repetition and may not provide significant educational value, nor meet learner expectations (Clark et al. 2017). While these games are often brought into classrooms to enhance learners' motivation, their motivational effects may not last longer than their novelty. The challenge of more complex and engaging educational games relates to how well the learning content is integrated with the game mechanics and the extent to which the game supports the learners in focusing on learning (Nousiainen et al. 2018).

2.3.2 Construction of games

Another approach to implementing games in education is learning by making games and tying into constructionist theories on learning as described by Seymour Papert (1980). This approach is aimed at enhancing understanding of a specific learning content by designing and building a game, as opposed to playing a game. Game design encourages students to solve problems and learn new things through constructing knowledge. It has also been connected with ICT competences, programming, communication and creative expression (Kafai and Burke, 2016a,b). Whitton (2014) argues that when students make

their own games, they have the opportunity to create what they would like to see and play. They can design their learning outcomes and develop their creativity and problem-solving skills. From this perspective, the focus is on creative games where learning emerges from experimentation and shifts the focus from a teacher-centred to a learner-centred approach. Approaches to constructionist gaming may also extend beyond designs on screen and include hybrid crafting approaches where digital components are used to extend game making beyond the screen. This may include the design of interactive touchpads, augmented board games or the coding of physical extensions with construction kits and involve the design or remixing of games, for example in Scratch (Kafai and Vasudevan, 2015).

2.3.3 Entertainment games

An alternative approach to game-based learning is the use of entertainment games. These are not inherently educational as their original aim is to provide an engaging game experience. However, entertainment games can also incorporate educational principles. For example, they may present tools, problems and challenges with incremental difficulty and include scaffolding that helps the player to engage with the game world (Marklund 2015).

As these types of games can become progressively complicated, it can be time-consuming to master the rules and game set-up. Designers might oversimplify objects when creating the game world, and the knowledge from games may be superficial, flawed and result in a potentially faulty teaching tool. This is also one of the fundamental critiques of using entertainment games in an educational context. Moreover, Linderoth (2012) cautions that if a game environment is not specifically designed to facilitate learning, the players are unlikely to learn anything beyond manipulating the game world. For example, visual clues and short cuts in the games can limit the need for exploration and practice since players just follow the clues. This problem is particularly prominent when a game is used in isolation without being put in a wider instructional context (Marklund 2015). Young et al. (2012) argue as well that games cannot succeed as stand-alone educational solutions. Teachers delivering the lessons have to identify the learning elements and make the necessary connections to the curriculum, learning goals and outcomes. Situating the entertainment game in a wider educational context can also provide space for discussion and reflection that can help to bridge the transfer gap (Marklund 2015). However, navigating a complex variety of game designs and adopting games can be a difficult task for teachers (Van Eck 2006).

2.3.4 Gamification

While technically not a game, gamification merits a place in this thesis due to the research findings from Nordic countries that indicated that DGBL may be understood by many teachers as the use of gamification (Brooks et al., 2019).

Gamification turns a non-game activity into a game to motivate learners (Deterding et al. 2011). In practice, it can take a wide range of forms from simple pointification to activities consisting of different game-like narrative, playful elements. Typical examples include rewards, points, badges and leader boards. Gamification can take place on a micro scale, for example an individual teacher gamifying his class. Traditional grading may be discarded in favour of experience points and homework assignments become quests. In these cases, gamification does not alter activities and how they are performed but attaches a layer of rewards and points in order to change the behaviour or experience of the learners (Marklund 2015). At the other end of the scale is where gamification becomes the organizing framework for teaching and learning.

Gamified systems can help learners to reach set goals. Koivisto and Hamari (2019) found that in research literature the learning outcomes of gamification are mostly positive, for example in terms of increased motivation and engagement as well as enjoyment. However, research also points out negative outcomes such as the effects of increased competition. Currently gamification designs are typically focused on achievement, while the motivations of players are more diverse. Some may enjoy achievement-related gratification but competition may discourage others who are motivated by social aspects, immersion in stories and role play or a mix of these elements. Critics point out as well that too much focus on rewarding simple tasks and too much reliance on reward systems rather than promoting interest and engagement can be problematic in the context of learning. Moreover, when possibilities for action are too concrete and strictly defined, creative thinking may be reduced (Koivisto and Hamari 2019). A common criticism of gamification, therefore, is that it tends to support routinized behaviourism, which distances it from the qualities of what games are meant to promote (Marklund 2015).

Due to its exploratory aims, this study employs a broad view on what constitutes a game. Thus, “digital games” are understood here as a blanket term that covers any kind of game played entirely or partially on any kind of a digital device. For brevity, the word “digital” is occasionally dropped when referring to digital games. In these cases, the readers can assume that I mean digital games.

2.4 Digital games and teachers

"Digital game-based learning" is often used as a term that includes everything that has to do with teaching and learning of digital games. However, Becker (2017) argues that DGBL should be looked at from two interrelated perspectives: from the perspective of the learner and from that of the teacher. On a similar not, Hanghøj (2013) proposes the use of the term "digital game-based teaching" in contrast to "digital game-based learning" to emphasize the focus on practices of teachers involved in selecting, facilitating and validating the use of games for educational purposes. The teachers´ perspectives are the focus of the next chapter.

Research shows that teachers are gatekeepers when integrating digital games into classrooms as they decide whether to introduce them in the first place and, if they do, which ones and how to use them (Takeuchi and Vaala 2014). They also have the most significant impact on student achievement (Hattie 2003). Moreover, games alone do not guarantee meaningful learning – much depends on the pedagogical practices of teachers, knowledge and skills and personal interest (Shah & Foster, 2015). Teachers are responsible for high-quality pedagogy and plan, realize and assess the learning processes (Kangas et al. 2016).

Nonetheless, teachers have been under-represented in game-based learning literature and it is often assumed that the effectiveness of game-based learning can be attributed solely to the game effect (Nousiainen et al., 2018). Several studies point out that current scientific discourse on game-based learning does not pay enough attention to the role and challenges of teachers (Molin 2017; Huizenga et al. 2017; Kangas et al. 2016).

Bourgonjon et al. (2013) state that game-based learning necessitates a coordination of various knowledge domains of teachers. Nousiainen et al. (2018) show that to implement games, teachers need a diverse set of competencies, including pedagogical, technological, collaborative and creative abilities. Becker (2017) argues that teachers should be able to understand and assess what constitutes a good game in order to create game-based lessons that are helpful in delivering learning objectives. Kangas et al. (2016) identify pedagogical activities of teachers in digital game-based learning: 1) planning, 2) orientation, 3) tutoring the gameplay, 4) elaboration, and 5) reflection.

Planning activities represent pre-interaction with the game when teachers might think about the learning goals and links to the curriculum, and how gaming can be organized (Kangas et al. 2016). During orientation, teachers introduce the game, the gaming process and the pedagogical aims. Orientation also comprised of reflection and familiarization with the subject matter and expected outcomes. The teacher's role here is that of leader and motivator. During the gameplay teachers can take the role of an active tutor who guides and supports students, for example by asking and answering questions. After the gameplay session teachers may discuss the game content and the way in

which that connects to the curriculum and learning goals. These activities can be referred to as "debriefing" and might include discussions to clarify possible misinterpretations. In the reflection phase, teachers reflect on their own learning to develop teaching practices (Kangas et al. 2016).

These tasks may be complex and daunting for teachers. Hanghøj (2013) argues that teaching with games is not an intuitive process and teachers do not naturally adopt these active roles when using games for learning. Most teachers have not been taught how to use games in their pre-service learning (Hamari and Nousiainen 2015) and it is not necessarily evident how to use a particular technology in a pedagogical way, especially if teachers themselves do not have much experience of playing digital games (Emin-Martinez and Ney 2013). Other challenges may relate to the limited time available to prepare and play a game, uncertainty about using games due to limited knowledge of digital games and difficulties with choosing appropriate games. It is also challenging to effectively integrate games, identify appropriate assessments and help students to connect in-game learning with real-world learning (Becker 2017; Marklund 2015). These challenges may be coupled with a lack of support from school administration, issues with the technical infrastructure, or high game or licence costs. Integrating digital games into the classroom environment may also include activities related to inventory, and maintenance. However, few games come with ready-to-use teacher guides (Marklund 2015). Many digital learning games do not provide places where teachers can discuss their experiences and share lesson plans or other resources (Becker 2017). Moreover, teacher participation is usually not considered in the game design process (Molin 2017). In the end, all this means that teachers may find themselves alone when implementing games.

Teachers are diverse in how they view and implement games and the benefits and challenges they see (Dondi and Moretti 2007). Teachers' diversity is apparent in the Joan Ganz Cooney Center's study that surveyed 694 K-8 teachers from 49 states in the USA about their use of digital games in teaching (Takeuchi and Vaala, 2014). The study examined whether there are certain types of game-using teachers. The study identified four profiles of game-using teachers. The dabblers play games less than their peers and report low levels of comfort when using games with their students. Players, on the other hand, are avid gamers but use games the least often, report the lowest comfort level when teaching with games and are the least likely to report any benefits of game use. Barrier busters are game players themselves, use games on a weekly basis and report a high level of comfort in using games in their teaching. Naturals play games often, teach with them often and are comfortable using them in their teaching. They also report highest on the efficacy of DGBT among all teachers. The identified teacher clusters are then described in additional dimensions as well (Takeuchi and Vaala, 2014).

The authors point out that a better understanding of teachers' use of digital games can help with the design of better games as well as support and training

for teachers. Much on the same note, Dondi and Moretti (2007) argue that for a broad adoption of game-based learning, teachers should not be seen as a single category of users. They point out that there is a need for support for the different categories of users with tools and support to facilitate the integration of games in their teaching.

2.5 The Swedish context

In order to situate the studies in the Swedish context, a brief introduction to the Swedish education system is provided.

2.5.1 Digital games in Sweden

Sweden is one of the world's important game-making regions with a revenue growth rate of 33% in 2018 (Swedish Games Industry 2019). As games are also becoming ubiquitous outside the gaming communities, numerous cultural events have started to embrace digital games as a form of creative expression, such as art fairs and exhibitions about visual game design or concerts with video game soundtracks. The Swedish Games Industry association promotes the introduction of game development into the curriculum to increase children's creativity, make them more discerning consumers and possibly future employees. Several Swedish cities have added game development to the curriculum in arts and cultural education where children and adolescents can learn how to develop games (Swedish Games Industry 2019).

Children and adolescents' consumption of digital games across Sweden is substantial. A recent study of 5000 Swedish children showed that an average of 79% of children between the ages of nine and 12 play digital games, with 78% of boys and 81% of girls (Statens Medieråd 2019). In the 13–16 age group, 68% of young people play games, 81% of boys and 57% of girls. As is apparent, more girls play games than boys in the 9–12 age group. However, boys play both for longer and more often than girls across all age groups. Most apparent are the differences among the 13-year-olds. In this age group, 39% of boys play for more than three hours a day. The same is true for only 6% of girls. Girls and boys differ not only in how much but also in what type of games they play. For example, currently popular titles like Fortnite, Counter-Strike: Global Offensive and FIFA are mostly preferred by boys while The Sims and Helix Jump are favourites played almost exclusively by girls. The only game title in the top-five list of both genders is Minecraft, but only in the 9–12 age group. Otherwise, game preferences of boys and girls rarely match (Statens Medieråd 2019).

2.5.2 Structure of the Swedish education system

The Swedish school system has three main levels: a) preschool for ages 1–5 (kindergarten); b) compulsory school for ages 6–16 (grundskola), which is divided into lower grades (1–6) and upper grades (6–9); and c) optional upper secondary school for ages 16–19 (gymnasieskola). Academic grades determine whether students will be admitted to the secondary school of their choice and a university programme after the secondary school.

Since the beginning of the 1990s the education system has been decentralized. The learning goals and outcomes are defined at a central level, while the municipalities implement a local school plan to achieve the learning outcomes within each school. At the school level, school administrators establish a local work plan that specifies the course content, organization and teaching methods in consultation with teachers and other staff. Thus, the school decides – in fact in most cases it is the teachers who decide – what teaching material and methods are used in the classrooms (Eurydice 2019).

Funding responsibilities are shared between the state and Sweden's 290 municipalities. The municipalities use municipal taxes and state funds, which they then allocate to the individual schools (Eurydice 2019). Since 1990, Sweden has allowed a free choice of schools and provided a public voucher system to cover tuition. The introduction of the voucher system opened up the school system to different private providers such as foundations, parental and staff cooperatives and profit firms (Henrekson and Wennström, 2019).

2.5.3 Teachers in Sweden

Teaching is a regulated profession in Sweden and requires a qualification such as a bachelor's degree or diploma in teaching. Registration is required for a teacher to be able to independently set grades, become a mentor to other teachers and for permanent employment. Teachers can specialize in preschool teaching; preschool class and years 1–3 or 4–6; a particular subject for years 7–9 or upper secondary school for years 10–12; or vocational education. At the compulsory level, around 70% of teachers had a qualification in at least one subject area in the school year 2018/2019. There were 88,200 active teachers working at grade levels 1 to 9 in 4834 primary schools. The typical age of a teacher at compulsory level is 40–49. Teaching is a female-dominated profession at the compulsory level with 75% of the teachers being women. At grade levels 10–12, the number of active working teachers is 29,500 across 1307 upper secondary schools (gymnasium), with 81% of the teachers being qualified in at least one subject. The gender distribution is balanced and most teachers are typically aged between 40 and 49 (Skolverket 2018).

Sweden today has a severe teacher shortage and the country has the oldest teachers among the European Union countries (OECD 2019). According to

the recent TALIS study (ibid), 63% of teachers in Sweden use IT tools frequently or always for projects while only 37% had IT included in their formal education or training. It is IT skills that teachers report they need the most (22%). On average, 10% of school principals report that the quality of instruction is hindered by a shortage or inadequacy of digital technology for instruction; however, this is lower than the 25% across OECD countries. According to the National Union of Teachers in Sweden, teachers' professional development varies across the country. Swedish teachers have 104 hours per year or 15 workdays for professional development, in accordance with an agreement between the Union and the Council of Sweden. However, it is difficult to obtain information on how these hours are actually used. Findings from a survey with 2400 upper secondary school teachers in Sweden show that only 26% of teachers think that the professional development offered by their employer covers their needs, and 69% of teachers indicated that they had to use their private time to meet their professional development needs (Parding et al. 2018).

2.5.4 Educational technology in Sweden

Since the early days of computers in the 1950s, Sweden has been investing in computers. From the 1960s to the 1980s computers become more widespread and computerization was seen as one of the most important driving forces of social development. Technological development was regarded by the state as important in creating a welfare society, decreasing poverty, increasing democratization, enabling a fairer distribution of resources and providing better educational support (Rahm 2019).

The appearance of digital tools in Swedish schools dates back to the 1970s and the electronic mini calculators. It was highly debated at the time whether the calculator should be seen as a support tool for learners to develop their mathematical thinking, or an obstacle that inhibits logical thinking and skill development in the four arithmetic operations. During the 1980s, personal computers became more widespread in Swedish schools and many upper secondary schools introduced computers (COMPIS) for programming and text editing. Graphing calculators were introduced in mathematics education and some schools experimented with personal digital assistants (PDAs), hand-held devices with wireless communication (Skolverket 2018).

Since the 1990s the role of the state has changed as competition has been seen as the key driver of the infrastructure required to realize an information society (Rahm 2019). As the numbers of computers increased in schools, there was both a growing supply and need for pedagogical tools that could support education. As a result, interactive multimedia on CD-ROMs and educational digital games started to appear in schools. The largest wave of digitalization started in 2007–2008 when stable Internet became available and classrooms could get access to its content. The period between 2005 and 2010 again saw

intense debates in society as to whether and how students' Internet use should be encouraged or limited. With increasingly accessible Internet, schools started to employ digital learning management systems, where teachers and students could share files and communicate. Another wave of investments focused on projectors and interactive whiteboards to visualize digital materials such as photos and films. Teachers started to use word-editing, presentations and video-editing software (Skolverket 2018).

During the 2000s, the idea of one laptop per student gained popularity and this has been complemented with investments in tablets. Today, in grade levels 1–9, the ratio of students per computer or tablet is 1.3, while in upper secondary schools every student has access to a device (Skolverket 2018). Since 2017, there has been a national digital strategy for education that promotes digital skills as an integral part of the Swedish national curriculum (Utbildningsdepartementet 2017). This strategy emphasizes that students should be able to solve problems and translate ideas into action in a creative way using digital technology, work with digital text, media and tools, and understand the impact of digital transformation on individuals and society. It also includes the interdisciplinary integration of programming in subjects such as mathematics and technology (Utbildningsdepartementet 2017).

The digitalization of the society outside of schools meant that the communication with parents and carers became more frequent through digital channels. Learning management systems allowed the tracking of students' progress, preparation for performance reviews and reporting of absence. Moreover, students carry their own mobile phones and tablets. Teachers have access to resources that they can use on their own initiative to plan for and apply in their teaching. While teaching/learning resources could be collected on a few learning management platforms earlier, today there is a very dynamic digital landscape consisting of social media, learning platforms and other digital resources. With a large part of the budget for teaching resources being spent on computers and tablets, teachers often have to produce their own teaching/learning materials. Consequently, much of the teachers' time in Swedish schools is spent on searching for teaching resources online (Grönlund and Wiklund 2018). In a survey with 691 teachers, more than half of the teachers reported that they produce their own teaching materials. Two-thirds of the teachers said that the most important reason is that they have no access to comprehensive, ready-made teaching materials, and their schools do not have enough resources to purchase these (Lärarnas Riksförbund 2016). Limited budgets coupled with complicated purchasing processes mean that teachers seek free teaching resources first of all. These resources have often completely replaced comprehensive teaching materials. These resources are also often applications with varying quality, limited functionality or use period, which means that teachers cannot make full use of these resources and have to change them frequently (Grönlund and Wiklund 2018). In the absence of clear quality

requirements, teachers have to decide themselves if there is no collegial quality assessment. Besides using free digital resources, teachers also increasingly develop their own teaching materials and spend on average 6.6 hours per month doing this. This corresponds to around 80 hours per year that could be used instead for teaching. For a medium-sized school with 500 students, teachers spend approximately 3300 hours per year searching for and producing their own teaching materials, which corresponds to two full-time teaching positions (Lärarnas Riksförbund 2016). These practices are very likely to lead to a varying quality of teaching materials and high costs (Grönlund and Wiklund 2018).

While the digitalization of schools happened without clear governance and guidance on the national level, private actors have strategically targeted schools (Skolverket 2018). Thus, the implementation of computers and educational technology in Swedish compulsory and upper secondary schools is typically described in research as an implementation that is "push-driven" (Rahm 2019; Skolverket 2018). Player-Koro et al. (2018), for example, describe how in the dominant discourse Swedish teachers are positioned as passive audiences to predefined ideas about what and how modern digital technologies ought to be used in classrooms rather than being partners in dialogue. The discourse often fails to acknowledge and explore the struggles of technology use in schools, while it is often concluded that schools do not live up to expectations simply because teachers lack sufficient interest or skills (Player-Koro et al. 2018; Pargman 2019). This discrepancy is referred to by Linderoth and Sjöblom as the teacher deficit model in the field of game-based learning, i.e. the general discourse claims that teachers have problematic attitudes towards game-based learning and therefore do not implement games in an effective way. The authors argue that game development should learn from the educational world, rather than the other way around (Linderoth and Sjöblom 2019).

3. Theoretical Positioning

The central tenet of the thesis is that educational tools cannot be understood by studying either the learning tool or the educational context in isolation from one another. Thus, in its ontological position, the study departs from the Cartesian reductionism that implies that processes are separated into elements for temporary study out of context (Bidell 1988). The dominance of the Cartesian approach can be observed in the field of digital game-based learning as the research field is dominated by controlled experimental and quasi-experimental studies. Such experimental studies examine games in controlled and researcher-driven environments often assuming that learning can be attributed solely to games.

To attend to the complex educational environments into which games are introduced, this study takes a dialectical transformative ontological and a social constructivist epistemological position. A dialectical transformative position means that the thesis attempts to grasp game-based teaching and learning processes in the complexity of the interrelationships of its elements, rather than isolating them. Complex systems embody contradictions and a dialectical approach seeks to bring these to the fore (Bidell 1988). In Hegel's view, contradiction is the motor of change that restructures relationships, and overcoming one contradiction creates new ones. As Tolman (1981) suggests, the changing relations among opposing tendencies are a natural part of any system. For scientific research this entails locating, describing and examining these oppositions and describing the nature of change that occurs in a system. In social human systems, dialectical transformation implies human agency as people are seen as creators of their own knowledge and cultures (Bidell, 1988).

This ontological position aligns with the social constructivist epistemological perspective where knowledge is actively constructed and learning happens in social contexts (Egenfeldt-Nielsen 2006; Plass et al. 2015). Social constructivism connects to Lev Vygotsky, who rejected the idea that it was possible to separate learning from its social context. From this perspective, learning is not merely the assimilation and accommodation of new knowledge by learners. It is rather the process by which learners are integrated into a knowledge community (Bidell 1988). From this perspective, learning should include opportunities to socially engage learners and provide spaces for interaction where learners can participate in groups, use collective knowledge to achieve goals, and relate learning to aspects of social and cultural influences that motivate learning (Marklund 2015).

As a theoretical underpinning, this study needed an approach that attends not only to the digital tools but also to the complex learning environments into which games are introduced. Activity theory (AT) is a widely used theoretical and analytical approach in education that focuses on understanding human activities as they continuously develop over a period of time and are influenced by their context. AT puts a particular emphasis on the role of artefacts and that

of conflict. Thus it can be used to problematize the integration of games into a teaching tool. It is important to point out that AT is not a predictive theory. Instead, it may help the orientation in complex real-life problems, identify key issues that need to be dealt with, and direct the search for relevant evidence and solutions (Kaptelinin, 2019).

The core idea of AT originates from Lev Vygotsky. AT is a concept focused on the mediation of the subject, the object and tools or artefacts in an interaction (Mwanza-Simwami 2013). Later, more elements were introduced by Alexei Leont'ev, such as the concept of activity, object of activity and division of labour (Leont´ev, 1978), and stressed that activities cannot exist without their objects. Division of labour was a result of individuals' specialization in making and using tools (Kaptelinin and Nardi 2012). In the 1980s and 1990s the activity system was further developed by Engeström (1987). He integrated elements of Vygotsky's and Leont'ev's frameworks and introduced the new ideas of community, rules and outcomes. Thus, based on Engeström´s view, AT constitutes seven elements: 1) subjects, 2) object, 3) tools, 4) community, 5) rules, 6) division of labour, and 7) outcomes. The model of an activity system is represented as a triangle as shown in Figure 2. The model represents the structure of an activity as well as the relationships that exist among the components of the activity system. It is the theoretical model by Engeström (1987) that is applied in the present study.

The central concept of AT is tool mediation, which refers to the notion that people develop and use tools to achieve their objectives. Using these tools, people perform activities that transform their individual minds. At the same time, people also modify the activities they are engaged in. The unit of analysis is human activity, namely what people do. Studying these activities helps to identify possible contradictions that might emerge during the activity.

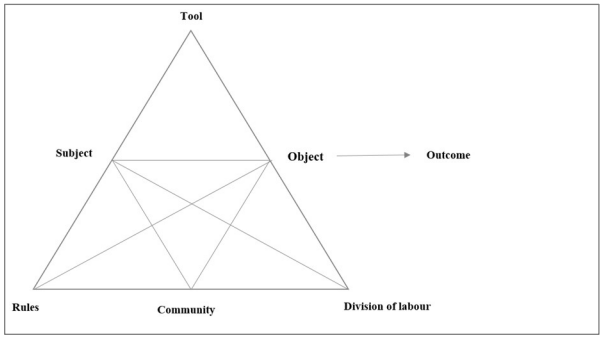

Figure 2. Activity triangle model (Engeström, 1987).

As an example, we can consider the activity of a teacher who works in school. The object of the activity is teaching students as required by the national curriculum and expected outcomes are the learning outcomes of her students. The teacher employs a variety of tools in her work, such as computers,

books, games, films and pedagogical methods. In other words, the relationship between subject and object is mediated through tools, e.g. in this thesis, digital game artefacts

. The community comprises other teachers, the school management, students, IT support personnel, parents and the developers of the teaching/learning resources. The teacher's relation with the community is mediated by explicit and implicit rules, e.g. curriculum, teaching responsibilities, taking part in administrative and professional development duties, managing contact with parents, etc. Further, producing the outcome of the activity system as a whole is the responsibility of the whole community, where the effort of the teacher is a part of a larger effort made by the community. Therefore, the work of the teachers needs to be coordinated with the work of other community members. This coordination is achieved by employing a division of labour, which then mediates the relation between the community and its object. This activity system is then part of a network of activity systems that in their totality constitute society (Roth and Lee 2007). For example, teaching mathematics to thirty second-grade students in a school is part of a larger effort involving thousands of schools and teachers across the country, necessitates teacher training and professional development programmes, and requires the development of teaching/learning resources and the coordination of resources on a national level. From a dialectical perspective, complex systems harbour contradictions that drive development. Activity theory attends to these contradictions at four levels as proposed by Engeström (1987):

1. At the primary level, contradictions may be fundamental to a dimension of the activity system, for example subjects experiencing technical issues when wanting to use a specific tool (Tool).
2. At secondary level, contradictions may exist between two dimensions, such as when the school-based rule of completing the curriculum in a fixed amount of time (Rule) contradicts with quality learning of complex issues (Object).
3. At tertiary level, contradictions may exist between the object of the dominant and that of the culturally more advanced form of activity: for example, memorizing certain concepts as opposed to generating knowledge. Likewise, when implementing problem-based learning to encourage higher-order thinking, high-stakes assessment and larger societal pressures may limit its effectiveness (Roth and Lee, 2007).
4. A fourth level of contradictions may arise between the central and another neighbouring activity system: for example, when a graduate of a teacher education programme is not sufficiently prepared to teach curricular knowledge in a classroom.

These contradictions may express themselves as problems in the ongoing activity. When the problem becomes available to consciousness, it can be addressed by the change of goals, or by abandoning the tool, for example the introduced technology. Contradictions can lead to "workarounds", when subjects circumvent the problem in unintended ways. For example, a teacher may obtain their own teaching resources to make up for the lack of school budget. The contradiction in this case may be related to policies or unequal distribution of financial resources among schools. By attending to these contradictions, it is therefore possible to shed light on how larger socio-political and economic struggles mediate local practices and learning (Roth and Lee, 2007).

AT is sometimes criticized for its collaborative and problem-solving orientation, which may run the risk of discounting other forms of social interaction such as conflict, opposition and resistance, desire, passion, fear or indoctrination (Nicolini 2012). Roth (2007) emphasizes the importance of the connection between emotions and actions. He argues that emotions are the outcomes of practical actions and are continuously produced and reproduced in practical activity and shaped by collective aspects as well (Roth 2007). The role of emotions has an implication for this thesis, as some of the teachers in Study 1 have described their personal interest in, and passion for, games. Therefore, teachers' emotions about games may play a role when it comes to implementing digital games in teaching. For the survey design, this means that besides asking teachers about their activities in regard to implementing game-based teaching, their emotional investment should be addressed as well.

4. Methodological Approach

4.1 Research design

The thesis employs a sequential mixed-method approach on two levels: qualitative and quantitative approaches are employed on the study level as well as on a cross-study level. This means that data are analysed in a particular sequence where one method is used with the purpose of informing the other (Bryman 2012). In Article 1, a qualitative, exploratory multi-case study design was employed and reported on the results of Study 1 and informed Study 2A and 2B. The unit of analysis is the DGBT activities of individual teachers based on collective experiences informed by multiple participants. Article 2 describes a quantitative survey analysis, while Article 3 uses a sequential mixed-method approach. In this case, the statistical method of clustering is used to analyse the survey data. The identified patterns are then further described using frequency distribution of additional survey data in the clusters.

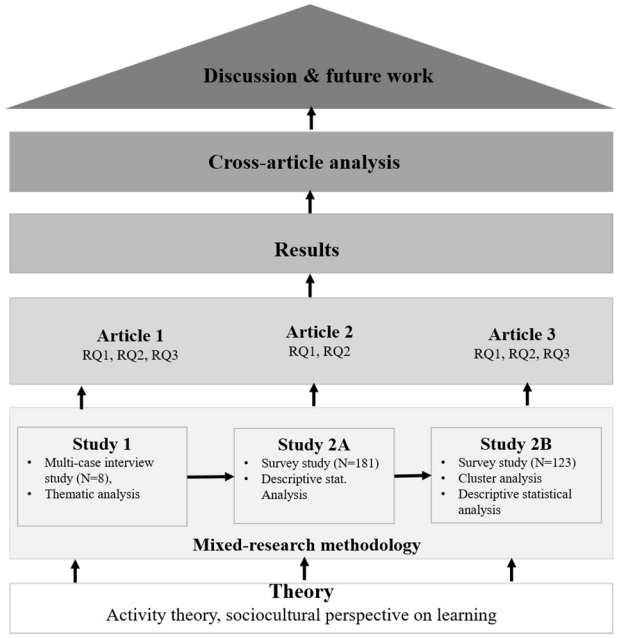

Figure 3. Research design and methodology.

As presented in Figure 3, AT has been used to support data collection. More specifically, it guided the design of the interview questions as well as the survey design and analysis based on the Activity-Oriented Design Method (AODM) (Mwanza-Simwami 2013). To this end, first the general research

questions were broken down into more specific questions. This was done in a way that the dimensions of AT were translated in terms of the activity of digital game-based teaching.

Table 2. Eight-step model adopted from Mwanza-Simwami (2013)

AT dimensions	**Question**	**DGBT concepts**
Activity of interest	What sort of activity am I interested in?	Digital game-based teaching
Object	Why is the activity taking place?	Students' motivation, engagement, skills/knowledge development
Subjects	Who is carrying out this activity?	Teachers
Tools	By what means are subjects performing this activity?	Digital games (various types), game-related technologies
Rules and regulations	Are there any cultural norms, rules or regulations governing the performance of this activity?	Curriculum, school rules, norms around games
Division of labour	Who is responsible for what when carrying out this activity and how are the roles organized?	Teachers roles and responsibilities (teaching, professional development)
Community	What is the environment in which the activity is carried out?	School community: students in the school, peer teachers, school management, parents
Outcome	What is the desired outcome from carrying out this activity?	Educational outcomes: motivation, engagement, knowledge and skills development etc.

These are graphically represented in the DGBT acitivy system model (see Figure 4):

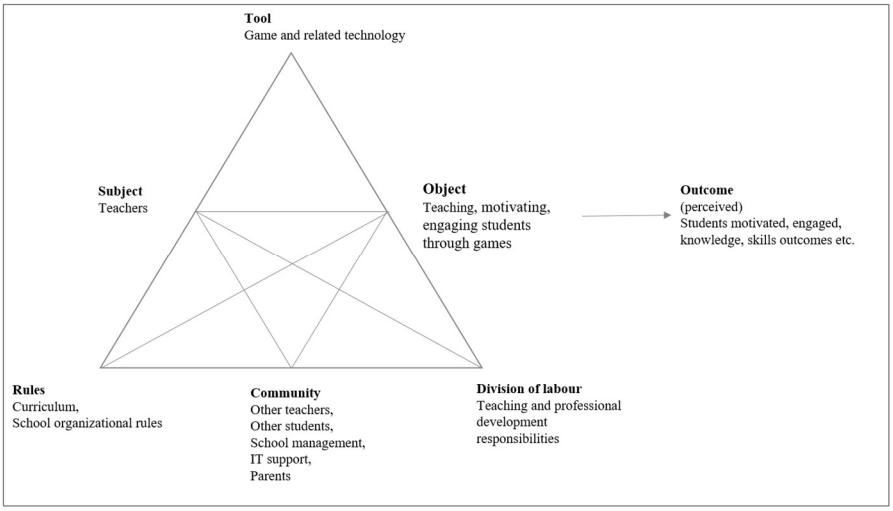

Figure 4. Activity system of digital game-based teaching

Subsequently, the activity notation method is used (Mwanza-Simwami 2013), which breaks down the activity system into subactivity systems and connects elements of the activity system whose interactions are being investigated (see Table 3).

Table 3. Subactivity system (Mwanza-Simwami, 2013)

Actors	Mediator	Object
Subjects	Tools	Object
Subjects	Rules	Object
Subjects	Division of Labour	Object
Community	Tools	Object
Community	Rules	Object
Community	Division of Labour	Object

Based on the activity notation, questions can be derived to examine interactions in subactivity systems:

- How do subjects use tools to achieve their objective?
- How do rules affect the way the subjects achieve the objective and how?
- How does the division of labour affect the way subjects achieve their objective?

- How do the tools that are used affect the way the community achieves the objective?
- How do rules affect the way the community achieves its objectives and how?
- How does the division of labour affect the way the community achieves the objectives?

These generated questions were operationalized as presented in the map of operational processes in Figure 5. The questions generated were broken down into subquestions for the interview and survey tool (Appendices 1 and 2, respectively).

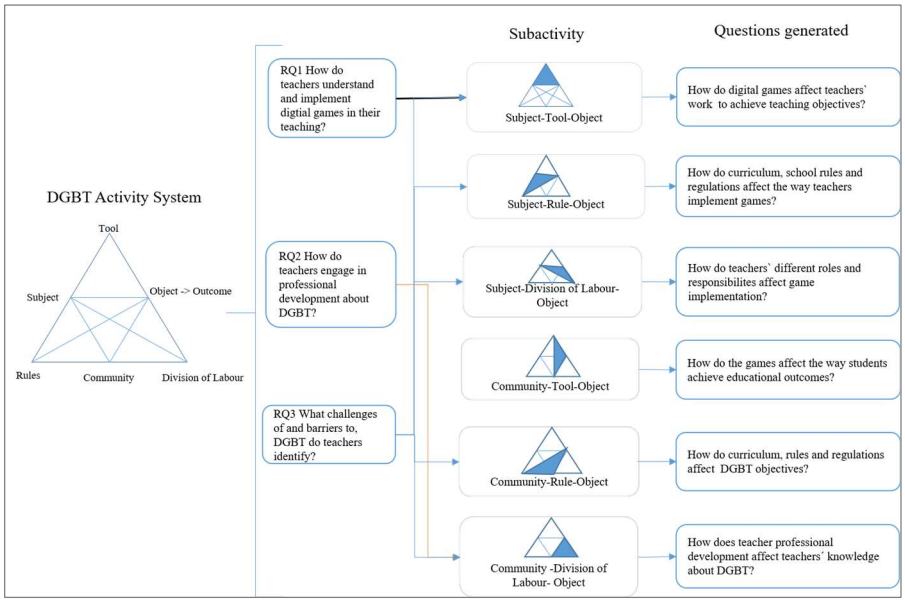

Figure 5. Map of operational processes (after Mwanza-Simwami 2013).

4.2 Data collection methods

This chapter describes the two steps of data collection. First, in-depth interviews were conducted, which then informed the subsequent survey study.

Interviews

In Study 1, eight teachers from Swedish compulsory and upper secondary school levels were interviewed. Respondents were purposefully selected through the snowball sampling technique through contacts with game developers, teacher and researcher networks, and a school development organization. There were no restrictions on the type of school or subjects taught, but

teachers had to have previous experience with implementing a digital game in their teaching.

Data were collected through in-depth, semi-structured interviews that were conducted in English or Swedish, depending on the teachers' preference. The questions were tested prior to the interviews by a schoolteacher, a teacher-researcher and a game researcher. The sessions were approximately 60 minutes in length and were recorded and transcribed. The interview guide can be found in Appendix 2.

Survey

Articles 2 and 3 are based on an online survey informed by Study 1, AT and previous studies as indicated in Table 3.

Sampling strategies for the survey relied chiefly on a random sampling of compulsory and upper secondary schools across Sweden. The schools were selected from the publicly available database of the Swedish National Agency for Education through a computer-generated randomized selection process. Altogether, 1200 compulsory and upper secondary schools were selected and contacted across Sweden in spring 2019. Challenges were related to difficulties in reaching teachers via contact routes through school directors or municipalities. Two schools indicated that they were already participating in other research studies and had therefore no capacity to join this study. A reminder was sent out during the month the survey was open. In an attempt to increase the response rate, teachers were also contacted through semi-random selection through social media platforms relevant to teachers. These included a newsletter on the topic of digitalization of schools from the Research Institutes of Sweden (RISE) foundation disseminated across Sweden, a Facebook forum for teachers interested in game-based learning and Facebook groups of teachers in sociology, culture, music, religion, geography, social studies and English. Some 61% of the participating teachers received the survey as a result of the random selection process – from their school directors, school administrative personnel or directly. The remaining teachers (39%) were recruited through a snowball strategy, through another participant or through the online forums. For the sample it means that most participants were recruited through the random selection of schools. Teachers interested in game-based learning, and teachers engaged in online professional communities in social subject areas recruited through social online forums, may be over-represented in the sample. An overview of the survey is presented in Table 4. It presents the survey constructs and previous research that the survey is built upon, as well as the number of adopted questions and the types of questions. The survey can be found in Appendix 2.

Table 4. Survey constructs

Construct	Authors	Adaptation	Question type
Survey access information	Author		Single-choice, open-ended responses
General teacher background: (Subject) • Age • Gender • Teaching level and experience • Subject areas taught	Author		Single- and multiple-choice items, open-ended responses, scaled items
Teacher gaming disposition: (Subject-Tool) • Experience/Interest/Comfort	Takeuchi and Vaala (2014)/ Joan Ganz Cooney Center (2012) Author	5 items	Likert-type scale (1–4 + I do not know option) Single-choice questions
Game implementation: (Subject-Tool/Rules/Division of Labour-Objective) • Pedagogical objectives • Games and technology tools used • Subject areas • Temporal and social characteristics of game implementation • Assessment • Financial resources spent • Challenges	Takeuchi and Vaala (2014)/ Joan Ganz Cooney Center (2012) Author	14 items	Single- and multiple-choice items, open-ended responses
Perceived efficacy: (Outcome) • Perceived educational outcomes	Takeuchi and Vaala (2014) Svanelid (2016) Author	2 items	Likert scale measuring agreement (1–5, completely agree–not at all agree) with N/A option Multiple-choice items, open-ended responses
Professional development: (Subject/Community-Division of Labour-Objective) • Current practices/Needs	Takeuchi and Vaala (2014) Author	2 items	Multiple-choice items, open-ended responses

4.3 Data analysis methods

In the first step, the results of Study 1 were analysed as described in Article 1. The analytical approach adopted was thematic analysis (Braun and Clarke 2006) of the transcribed interviews. The data were used to investigate how teachers employ digital games in their teaching. Two main codes were derived from the data: pedagogical and technological implementation processes. Further categories included before-, during- and after-game activities. Finally, perceived challenges and perceived changes resulting from game use were discussed.

In Article 2, descriptive statistical analysis using frequency distribution was applied to investigate RQ1, RQ2 and RQ3.

Article 2 used the statistical classification method of k-means cluster analysis to identify subgroups of 123 game-using teachers and combined it with descriptive statistical analysis to further investigate RQ1, RQ2 and RQ3. While there are different types of classification techniques, a widely applied tool in the field of education is k-means clustering. This study draws mainly on the study by Takeuchi and Vaala (2014), who applied k-means analysis to investigate the digital game-based practices of 694 K-8 teachers. K-means clustering requires the selection of variables and cluster numbers prior to the analysis.

In this study, the selection of the cluster variables ties into the subject dimension of AT. Current research on game-based pedagogy competency shows that for effective implementation of digital games, personal interest and a playful stance are important together with knowledge of games-based learning processes and practical technological skills. The selected disposition variables are adopted from Takeuchi and Vaala (2014), who used digital gameplay and teaching frequency and comfort level variables. In this study, disposition is understood as: 1) interest in playing games for entertainment purposes as found in (Mathe et al. 2018); 2) interest in applying games in teaching as found in (Mathe et al. 2018); and 3) comfort levels of applying games in education (Takeuchi and Vaala 2014).

While Takeuchi and Vaala (2014) included environmental factors to form their clusters, this was omitted in this study. In the US, education is primarily the responsibility of the 50 member states and local governments. This means that every state has its own department of education and laws regulating finance, the hiring of school personnel, student attendance and the curriculum. States also determine the number of years of compulsory education. This means every state has great control over what is taught in its schools and over the requirements that a student must meet, and it is also responsible for the funding of schooling (U.S. Department of Education 2020).

In Sweden, however, the state governs education through a series of statutes, government orders, curricula and syllabuses. These contain aims and guidelines for all aspects of education. All schools are obliged to follow the Education Act, which provides equal terms for all education providers and all schools. Everyone working in the school system is obliged to work towards common goals and objectives, thereby guaranteeing education of uniform value (Eurydice 2019). Due to the fact that the regulatory environment is the same for all schools, implementation of digital games would primarily depend on individual teachers.

To investigate the disposition of 123 teachers towards DGBT, cluster values from two to four were assessed and compared. Visualization and cross-tabulation were used to assess the different cluster solutions and to understand how the algorithm perceived the similarities and differences of the clusters. The reliability of the clustering and the consistency of characteristics in each cluster were assessed by measuring dispersion expressed as standard deviation and range. This was helpful to assess how much variation exists with each variable in each cluster, as clusters may include teachers with a high level of variability. Due to the high dispersion, the two-cluster solution was unhelpful in answering the research questions. The four-group solution included a cluster with few members (N = 6) and did not meaningfully contribute to the research question. Given the SPSS iteration statistics, significance statistics for each variable's contribution to the clustering, the number of cases in the clusters and dispersion, it was determined that the three-group solution was optimal. While k-means analysis was used by Takeuchi and Vaala (2014), other clustering techniques can be helpful in investigating whether clusters are consistent.

To investigate cluster validity, a two-step cluster analysis was conducted both with automatic analysis and a specified number of three. This type of clustering analyses data in two steps, i.e. a pre-clustering and a subsequent hierarchical cluster analysis. The automatic analysis returned a two-cluster solution. Both the automatic analysis and the manual three-cluster grouping had a silhouette coefficient of 0.5, suggesting a fair separation distance between the clusters in both cases. Comparing the three-cluster results from the two methods showed minor differences on the individual level (9.7% of the cases were reassigned) while the main cluster characteristics remained consistent across both methods. Thus, the three-cluster solution was deemed most informative for the sample.

On the cross-study level, the results from the studies are summarized. The qualitative data from the interviews and free text inputs from the survey are used to further deepen the discussion and provide more insight into the issues raised.

4.4 Ethical considerations

One of the key ethical considerations has been to secure the permission and interest of those who have been involved in the studies (Recker 2012; Myers and Venable 2014). Prior to participants' involvement, the researcher obtained written informed consent from the teachers. Participants were informed about the research aim, their rights and any risks that might be involved with their participation and given data-handling information. They were be able to withdraw from the study if they wished to.

A cornerstone of research ethics is that respondents should be offered the opportunity to have their identity hidden in a research report (Oliver 2010). In the studies, the confidentiality of the data has been maintained and participants are not identifiable from any form of research disclosure, such as reports, papers and presentations. Participation in the studies was voluntary, meaning that participants were free to choose whether they wished to participate in the study without any consequence.

The survey study utilized an online survey tool of Stockholm University; thus the source data are kept on local servers and data cannot be collected through a third-party tool provider. Information was acquired anonymously and it is not possible to uniquely identify a respondent.

Ethical considerations also include the storage and ownership of the data. Raw data such as interview recordings, transcriptions and survey source data are handled and stored in accordance with the applicable GDPR (European Union 2018), the Swedish Public Access to Information and Secrecy Act, the Archive Act and Stockholm University Guidelines (Stockholm University 2018).

Ethical consideration in writing will relate to honesty and accuracy in research conduct (Myers and Venable 2014; Recker 2012). The results are the original contribution of the researcher and no ideas were plagiarized in the process. Co-authors' contributions have been recognized and inspiration from other sources has been adequately acknowledged. Furthermore, research results have been reported honestly and completely. This means that data analysis has been conducted ethically. The researcher has done her utmost to ensure the appropriate use of language and carefully worded documents and her oral communication with participants to avoid any bias in terms of gender, race, orientation or culture. This means adhering to principles such as specificity, labelling and professional acknowledgement (Recker 2012).

5. Results and Analysis

This chapter discusses the research questions, drawing on all three studies reported in this thesis. Findings from Article 1, Article 2 and Article 3 are summarized and discussed. Teachers' comments from the qualitative interview from Study 1 and open-ended questions from Study 2B are provided to illustrate the points in greater depth.

We revisit the research questions:

Q: How do teachers in Swedish compulsory and higher secondary schools:

- understand and implement digital games?
- engage in professional development about DGBT?
- perceive challenges of, and barriers to, using digital games in teaching?

5.1 RQ1: How do teachers understand and implement digital games?

This research question examines the Subject, Tool, Object and Outcome dimensions of AT. It investigates teachers (Subject), the games they use (Tool) and their objectives of DGBT (Object) of implementation, the social and temporal characteristics of implementation, assessment and the educational outcomes (Outcomes) as they perceive these. See Figure 6.

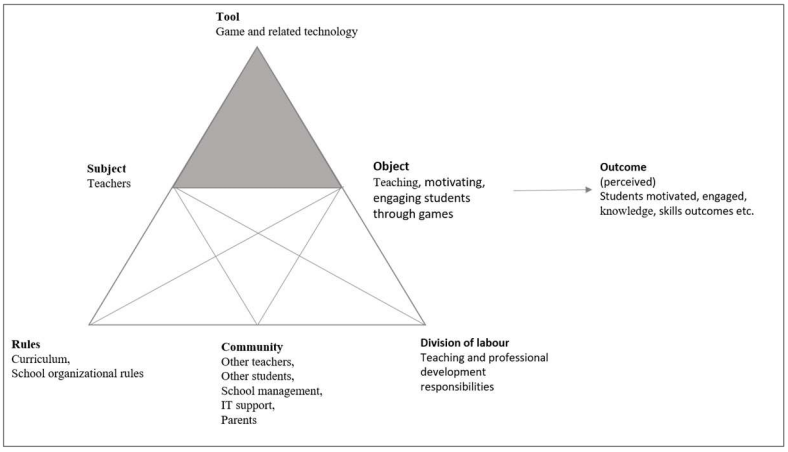

Figure 6. Activity system of DGBT.

Results show that the largest age group in the sample is the 40–49 years group (30%) and these are typically women (65%). Around half of the respondents teach at compulsory level from grade 1 to 9 (N = 106) and half teach in upper

secondary schools (N = 103). Almost all teachers (92%) have previous experience of playing digital games for their own pleasure. However, the younger the teachers are, the more play experience they have. Male teachers tend to have longer play experience and play more frequently than female teachers (Mathe et al. 2019a).

Almost two-thirds of them say that they have used digital games in their teaching at some point in time (69%) (Mathe et al. 2019a). These *game-using teachers* (GUTs) who have already implemented some form of digital game in their teaching at some point in time are also typically 40–49 years old and are more likely to be women (69%). Over half of them have over 10 years of teaching experience, while 88% say that they have a teaching qualification in the subject areas they teach (Mathe et al. 2019a). GUTs are diverse in terms of their disposition towards DGBT as found in the cluster analysis. Disposition is understood as interest in playing games, using games in teaching and how comfortable teachers feel about using games in their teaching. Based on their disposition, teachers can be described as 1) sceptics, 2) curious adopters, or 3) advanced adopters (Mathe et al. 2019b).

Teachers named *sceptics* have been found to have a generally negative disposition towards games. They have little interest in playing games, and report a lack of interest and low comfort levels in using games in teaching even though they have at some point in time implemented digital games in their teaching. They make up 9% of the survey population.

Curious adopters have a mixed disposition towards games as they are not interested in playing games themselves but *are* interested in using them for teaching. They generally feel comfortable in their ability to apply games. These teachers constitute 20% of the survey population.

Advanced adopters have a generally positive disposition towards DGBT. They are interested in playing games and using games, and feel comfortable in their ability to implement games. They make up 39% of the survey respondents. See Figure 7.

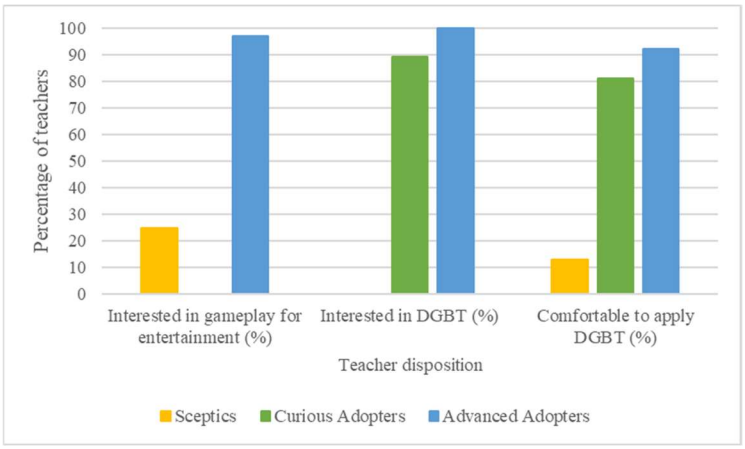

Figure 7. Game-using teachers' disposition towards DGBT.

The *non-game-using teachers* (NGUTs) constitute 31% of all the teachers in the sample. They are typically 40–49 years old, more likely to be women (57%) and have typically 10+ years of teaching experience (52%). Some 77% of them have teaching qualifications in the subject areas they teach, which is somewhat lower than GUTs. NGUTs generally express interest in using games in their teaching (57%) but most of them are not interested in playing games for their own entertainment (59%). Figure 8 represents the different types of teachers.

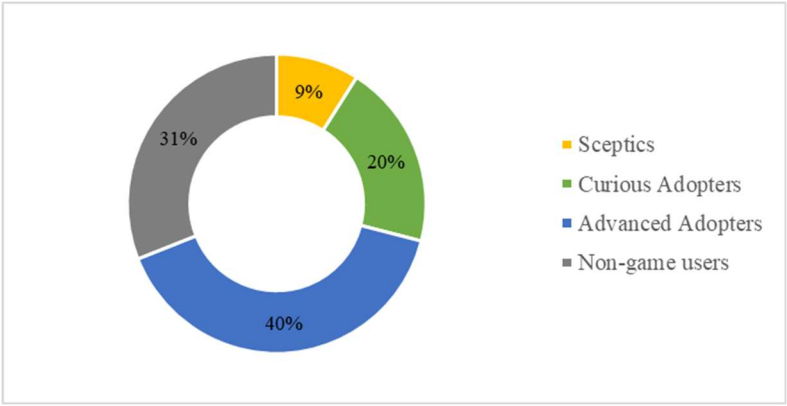

Figure 8. Teacher DGBT types (% of teachers).

5.1.1 What games do teachers use?

"From a thousand games it is maybe one that is useful in the school but it can be of great value, if you find it." (Social sciences teacher)

Both male and female GUTs say that they use gamification tools and educational games the most frequently, while males and teachers younger than 30 are more likely to use entertainment games than their peers (Mathe et al., 2019a). Teachers say they use 2D and 3D games developed for mobile, tablet or PC platforms. Two teachers report the use of augmented reality and virtual reality games. The most popular gamified resources are the quiz-making tools such as Kahoot, Quizlet and Mentometer. Educational games and other gamification resources are either stand-alone resources or integrated in digital textbooks. Stand-alone games can also be free or a part of a subscription plan. These are often arranged according to topics, age or educational levels and may come with leader boards and teacher guides. Another approach is integration within digital textbooks, where gamified approaches and games are used in conjunction with the learning material and overarch several educational levels. For example, through learning outcomes students can upgrade their avatars or play smaller games that accompany the textbook. Examples include Bingel, Elevspel, Skolplus, Vektor, Studi.se, Mangahigh games and King of math.

Entertainment games range across various genres from visual novel (e.g. Gone Home) to simulations (e.g. PC Building Simulator), strategy games (e.g. Civilization, Battlefield 1, Besiege,) first-person shooters (e.g. Counter-Strike, League of Legends, Dota2), constructionist games (e.g. Bridge Constructor) exergames (e.g. Let's Dance) and augmented reality games (e.g. Pokemon Go, Ingress). However, most entertainment games are reported by single teachers. Entertainment games adapted for education include Minecraft. The creative tools mentioned include Scratch, Bluebot, SmartLab and Hopscotch. Few teachers use teacher-designed games, but here we find jeopardy games and a music game programmed by teachers (see Figure 9). A full list of games and gamified resources named by the survey participants is included in Appendix 4.

Sceptics say that they rely mostly on gamification resources (56%) such as quizzes and some use educational games (25%). Curious and advanced adopters use a wider variety of digital resources and they report the highest on using game creation tools (27.8%). Advanced adopters are the most likely to report the use of entertainment games (21%).

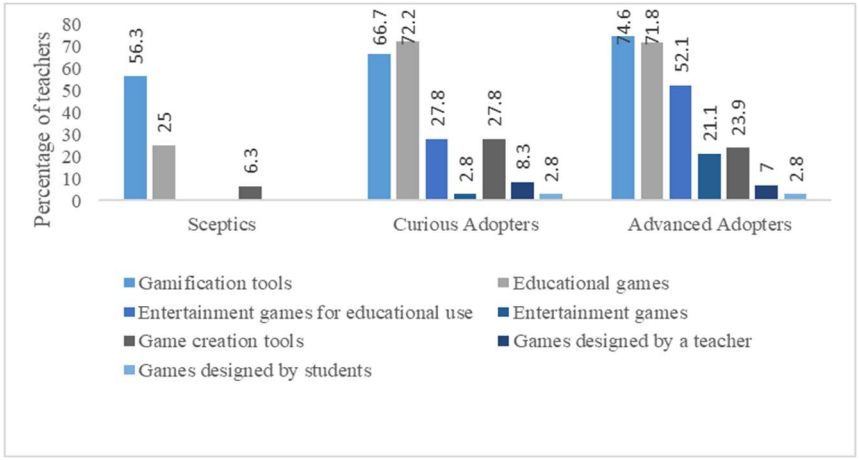

Figure 9. Types of digital games used.

Games are applied across a wide range of subject areas (see Figure 10), most typically in mathematics, languages, social sciences and vocational education areas. Some teachers indicate games used in connection with e-sports, which reflects the fact that several upper secondary schools in Sweden today offer e-sport programmes for students who aspire to become professional players or e-sport event organizers.

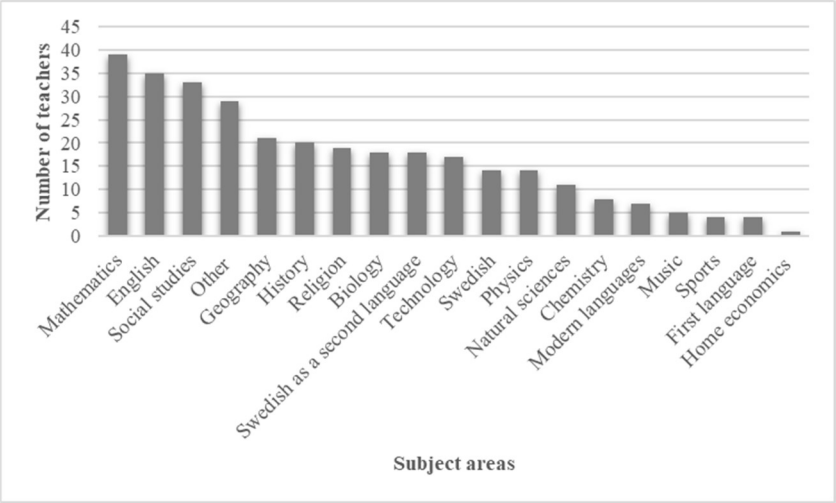

Figure 10. Subject areas of DGBT.

5.1.2 Why and how do teachers implement games?

"Games are another box for me to open and look for good things in it. [...]. Even if I don't use every tool all the time, I would say digital games have opened up

new possibilities to create interesting learning." (Social sciences teacher, interview)

Objectives

Sceptics mainly use games to motivate their students (50%) and practise (50%) but rarely apply games to teach new knowledge (12%), evaluate learning (12%) or promote interaction (19%). *Curious adopters'* purpose is also primarily to motivate students (80%) and practise already taught knowledge (86%), but they are more likely to set other pedagogical objectives as well, such as increased interaction (50%) and teaching new knowledge (42%). *Advanced adopters'* main objectives are similarly motivation (94%) and practice (86%), but they put greater emphasis on interaction (62%), and teaching new knowledge and skills (58%), and use games for formative (48%) and summative evaluation (25%) (Mathe et al. 2019b).

A game-using teacher explains that he considers students' interest in digital games:

> "Whether we build Viking villages out of wooden sticks or Minecraft building blocks makes no major difference other than that it [Minecraft] is **more appealing first of all to the learners**." (Social sciences teacher, interview)

Another teacher also points out the importance of students' interest in digital games and highlights how he uses game development tools to develop the digital literacy skills of his students:

> "I want them (students) to have a tool for creative development […]. I want them to be familiar with game development because they play games. **Many of them want to work with game development** and you can do so many things. It is not only games you can make with a game engine but you can make other teaching modules, presentations and so on. I think it is relevant that they learn this. **It is a kind of digital literacy** to know **how a program works**." (Technology teacher, interview).

A summary of teaching objectives is presented in Figure 11.

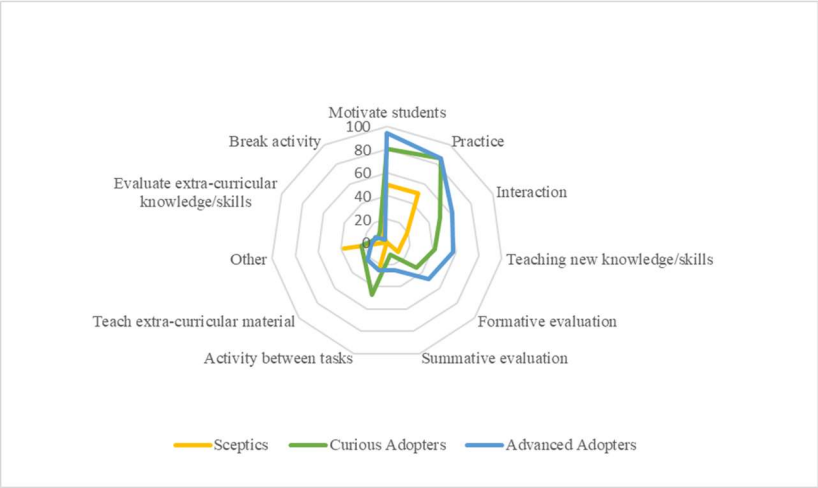

Figure 11. Objectives of DGBT implementation (% of teachers in clusters).

Implementation

When it comes to implementation, teachers typically plan activities for individual play (Figure 12) and for shorter time during the class, except for sceptics who use both individual (25%) and class activities (25%). Under the category "other", teachers indicate either a mix of the options or that they currently do not use games (sceptics). The majority of sceptics (81%), curious adopters (75%) and advanced adopters (94%) say that they use games during lessons for a shorter time. Few teachers (15%) use games for one entire lesson or more (Mathe et al. 2019b). They indicate that the duration often depends on the type of game used. For example, an educational game may be used for a shorter time as a part of a lesson, while a game with a narrative in a language class may be played over one or two full lessons or more.

A language teacher explains how he plans activities with an entertainment game:

> Researcher: "What do you consider when you are planning to implement a game?"
> Teacher: "When you plan for a game, it is very **important to plan** like you do for a movie or a film. You have to **know what the purpose is**, if it **fits thematically** and if it **matches the level of the group**. I mean the difficulty of the language compared to the students' language level. So that it is **relevant** for the course. I have picked games that **don't have too difficult game mechanics**. It should not take too long time to learn the game because then important classroom time will be spent only on that." (Language teacher, interview)

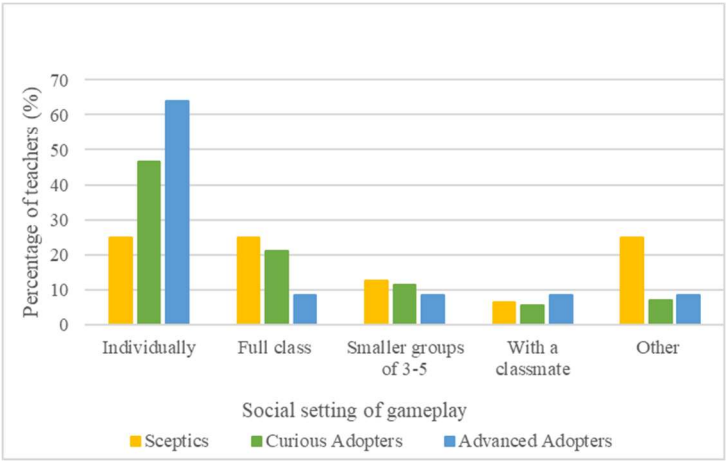

Figure 12. Social settings of gameplay (% of teachers in clusters).

Assessment

Sceptics (56%) and curious adopters (59%) are the least likely to report that they assess learning around games. However, curious adopters may use whole-class discussion (33%), inbuilt assessments in games (31%) and game points (25%) more than sceptics. Advanced adopters are the most likely to use assessment such as whole-class discussions (47%), create their own assessments and questions in combination with games (41%), and to a lesser extent use game points (34%) and inbuilt assessments (28%) in games (see Figure 13).

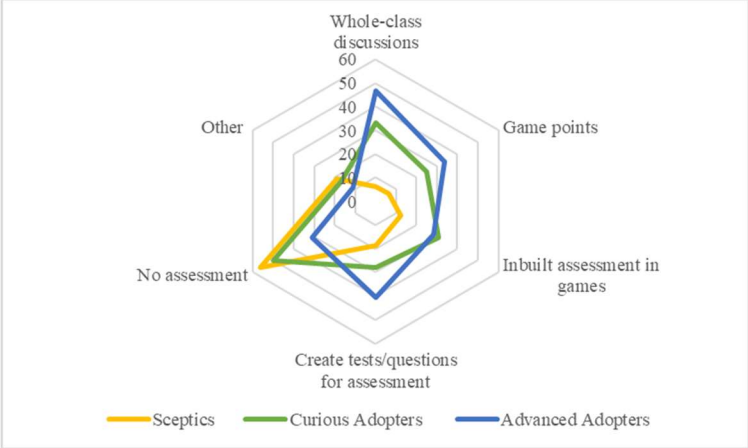

Figure 13. Assessment approaches in DGBT (% of teachers in clusters).

Perceived outcomes

When asking about perceived educational outcomes, all teachers agree that games are the most effective way to motivate and engage students. Sceptics

report that games can effectively support motivation (56%) and engagement (62%), but in general they see the games they use as being less effective for teaching information management (31%) and concepts (25%), and for evaluating (25%) and developing analytical skills (18%).

Curious adopters also find games effective for supporting motivation (86%) and engagement (83%), but unlike sceptics they generally think that games can support the understanding of concepts (58%) as well. They perceive games as being somewhat less effective in evaluating the knowledge of subject matter (22%) than sceptics do. The motivational power of gamified resources is described by a teacher in this way:

> Researcher: "What do your students think about the games?"
> Teacher: […] "What they like is the leader board in their own class. So for every single task they have a leader board and it is quite good because it **doesn't show the full leader board**. Because you don't want to see your name at the bottom of the list. It shows the top five. Which I think is really good **because it provides some healthy competition** but it does **not demoralize anyone who is towards the bottom end** of it. And that is **quite fun**, especially when they are all in the classroom competing and they can see the **leader board constantly changing** as well." (Mathematics teacher, interview)

Advanced adopters report highest on perceived motivational (93%), knowledge (70%), communicative (62%), analytical and metacognitive skills outcomes (56%). Teachers who report the use of entertainment games tend to report higher on skills communicative (88%), analytical (75%) and metacognitive outcomes (62%) than teachers who do not (Mathe et al. 2019b).

For a summary of the perceived outcomes across the clusters see Figure 14.

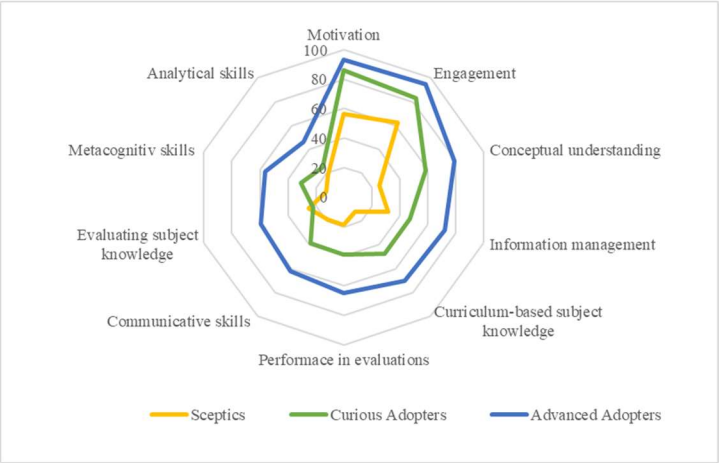

Figure 14. Perceived outcomes of DGBT (% of teachers in clusters).

5.2 RQ2: How do teachers engage in professional development about DGBT?

The most common way for teachers to learn about DGBT is through discussions with other teachers at their school. Curious adopters learn the most through these means; altogether 67% of them say they learn from others. They report higher on the use of online discussion forums (47%), their social networks (39%) and pedagogical periodicals (39%) than other teachers. Half of the sceptics and 58% of advanced adopters say they learn from other teachers. Advanced adopters also learn through online discussion forums (39%) and social networks (38%). Only 7% of advanced adopters say that they visit gamer forums and 2.8% learn from online courses (Mathe et al. 2019b). Thus, most teachers report informal learning from peers as the most important form of DGBT professional development.

5.3 RQ3: How do teachers perceive challenges of, and barriers to, DGBT?

This research question investigates possible contradictions that may arise in relation to the specific contexts. The contradictions in DGBT activity systems are represented in figures with broken arrows after Engeström (1987) in this chapter.

Both GUTs and NGUTs have reported their challenges in 14 predefined areas with a free-text option. Altogether 181 respondents generated 543 instances. On the aggregate level, teachers have difficulty in finding good-quality games that match the curriculum and many report challenges regarding preparation time. The lack of preparation time is especially an issue for curious adopters (50%). Cost-related issues are reported most typically by curious and advanced adopters. The lack of knowledge on how to integrate games in their teaching is highest among non-game users (47%) and a lack of familiarity with game technologies is most prevalent among non-game users (29%) and sceptics (38%) (see Figure 15).

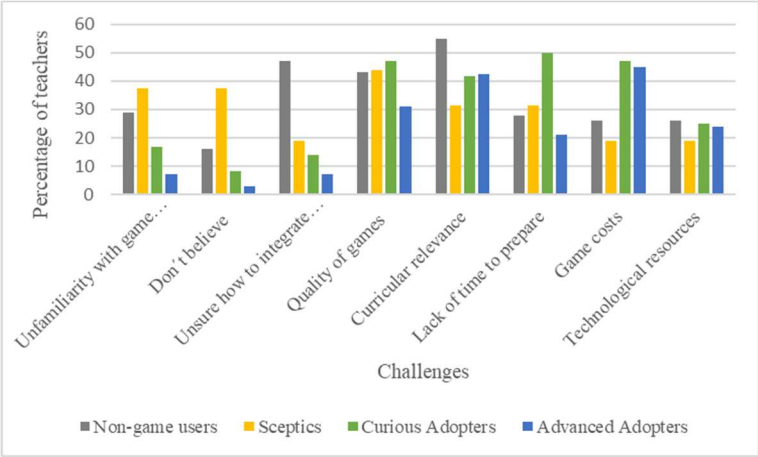

Figure 15. Challenges of DGBT (% of teachers in clusters).

Based on the challenges reported by teachers in the predefined categories, as well as the analysis of the perceived educational outcomes, challenges in three major areas are identified and discussed in this chapter: a) outcomes, b) resources, and c) professional development.

5.3.1 Outcomes

These challenges revolve mainly around the subject, object and outcome aspects of AT (see Figure 16). Around one-third of the teachers in the sample (32%) say that they have not changed their practices, since they do not use games. For these teachers it may be unclear what educational outcomes to expect, or they may think that games are not appropriate for educational use. Three teachers formulate their concerns in the following way:

> Survey question: What are your greatest challenges, if any, when it comes to using games in your teaching?
> Teacher 1: It is **unclear what games would contribute**. (Non-game-using teacher, survey)

> Teacher 2: I am **worried that the students would not focus on their "normal" studies** if we used games. (Non-game-using teacher, survey)
> Teacher 3: "It is important that digital game-based learning is just **one form of learning** and it is **not meant to replace** other forms of learning. [...] my perception is that in digital game-based learning one is **being led by a digital tool** with the aim of **keeping the students focused** and **entertained**. Not everything is fun and it is also important to learn **to deal with things when there is a bit of a resistance.**" (Non-game-using teacher, survey)

GUTs, in general, find games less effective for teaching new knowledge or skills or use games for evaluation (see Figure 14). *Sceptics* in general say they do not believe in games as a teaching/learning tool (38%). One teacher points out issues with superficial learning:

> Teacher 4: I think that they [digital games] contribute to superficial learning that limits basic understanding." (Sceptic, survey)

Contradictions between *playing* and *learning* are pointed out by some of the curious and advanced adopters:

> Teacher 5: "I am **unsure if the students learn** the content, the subject matter or if they learn the 'technique' to progress in the game." (Curious adopter, survey)
> Teacher 6: "Too much of the **game-related takes from the school-related**." (Advanced adopter, survey)

Another teacher explains how he gradually changed his approach of using gamified worksheets and educational mathematics games when he did not reach the intended objectives:

> "In my first year here **I used it extensively** with one class, I **didn't use it at all the following year** and **this year I am using it as a learning support**, so for students who are failing, they have access to an account and they can use it for extra practice. […] I haven't really had...**it didn't have the impact that I wanted to or what I was expecting**. I was expecting students to engage more with mathematics outside of lessons and that didn't really happen unfortunately." (Maths teacher, interview)

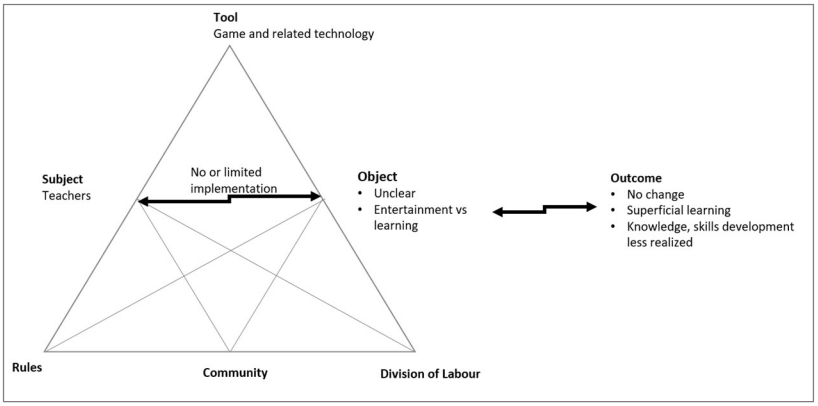

Figure 16. Contradictions related to objectives and outcomes.

5.3.2 Resources

Results from Studies 1 and 2 show that challenges relate to the availability of resources as well, such as the games, teachers' time, financial and technological resources.

Good-quality games with curricular relevance

This issue relates chiefly to the rules and object aspects of AT and concerns the question of how the curriculum, school rules and norms affect the way teachers implement games. Findings from the survey show that one of the most pressing issues both for NGUTs and GUTs is finding good-quality and curriculum-related games (see Figure 17). Teachers say the following:

> Teacher 7: "There is **a lack of games that have learning built in them** and they tend to take the form of glorified online textbooks." (Non-game-using teacher, survey)
> Teacher 8: "Digital games are **often not adapted for the school environment**." (Advanced adopter, survey)
> Teacher 9: "It is mostly about finding **games that really make students learn while they play**. **The game mechanics should be integrated with the knowledge acquisition**." (Advanced adopter, survey)

Another interviewee from Study 1 highlights the connection between the commercial aspects of the game industry and game quality:

> "I would say that there are two types of games developers. The **commercial game [developers]** is one. These [games] are motivating and are fun to play. And there is another group, which is a much **smaller market**, that makes **educational games**. They make a very obvious attempt to teach but are quite bad at making the game fun. The students get bored quite quickly and they quickly understand that aaah…now I have to learn something…aah. So these two

should meet somehow. **There is a need for games that have short playtime, high potential for learning but still have this attraction power that good games have. So that is really a barrier. There are no such [games].** You can find many interesting ones on the commercial market but then they fall flat on the pedagogical side to be useful and hmm.... that would make me want to test them with my students." (Social sciences teacher, interview)

The contradictions related to the rules and objects are represented in Figure 17.

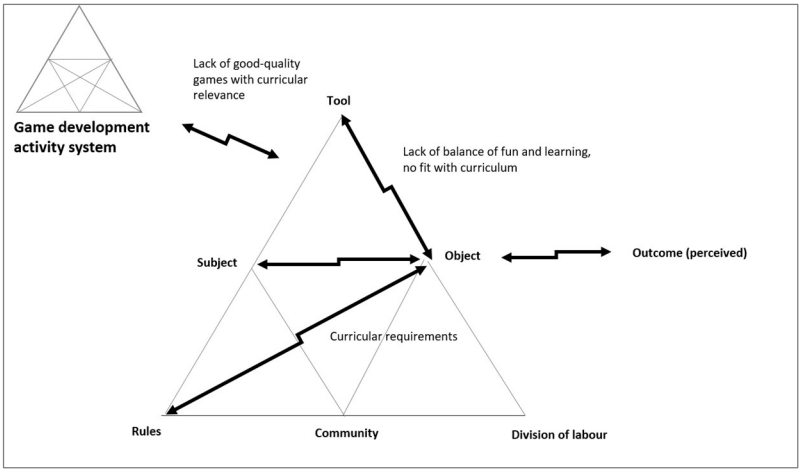

Figure 17. Contradictions related to rules and object.

Preparation time

These challenges mainly relate to the division of labour, namely the different roles and responsibilities of teachers (see Figure 18). Implementing digital games means that teachers need to acquaint themselves, and plan their activities, with these tools, which requires time. For curious adopters the lack of time to prepare is the most important challenge (50%), but to a lesser extent advanced adopters (21%), sceptics (31%) and NGUTs (28%) report this as well (see Figure 15). One teacher says that what is needed is *"paid time to test the digital games to see if they work as teaching/learning tools"* (non-game-using teacher).

Another teacher reflects on these challenges in the following way:

"I am not interested in games that do not contribute pedagogically, and it is also that **I** should have time to acquaint myself with it." (Curious adopter, survey)

Two teachers from Study 1 point out the lack of time as well. One teacher suggests that there is significant initial time investment, but once that hurdle is overcome by investing extra time, allowing for gradual planning and using

student test groups, there is little difference in terms of preparation when compared to previous practices:

> Researcher: "How do the games fit in among all your other tasks?"
> Teacher: "They are included in the usual preparation time. But of course you have to… it takes time before you know how things work in the school. Who can help and so on. Of course **you have to spend a couple of your evenings on this at the beginning**. But once you have figured it out, then you can do it under your usual preparation time that you have. Apart from those few times, there is very little difference whether I run to the copy machine to copy a few pages to hand out, or if I check that everybody's iPad has a specific game installed and that the network is functioning. Of course, it is different. **You should not hurry, but plan slowly and test your way forward**, see that everything works. Maybe **have a small test group in the classroom** to make sure that it works. To connect and so on." (Social studies teacher, interview)

Another game-using teacher points out that time investment is significant, however there is a personal emotional reward that comes with it:

> Researcher: "How does the game fit in among all your other tasks?"
> Teacher: "If I have time to do it? It is a threshold and many teachers think it is difficult. It **requires an open mind and interest to make it work**. But I think that the **time and energy investment… it is so rewarding that I have no problem** using my private time to make it work. As a teacher we also have 10 hours per week that **we should invest in personal development, to be able to work with fun projects**. For me, this is exactly like that." (Language teacher, interview)

For others, the resources may actually help to address the lack of time from another perspective. One teacher reflects how gamified resources may help to address homework-related time constraints. Even though he didn't find that student engagement with homework improved as a result of the gamified resources, he still thinks that the gamified resources can be useful. This indicates that the use of gamified approaches to teaching may still be used if they ease the workload of teachers, while not necessarily improving the learning outcomes of students.

> "I think we all agree as teachers that homework is …beneficial to students. In terms of mathematics you have got to reinforce what they learned in class, and with the other demands of the job, setting it [homework], giving effective feedback and marking it is just... impossible. So if this [gamified resource] does make it possible then it is something we want to use." (Maths teacher, interview).

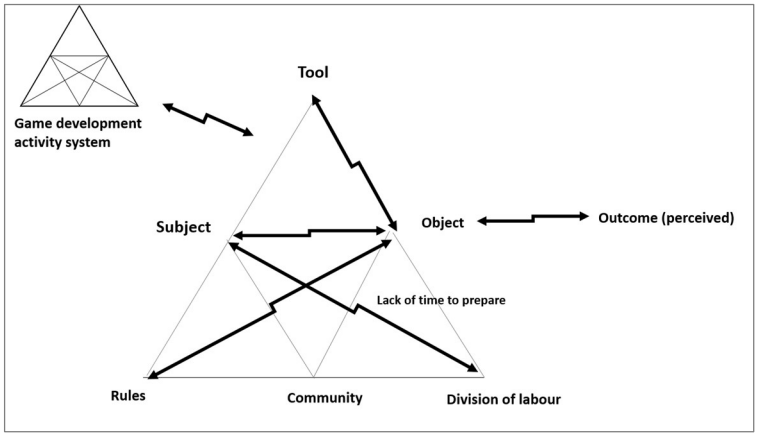

Figure 18. Contradictions related to division of labour.

Game costs

For the most game-adept teachers, however, challenges are chiefly connected to game-related costs as reported in Article 3 (Mathe et al. 2019b). One teacher provides an insight into these issues:

> Survey question: "What are your greatest challenges, if any, when it comes to using games in your teaching?"
> Teacher: "It is first of all **cost and licensing** problems. I can list a dozen shorter games based on my own interest and I know how to integrate these in my teaching, but practically it is very difficult to bring the game to the students. It is **too expensive to buy new for every year**, using only free games does not work and the game industry has so far **no infrastructure for educational licences/volume licences**. I had to negotiate directly and personally with the developers of those two 'normal games' that I use to get some kind of legal contract per game. In one case, **it required quite a big personal expenditure**." (Advanced adopter, survey)

The comments indicate that game cost-related challenges may be multifaceted and may arise from the profit-oriented nature of the commercial game industry that does not necessarily consider public education as a viable customer. Consequently, especially when it comes to entertainment games, there is a lack of infrastructure to cater to the needs of education. These challenges may also be combined with financial constraints in schools and the way financial resources are spent on digital resources. Contradictions of the DGBT activity system, game development and school governance activity systems are represented in Figure 19.

Technology resources

Nearly every fourth teacher (24%) indicates that a lack of technology resources can become a bottleneck when it comes to game implementation in

the classroom. Entertainment games often require computers with hard drives, and for collaborative work, computers have to be connected. Access to servers may be difficult due to firewall settings, and network capacity is another concern. Purchasing the licences, installing games and maintaining passwords can be a tedious process (Mathe et al. 2018). One teacher points out these technology issues:

> "[…] And then there are the practical parts. **How do you connect the computers? Who has a server?** The school doesn't. And then the network should manage it. And many of these practical issues. You don't get intranet service and they you have to go and ask for help with the **network problem**. So there are many of these technical problems that you have to consider. It doesn't work that you just throw yourself out there that now I want to build something in Minecraft. **You have to be prepared that there will be problems** but **the kids know this**. They know how to do it. **They are much quicker than me in solving these** technical issues." (Social studies, interview)

For another teacher it is about slow computers that demotivate students:

> "I think that it is technological process that is the biggest challenge for games in schools. Partly because everything must work, the network and the computers. And it is mostly about that. And if you have **computers that take time to start up**, then this process becomes heavy and **the students often lose interest.** I had a student who sat with a computer the whole class that didn't work for some unknown reason. And then they lose their interest **because they want to be there and they want to build**." (Primary-level teacher, interview)

Contradictions related to tools and neighbouring activity systems are represented in Figure 19.

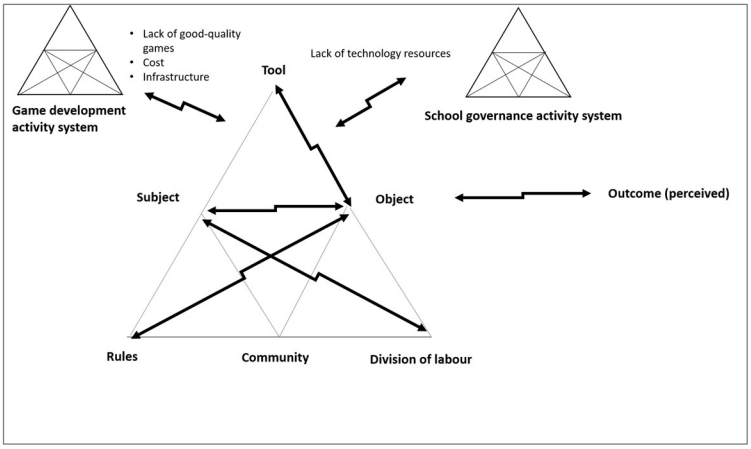

Figure 19. Contradictions related to tools and neighbouring activity systems.

5.3.3 Professional development

More than half of the NGUTs (57%) say that one of their most pressing challenges is their lack of knowledge on how to integrate digital games into their teaching. More than a third (38%) of the sceptics say that they are unfamiliar with game technologies (see Figure 20).

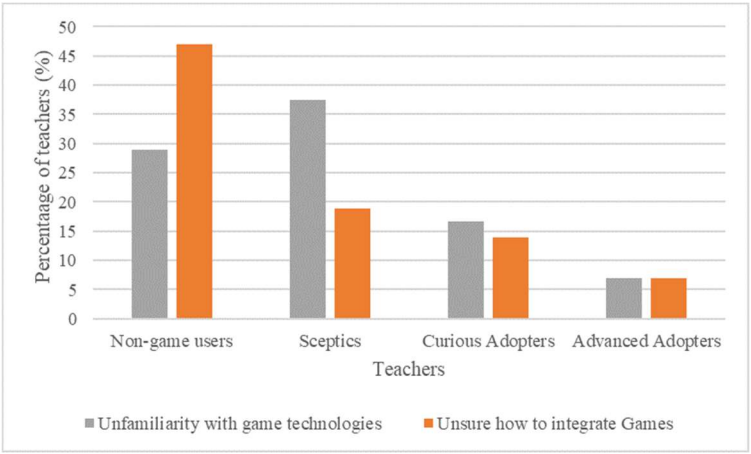

Figure 20. Knowledge gaps in DGBT (% of teachers in clusters).

However, the majority of all the teachers in the survey (90%) indicate that they are interested in developing their DGBT competencies. The preferred options include learning from and with others in their own school contexts

through workshops and discussions across all teacher groups. Advanced adopters are the most interested in the use of online courses – currently 2.8% of them say they learn from online courses, however every second advanced adopter (51%) is interested in such an option in the future. Among all teachers, curious adopters most prefer learning from discussions with their colleagues (72%) while sceptics (44%) are the least interested in DGBT professional development. NGUTs are generally more interested (85%) than sceptics (56%). The results indicate that NGUTs and teachers with mixed and positive dispositions towards games also tend to be the most interested in DGBT professional development (see Figure 21), while they may lack time, supporting tools, programs and opportunities (Mathe et al. 2019b).

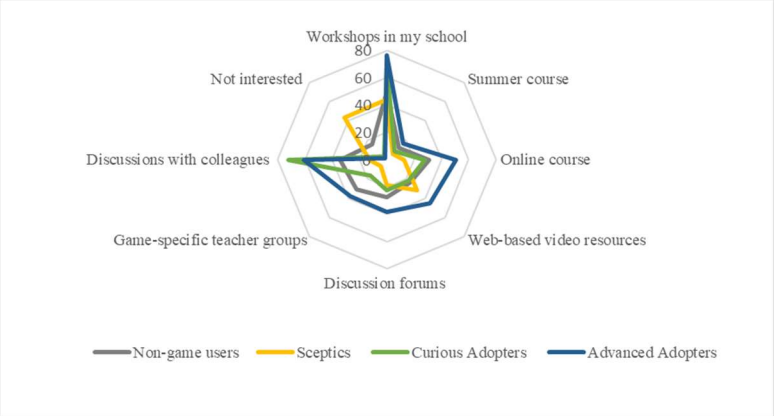

Figure 21. Interest in professional development options in future.

Figure 22 illustrates the contradictions related to division of labour and a professional development activity system.

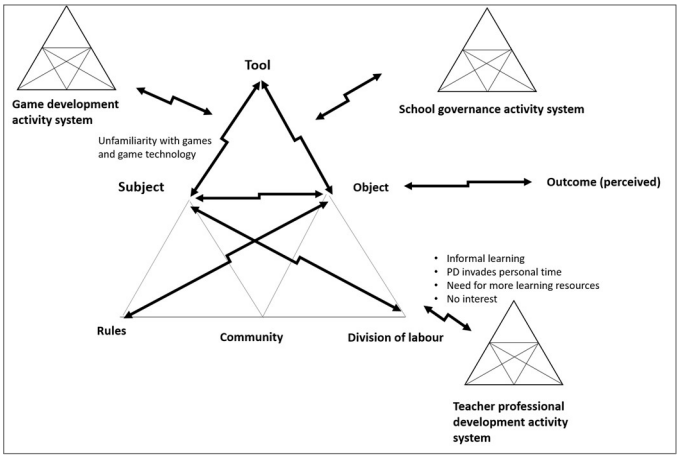

Figure 22. Contradictions related to division of labour and professional development activity system.

6. Discussion and Future Work

This thesis investigates the landscape of digital game-based learning in Swedish compulsory and higher secondary schools in Sweden. In particular, it has examined what teachers say about the use of digital games, their professional development approaches and the challenges they face. Data have been collected in two studies including eight in-depth interviews and a survey with 181 compulsory and upper secondary school teachers in Sweden during 2018 and 2019. Both the data collection and analysis have been informed by activity theory. In this thesis, compulsory and upper secondary education is seen as a regulated and multi-vocal activity system. In addition to teachers (subjects) it includes the students who are the object of the teaching activities, and different artefacts (teaching tools) that mediate the activity between subject and object. It also includes a variety of specific rules that regulate education and teachers' work and a community of education professionals, parents, teaching tool and resource developers, and professional development providers. This arrangement of people, artefacts, regulations and relationships forms what it is conceived as education. When one mediatory artefact is substituted with another, in this case digital games, contradictions in the activity system and between neighbouring activity systems may arise.

As discussed in Chapter 3, AT is sometimes criticized for discounting the importance of the connection between emotions and actions. For example, a large proportion of teachers in Sweden say that they develop their competencies due to their own interest in digital tools (Lärarnas Riksförbund 2016) in their own time (Parding , et al., 2018), as have done those teachers in the studies who have described their personal interest in, and passion for, games. Addressing these emotional attributes was helpful in better understanding teachers' DGBT activities.

Results show that around two-thirds of the teachers (68%) in the sample have implemented a variety of game artefacts across different subject areas at some point in time. The implemented tools include interactive digital materials, quizzes, gamified digital textbooks, educational games, game creation tools, 2D and virtual reality simulations and augmented reality games, as well as immersive entertainment games and e-sport. Gamification and educational games are the preferred choices of both male and female teachers, however males are more likely to use entertainment games than their female peers. The reason for this could be that male teachers also indicate longer game experience and play more frequently for their own entertainment than female teachers. Munkvold and Sigurdardottir (2018), for example, found that male teachers in Norway are more likely to play shooter games, action games, sport and fighting games, racing and adventure games, while female teachers tend to play casual mobile games and family entertainment games. In the Swedish context, teachers under the age of 30 are also more likely to use entertainment games for teaching than their older peers. The choice of tools may have some

impact on the outcomes as teachers who indicate the use of entertainment games also report higher communicative, analytical and metacognitive skill outcomes than their peers (Mathe et al. 2019b). This indicates that game-using teachers are different in the way they understand and use digital games. In this thesis, three subsets of game-using teachers have been identified based on whether they have negative, mixed or positive dispositions towards DGBT. Teachers with a negative disposition are called "sceptics", teachers with a mixed disposition are known as "curious adopters", and teachers with a positive disposition are labelled "advanced adopters". These three subsets of teachers are partially comparable to Takeuchi and Vaala's (2014) findings of four types of teachers ranging from the least game-adept dabblers to skilled implementors such as players.

The results from this thesis indicate that a more positive teacher disposition towards DGBT generally relates to a greater variety of game use, an increased pedagogical integration, more varied and higher outcomes and an interest in professional development. The most game-adept teachers are also more likely to use new mediatory instruments in connection with games, such as self-designed task sheets and assessments, than their peers. Teachers in general perceive that the games they use are extremely effective for motivating and engaging students, but less so for developing communicative and higher-level thinking skills. The results from this thesis show that Swedish teachers indicate the use of gamification tools (quizzes) the most frequently. Teachers also tend to implement game-based learning activities that are individual and a short part of a lesson while social settings and longer play activities are not typical (Mathe et al. 2019b). These results corroborate findings from the US and the Nordic countries. Takeuchi and Vaala (2014), for example, found that K-8 teachers in the US typically implement educational games that are short and fit within a single class period. Munkvold and Sigurdardottir (2018) found that Norwegian teachers use gamification tools the most frequently followed by educational games. The authors point out that teachers have claimed to use digital game-based learning, while creating quizzes to drill student knowledge may account for a large proportion of activities.

The preference for gamification tools is interesting considering that all teachers in the Swedish studies communicate the need for quality games with curricular relevance that balance fun and learning well. The issue of game design is discussed by Linderoth and Sjöblom (2019), who argue that modest effects of game-based learning are often explained by the teacher deficit model, namely that teachers have problematic attitudes, and hence do not implement games in productive ways. Instead of teachers' attitudes, the authors argue that modest effects point towards the quality of games themselves. Findings from the studies in this thesis indicate that most teachers in the sample are interested in using digital games while they say that the lack of relevant and good-quality games, financial resources, preparation time and, to a lesser extent, adequate technology are the most important barriers to digital game

implementation. These challenges are similar to those in the US and other Nordic countries. Teachers in the US see insufficient time and cost as major challenges while teachers across other Nordic countries indicate technical and time/management obstacles, knowledge and skill challenges and the lack of digital games most frequently (Brooks, et al., 2019).

Grönlund and Wiklund (2108) argue that the digitalization in Swedish schools means that a large part of the budget for teaching resources is spent on computers and tablets. Limited budgets coupled with complicated purchasing processes mean that much of teachers' time is spent on seeking free teaching resources first of all on the Internet. However, the quality of resources on the Internet varies greatly, and they may have limited functionality or use period, which means that teachers cannot make full use of these resources and have to change them frequently. Besides using free digital resources, teachers also increasingly develop their own teaching materials and spend significant amounts of time on doing this. These conditions are likely to influence DGBT as well. As teachers' preparation time is already strained by searching for or developing their own teaching materials, their time for learning and implementing DGBT may be limited. Moreover, when school budgets are limited, teachers may select free gamification tools and games of varying quality.

Around a third of the Swedish teachers have not yet implemented any games and almost 10% of the game-using teachers are sceptical. These teachers are also the least familiar with digital game technologies and most unsure about how to implement these in their teaching. Previous research findings show that digital games can be looked upon with scepticism by teachers as tools that impede rather than facilitate learning. Grove et al. (2012) found that teachers implementing games do not necessarily have a positive experience. Teachers might come to reject DGBT if they perceive games as being less adequate than their previous practices (Emin-Martinez and Ney 2013). The lack of knowledge about game-related technologies and implementation, especially among non-game-using teachers and Sceptics, highlights the need for professional development. Teachers say they generally learn about DGBT informally through inspiration from other teachers. Some teachers may get game ideas from students, their own children's games and experiences (Mathe et al. 2018). However, learning formally about DGBT is not typical as only a quarter of teachers say that they heard about games at courses or in more formal professional development settings. There is a gap between current teachers' professional development practices and teachers' needs, indicating the lack of supporting tools, programs and opportunities for teachers to develop their game-based teaching competencies.

In summary, teachers in the sample are generally interested in implementing game-based approaches to teaching, although there are gaps in their use of game resources and the extent to which they can leverage these for educational outcomes. The threshold for teachers at entry levels of digital game-based

teaching may still be too high, thus a large proportion of teachers, and consequently their students, might currently be excluded from the possible benefits that digital games and gamification tools may bring to classrooms. DGBT requires pedagogical, technological, collaborative and creative teacher competency development (Nousiainen et al. 2018). Teachers need adequate content (Bourgonjon, et al., 2013), examples of good practice (Ketelhut and Schifter 2011) and support from their local contexts including access to technical support and related resources. Future research should investigate how game developers and educational stakeholders can identify ways to lower the threshold for teachers at entry levels of digital game-based teaching and support competency and community development around games. This should include further stakeholders such as game developers and a wider circle of educational stakeholders, including school management students, and should investigate how teachers and learners could benefit from digital games and gamification more inclusively in the future.

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Appendices and Articles

Appendix 1: Information and consent form

Appendix 2: Interview guide

Appendix 3: Survey

Appendix 4: Games and gamification tools

Included Articles:

Article 1
Mathe, M., Verhagen, H. and Wiklund, M., 2018. Digital games in education: exploring teachers´ practices and challenges from play to co-design. In M. Ciussi (Ed), *Proceedings of the 12th European Conference on Game Based Learning,* SKEMA Business School, Sophia Antipolis, France, 4-5 October 2018, pp. 388-395.

Article 2
Mathe, M., Verhagen, H. and Wiklund, M., 2019a. Digital games-based teaching in Swedish compulsory and upper secondary schools. In L. Elbæk, G. Majgaard, A.Valente and Md. S. Khalid (Eds), Proceedings of the 13th European Conference on Game Based Learning, Odense, Denmark, 3-4 October 2019, pp. 503-511.

Article 3
Mathe, M., Verhagen, H. and Wiklund, M., 2019b. From skeptics to advanced adopters: investigating digital game adoption practices, challenges and needs of teachers in Swedish school. In A. Liapis, G.N.Yannakakis, M. Gentile and M. Ninaus (Eds)*, Games and Learning Alliance 2019: 8th International Conference,* Athens, Greece, 27-29 November 2019, pp. 73-82.

Appendix 1 Information and consent form

Teaching with Digital Games
Research Project
Information for Teachers

My name is Melinda Mathe, and I am a PhD candidate at Stockholm University, Department of Computer and Systems Sciences in Stockholm.
This information sheet informs you about my research project and activities I would like to involve you in. I am happy to answer any further questions you have either via email or phone.

Why is this research important?

The study is being conducted with teachers in Swedish schools and aims to describe the current perspectives, practices and challenges of digital game use in education in various subjects at primary and secondary school levels.

Who will take part in the project?

In this project, I am looking to involve a number of teachers in different subject areas who have used digital games in their teaching.

How will you be involved?

I would like to conduct an interview with you to find out about your experiences, practices and challenges with regards to teaching with digital games. The interview would take 45 – 60 min. and be conducted during April or May at a time that is convenient for you.

What data will be collected? How will it be stored and used?

I will take notes and audio recordings. The recordings will be deleted once transcribed. The notes and transcripts will be anonymized and stored in a secure location, accessible by myself and my academic advisor at Stockholm University. Identifiable personal data will not be published. The data will be used for research purposes and will be kept for 10 years.

How can you find out about the research results?

I will inform participants about the research results. If you wish to receive information via email you can provide your email address.

You would like to participate, but what if you change your mind?

After reading this information you decide if you want to participate in the study. You are free to withdraw any time without giving a reason. Upon retraction the collected data will be removed from the dataset.

Thank you for reading this information sheet.

Melinda Mathe
Department of Computer and Systems Sciences
Stockholm University
Stockholm, Sweden
Email: melinda@dsv.su.se
Tel: +46 70 4158770

Consent Form

Please tick all statements that apply and sign the form below.

I have read and understood the information sheet ☐
I agree to take part in the interviews ☐
I am happy to be audio-recorded ☐

Name: _____

Signed: _____

Date: _____

If you want to be kept updated with the study outcomes please provide your email address below:

_____
_

Researcher's Name: _____

Signed: _____

Date: _____

Appendix 2 Interview guide

Skol:

_____

Datum och tid:

_____

Identifiering:

_____

1. Lärarbakgrund

1.1 Kan du berätta om dina undervisningserfarenheter? Hur länge har du undervisat?

1.2 Kan du berätta om dina erfarenheter med digitala spel? Identifierar du dig som en gamer?

1.3 Hur länge har du undervisat med spel? Vilka digitala spel använder du i undervisningen?

1.4 Hur skulle du beskriva din undervisningsstil? Vilken klassrumsatmosfär föredrar du?

2. Mål/syfte

2.1 Vad är ditt mål med att använda digitala spel i din undervisning?

2.2 Hur hjälper digitala spel dig att uppnå dessa mål? Skulle du kunna nå dem på något annat sätt?

2.3 Hur vet du om du har uppnått dessa mål?

2.4 Har du upplevt oväntade effekter som du inte har planerat?

3. Användning av spel och andra pedagogiska verktyg

3.1 Kan du berätta om processen hur du integrerar digitala spel i klassrummet och hur processen kan variera?

3.2 Hur passar spelet in bland dina andra aktiviteter som lärare?

3.3 Vilka andra pedagogiska material och verktyg kombinerar du med digitala spel?

3.4 När använder du dessa och hur?

3.5 Hur får du tillgång till dessa material?

4. Regler, regleringar

4.1 Vad behöver du förhålla dig till när du planerar för att använda digitala spel i undervisningen? (regler, regleringar i skolan, prover, läroplan) Hur påverkar de ditt arbete?

4.2 Vilka kommentarer, synpunkter får du när du berättar om att du använder digitala spel i undervisningen? Vilka normer ger de uttryck för? (olika synpunkter i samhället, etiska frågor, oskrivna regler)

5. Arbetsfördelning

5.1 Har digitala spel påverkat/förändrat hur du undervisar? I så fall, hur?

5.2 Har spelen påverkat din roll och ditt ansvar som lärare? I så fall, hur?

5.3 Hur påverkas dina studenter av spelen? Kan du ge exempel på vad de säger?

5.4 Tycker du att spelet har påverkat/förändrat studenternas roll och ansvar? Hur?

6. Samhälle/skolmiljö

6.1 Delar du med dig dina pedagogiska verktyg (planer, ideer, guider, osv) med andra? Hur?

6.2 Samarbetar du med andra lärare avseende digitala spel? I så fall, hur?

6.3 Tror du att spelet/n har påverkat icke-spelande lärare på din skola? I så fall, hur?

6.4 Om något inte funkar för dig, vem kan du be om hjälp? (administration, teknisk personal, andra lärare, studenter osv)

7. Utmaningar

7.1 Kan du sammanfatta de viktigaste utmaningarna angående användningen av digitala spel i klassrummet?

7.2 Hur hanterar / skulle du vilja hantera dessa utmaningar?

7.3 Vilka är dina framtida planer angående digitala spel i klassrummet?

8. Finns det något mer du skulle vilja dela med dig?

9. Har du förslag på andra lärare som använder digitala spel som jag kan intervjua för min forskning?

Appendix 3 Survey

Stockholms universitet

Digitala spel i skolan: fungerar de som läromedel?

Bästa Lärare,

Hypen runt användningen av digitala spel i undervisning har varit stor under de senaste åren, men fungerar de bra som läromedel? I denna forskningsstudie frågar vi dig, som är **lärare i grund- eller gymnasieskolan,** om hur du ser på digitala spels användbarhet i din undervisning. Med dina svar hjälper du oss forskare och även skolaktörer att bättre förstå ditt perspektiv och eventuella behov avseende digitala spel som läromedel i de svenska skolorna. Med digitala spel menar vi **alla typer av spel som används på någon typ av digital plattform.**

Har du aldrig använt digitala spel? Vi är ändå intresserade och uppskattar om du kan ta 5 minuter av din tid att dela med dig av dina synpunkter. Har du någon gång använt digitala spel eller syns de ofta i dina klassrum? I så fall är vi lite extra nyfikna om hur du använder dem och ber dig att dela med dig dina erfarenheter genom att fylla i den här enkäten i cirka 10-15 minuter. Enkäten kan **besvaras till och med den 3 maj 2019**.

Undersökningen är en del av ett forskningsprojekt vid Stockholms universitet, Institutionen för data- och systemvetenskap.

Hur går studien till?

Det är helt frivilligt att medverka i studien och du kan enkelt svara på frågorna online. Materialet från enkäten kommer att hanteras och behandlas anonymt. Är du intresserad att delta i en uppföljningsstudie och/eller få information om resultaten från enkäten, kan du välja att ange din mejladress. Genom att klicka vidare väljer du att delta i studien och godkänner att Stockholms universitet är personuppgiftsansvarig och kommer att behandla dina personuppgifter och lämnad information i enlighet med gällande dataskyddsförordning.

Ditt deltagande är mycket uppskattat och vi hoppas att du kan stödja detta forskningsprojekt.

Om du har frågor eller funderingar, kontakta oss här:

Melinda Mathe

Doktorand

Stockholms universitet

Institutionen för data- och systemvetenskap

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Harko Verhagen

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Hur kom du i kontakt med enkäten?

- ○ Online-forum
- ○ Genom en annan lärare
- ○ Genom skolans rektor
- ○ Pedagogisk tidning
- ○ Om annat, vänligen ange

Kön

- ○ Kvinna
- ○ Man
- ○ Annat

Ålder

○ under 25 ○ 25–29 ○ 30–39 ○ 40–49 ○ 50–59 ○ 60+

Är du behörig i de ämnen du undervisar under läsåret 2018/2019?

- ○ Ja
- ○ Mestadels
- ○ Delvis
- ○ Nej

Hur länge har du jobbat som lärare?

Om möjligt, uteslut förlängda perioder av frånvaro (t.ex. karriäravbrott).

- ○ Detta är mitt första år.
- ○ 1–2 år
- ○ 3–5 år
- ○ 6–10 år
- ○ Mer än 10 år

På vilken/a nivå/er undervisar du under läsåret 2018/2019? Välj allt som gäller.

- [ ] Årskurs 1–3
- [ ] Årskurs 4–6
- [ ] Årskurs 7–9
- [ ] Gymnasium

Vilka grundskolämnen undervisar du under läsåret 2018/2019? Välj allt som gäller.

- [ ] Bild
- [ ] Biologi
- [ ] Dans
- [ ] Engelska
- [ ] Fysik
- [ ] Geografi
- [ ] Hem och konsumentkunskap
- [ ] Historia
- [ ] Idrott och hälsa
- [ ] Kemi
- [ ] Matematik
- [ ] Moderna språk
- [ ] Modersmål
- [ ] Musik
- [ ] Religionskunskap
- [ ] Samhällskunskap
- [ ] Slöjd
- [ ] Svenska
- [ ] Svenska som andraspråk
- [ ] Teckenspråk
- [ ] Teknik
- [ ] Om annat, specificera

Har du någon gång spelat digitala spel för nöjes skull?

Med digitala spel avses alla typer av spel som används på någon typ av digital plattform.

- ○ Ja
- ○ Nej

Hur skulle du beskriva ditt intresse för att spela digitala spel för nöjes skull?

- ○ Mycket intresserad
- ○ Intresserad
- ○ Ointresserad
- ○ Mycket ointresserad
- ○ Vet ej

Hur skulle du beskriva ditt intresse för att använda digitala spel in din undervisning?

- ○ Mycket intresserad
- ○ Intresserad
- ○ Ointresserad
- ○ Mycket ointresserad
- ○ Vet ej

Har du någon gång spelat/använt digitala spel för undervisning eller för andra jobbrelaterade syften?

Med digitala spel avses alla typer av spel som används på någon typ av digital plattform.

- ○ Ja
- ○ Nej

Hur bekväm känner du dig att använda digitala spel som ett lärandeverktyg?

- ○ Mycket bekväm
- ○ Något bekväm
- ○ Något obekväm
- ○ Mycket obekväm
- ○ Vet ej

Hur många år har du använt digitala spel i undervisning eller andra jobbrelaterade syften?
Om möjligt, uteslut längre uppehåll.

- ○ Mindre än 1 år
- ○ 1–2 år
- ○ 3–5 år
- ○ 6–10 år
- ○ mer än 10 år

Hur ofta har du använt digitala spel i din undervisning under läsåret 2018/2019?

- ○ Varje dag
- ○ 2–4 gånger per vecka
- ○ 1 gång per vecka
- ○ 1–3 gånger per månad
- ○ Mindre än 1 gång per månad

Skulle du vilja använda digitala spel i din undervisning under läsåret 2019/2020?

- ○ Ja
- ○ Nej
- ○ Vet ej

Vad är de viktigaste anledningarna för dig att använda digitala spel i din undervisning?

Välj allt som gäller.

- [ ] Undervisa nya kunskaper/färdigheter enligt läroplanen
- [ ] Träna elevernas kunskaper/färdigheter som jag redan har undervisat
- [ ] Undervisa extra material som inte finns i läroplanen
- [ ] Göra formativ bedömning av elevernas kunskaper/färdigheter enligt läroplanen
- [ ] Göra summativ bedömning av elevernas kunskaper/färdigheter enligt läroplanen
- [ ] Bedöma elevernas kunskaper/färdigheter utöver läroplanen
- [ ] Motivera eleverna
- [ ] Ge eleverna en rastaktivitet
- [ ] Ge eleverna aktivitet mellan uppgifter
- [ ] Få elever att interagera
- [ ] Om annat, vänligen ange

Var hörde du först om användningen av digitala spel i undervisning?

- ○ Av en annan lärare
- ○ Jag kom på idén själv
- ○ I vidareutbildning för lärare
- ○ På lärarprogrammet
- ○ Av eleverna eller mina egna barn
- ○ Genom en online-resurs
- ○ Om annat, vänligen ange

Hur bestämmer du vilka spel du använder? Välj upp till 3 svar.

- [ ] Vad andra lärare säger om spelet
- [ ] Spelet har bedömning, spårning, och/eller andra klassrumsledningsfunktioner
- [ ] Dina erfarenheter eller personliga preferenser för spelet
- [ ] Forskningsresultat om spelets lärandepotential
- [ ] Vad eleverna säger om spelet
- [ ] Spelets kostnader
- [ ] Utvärdering av spelet (i tidning, blog, på nätet)
- [ ] Omdömen om spelet
- [ ] Om annat, vänligen ange

Vilka kvaliteter i digitala spel finner du värdefulla? Välj upp till 3 svar.

- [ ] I linje med läroplan
- [ ] Främjar samarbete mellan elever
- [ ] Levererar innehåll utan direkta instruktioner
- [ ] Elever kan använda spelet självständigt och kräver liten andel individuell instruktion
- [ ] Ger ett alternativ till att bedöma lågpresterande elever
- [ ] Ger underlag till utvärdering
- [ ] Erbjuder ett sätt att träna kunskap och färdigheter
- [ ] Motiverar eleverna
- [ ] Om annat, vänligen ange

Vilken typ av digitala spel använder du mest i din undervisning? Välj allt som gäller.

- [ ] Spel med utbildningssyfte som används främst i klassrum
- [ ] Spel med underhållningssyfte men anpassade för utbildning
- [ ] Spel med underhållningssyfte som används främst på fritiden
- [ ] Gamification tools, hjälpmedel för spelifierande av undervisning (t.ex.: Kahoot, Mentometer)
- [ ] Digitala verktyg för programmering av spel (t.ex.: Scratch)
- [ ] Spel framtagna av dig eller annan lärare
- [ ] Spel framtagna av elever
- [ ] Om annat, vänligen ange

I vilka ämnesområden har du redan använt digitala spel? Välj allt som gäller.

- [ ] Biologi
- [ ] Engelska
- [ ] Fysik
- [ ] Geografi
- [ ] Hem och konsumentkunskap
- [ ] Historia
- [ ] Idrott och hälsa
- [ ] Kemi
- [ ] Matematik
- [ ] Moderna språk
- [ ] Modersmål
- [ ] Musik
- [ ] Naturkunskap
- [ ] Religionskunskap
- [ ] Samhällskunskap
- [ ] Slöjd
- [ ] Svenska som andraspråk
- [ ] Teknik
- [ ] Om annat, specificera

Ange upp till tre spelresurser som du använder/har använt i din undervisning.

Vilka medier använder eleverna för spelandet i dina klassrum? Välj allt som gäller.

- [ ] Stationär dator
- [ ] Laptop
- [ ] Tablet
- [ ] Chromebook, Netbook
- [ ] Interaktiv Whiteboard
- [ ] Mobiltelefon
- [ ] TV-spelskonsol
- [ ] Bärbar spelkonsol
- [ ] Om annat, vänligen ange

När gör dina elever oftast uppgifter som innehåller digitala spel?

- ( ) Under lektionstid
- ( ) Utanför lektionstid
- ( ) Om annat, vänligen ange

Hur spelar eleverna oftast digitala spel i din undervisning?

- ( ) Själva, individuellt
- ( ) Med en annan klasskamrat
- ( ) I mindre grupper av 3–5 elever
- ( ) Hel klass, tillsammans
- ( ) Om annat, vänligen ange

Hur lång är en typisk spelsession under lektionstid?

- ○ Kortare tid, som en del av en lektion
- ○ En hel lektion
- ○ Flera lektioner
- ○ Om annat, vänligen ange

Vilka är dina största utmaningar, om några, gällande digitala spel i undervisningen? Välj allt som gäller.

- ☐ Tror inte på digitala spel som lärandeverktyg
- ☐ Inte säkert på hur jag integrerar spel i min undervisning
- ☐ Otillräcklig tid att spela digitala spel i undervisning
- ☐ Otillräckligt tid för förberedning
- ☐ Obekant med spelrelaterad teknologi
- ☐ Svårt att hitta spel som passar läroplanen
- ☐ Spelkostnader
- ☐ Brist på teknologiska resurser
- ☐ Inte säkert på var jag hittar kvalitetsspel
- ☐ Brist på stöd från skoladministrationen
- ☐ Brist på stöd från föräldrarna
- ☐ För mycket fokus på testresultat
- ☐ Oro för elevernas hälsa
- ☐ Det finns inga utmaningar
- ☐ Om annat, vänligen ange

Hur mycket har du spenderat/kommer du att spendera av skolans medel på digitala spel under läsåret 2018/2019?

- ○ 0 SEK
- ○ 1–500 SEK
- ○ 501–1000 SEK
- ○ Mer än 1000 SEK
- ○ Vet ej

Hur bedömer du elevernas prestation i/kring spelet? Välj allt som gäller.

- ☐ Jag vet vad eleverna har lärt sig genom att diskutera med hela klassen
- ☐ Jag tittar på elevernas samlade spelpoäng och bedömer deras kunskaper/färdigheter i ämnen som har bearbetats i andra format
- ☐ Jag använder de inbyggda bedömningssystemen som kommer med vissa spel
- ☐ Jag skapar test/frågor för att bedöma vad eleverna har lärt sig genom spelandet
- ☐ Jag bedömer inte elevernas prestation i/kring spel
- ☐ Om annat, vänligen ange

Vilka elever, om några, har haft mest nytta av din undervisning med digitala spel? Välj allt som gäller.

- ☐ Alla elever verkar ha samma nytta
- ☐ Inga elever verkar ha nytta
- ☐ Elever med emotionella/beteendemässiga störningar
- ☐ Elever med kognitiva svårigheter
- ☐ Elever med funktionsnedsättning
- ☐ Lågpresterande elever
- ☐ Genomsnittligt presterande elever
- ☐ Högpresterande elever
- ☐ Om annat, vänligen ange

Nu är det bara några frågor kvar. Tack för att du besvarar dem också. Din medverkan är mycket värdefullt för oss.

Baserat på dina praktiska erfarenheter med digitala spel, ange hur mycket du instämmer i följande påståenden.

Markera ett svar per rad.

	Instämmer helt	Instämmer	Obeslutsam	Instämmer inte	Instämmer inte alls	Gäl ej
Digitala spel är effektiva för att...						
lära ut läroplansbaserade ämneskunskaper till eleverna	○	○	○	○	○	○
bedöma elevernas ämneskunskaper	○	○	○	○	○	○
förbättra elevernas prestationer i utvärderingar	○	○	○	○	○	○
lära ut analysförmåga	○	○	○	○	○	○
lära ut kommunikativ förmåga	○	○	○	○	○	○
lära ut begreppslig förmåga	○	○	○	○	○	○
lära ut förmåga att hantera information	○	○	○	○	○	○
lära ut metakognitiv förmåga	○	○	○	○	○	○
höja mina elevers engagemang	○	○	○	○	○	○
höja mina elevers motivation	○	○	○	○	○	○

Redogör för dina elever som presterar under genomsnittet och deras användning av digitala spel i klassrummet. Vänligen ange hur mycket du instämmer i följande påståenden.
Markera ett svar per rad.

	Instämmer helt	Instämmer	Obeslutsam	Instämmer inte	Instämmer inte alls	Gäll ej
Digitala spel har förbättrat mina elevers ämneskunskaper.	○	○	○	○	○	○
Digitala spel har förbättrat mina elevers förmågor.	○	○	○	○	○	○
Användning av digitala spel uppmuntrar eleverna till högre närvaro.	○	○	○	○	○	○
För mycket digitalt spelande kan vara orsaken till att eleverna underpresterar.	○	○	○	○	○	○

Vart vänder du dig för att lära dig om att integrera digitala spel i din undervisning? Välj allt som gäller.

- ☐ Andra lärare i min skola eller område
- ☐ Diskussionsforum online för lärare
- ☐ Diskussionsforum online för gamers
- ☐ Spelspecifika grupper
- ☐ Webbaserade videoresurser
- ☐ Online-kurser
- ☐ Sociala nätverk
- ☐ Pedagogisk tidning
- ☐ Jag går ingenstans för professionellt lärande om digitala spel
- ☐ Om annat, vänligen ange

Vilken av de dessa professionella utvecklingsalternativ inom digitalt spelbaserat lärande skulle du vara intresserad av, om något? Välj allt som gäller.

- [ ] Workshops i min skola
- [ ] Kortare sommarkurs
- [ ] Online kurs på begäran
- [ ] Webbaserade videoresurser
- [ ] Diskussionsforum online om digitalt spelbaserat lärande
- [ ] Spelspecifik lärargrupp
- [ ] Diskussioner med mina kollegor
- [ ] Jag är inte intresserad
- [ ] Om annat, vänligen ange

Om du är intresserad av att delta i en uppföljningsstudie och/eller får information om resultatet, vänligen ange din emailadress. Markera svaret som gäller.

Ja, jag skulle vilja delta i en uppföljningsstudie.	☐
Ja, jag skulle vilja få information få information om resultatet från den här enkäten.	☐
Jag är inte intresserad.	☐

Vänligen ange din mejladress här.

Appendix 4 Games and gamification tools

Name of game/gamification resources as indicated by teachers	Number of mentions
Algodoo	1
Answergarden	1
Arcademica	1
Backpacker	1
Battlefield 1	1
Besiege	1
Bingel	7
Blood typing game	1
Blue bot	1
Bornholm	1
Bridge constructor	1
Chefren's pyramid	1
Cilivization	2
Classcraft	2
Code.org	2
Cogmed	1
CounterStrike	2
Digilär	1
Digitaliserade brädspel	1
DNA-the double helix	1
DOTA2	1
Dragonbox	1
EdQu Elev	1
Jeopardy (self-made)	1
Elevspel	7
Eslgames (jeopardy)	2
Ethics Games (not specified)	1
flykting	1
freerice.com	1

gamestolearnenglish.com	1
Glosor.eu/se	3
Gone Home	1
hejsvenska	1
Hopscotch	1
Hot potato	1
Ingress	1
Jackbox.tv	1
Jeopardy	1
Just dance	1
Kahoot	70
Khanacademy.ort	1
Kheops pyramid	1
King of math	1
Klimatkompassen	1
Legimus	1
Lexia	1
Light bot	1
League of Legends	2
Lyricstraining	3
Mangahigh	1
MatteMaraton	1
Mentometer	16
Minecraft	5
Mot alla odds (UNHCR)	1
Multiplikationsspel	1
Music game (developed by teachers)	1
namngeografi	1
Nationstates	1
nobelprize.org	1
Notebook Smart Lab	1
One more story	1
Padlet	2
PC building simulator	2
PetBingo	1
phet.colorado.edu	1
poio	1
Pokemon Go	1

Quizizz	4
Quizlet	18
Readtheory	2
Reality check	1
Rixdax	5
Runjakten	1
Scoolitys	1
Scratch	11
Seriestrips	1
Sim City	1
Simulatorer (traktorkörning)	1
Skolplus	4
Smart LAB	1
Snoddarna	1
Socrative	3
Spore	1
studi.se	4
Tenmonkeys	1
The minnits	1
The Stanley Parable	1
Typesy (ztype)	1
Vektor	4
Virtual Reality games (not specified)	1
Voto	1
We Become What We Behold	1
webbmagistern.se	1
Webenglish	1
wordwall.net	1
WWFs handla hållbart	1