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Educational Games in Practice: The challenges involved in conducting a game-based curriculum

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Abstract: The task of integrating games into an educational setting is a demanding one, and integrating games as a harmonious part of a bigger ecosystem of learning requires teachers to orchestrate a myriad of complex organizational resources. Historically, research on digital game-based learning has focused heavily on the coupling between game designs, previously established learning principles, student engagement, and learning outcomes much to the expense of understanding how games function in their intended educational contexts and how they impact the working processes of teachers. Given the significant investments of time and resources teachers need to make in order to conduct game-based learning activities, the foci of past research is problematic as it obfuscates some of the pressing realities that highly affect games' viability as tools for teaching and learning. This paper aims to highlight the demands that the implementation and use of an educational game in formal educational settings puts on teachers' working processes and skillsets. The paper is based on two case studies in which a researcher collaborated with K-12 teachers to use MinecraftEdu (TeacherGaming LLC, 2012) as a classroom activity over a five-month long period. By documenting both the working processes involved in implementing the game into the classroom environment, as well as the execution of the actual game-based classroom activities, the studies identified a wide variety roles that a teacher needs to take on if they are to make games a central part of a school curriculum. Ultimately, the paper highlights the importance of understanding the constraints under which teachers work, and argues that a better understanding of the contexts in which games are to be used, and the roles teachers play during game-based learning scenarios, is a necessary foundation for improving games' viability as educational tools.

Keywords: computers in classroom, distraction, gaming literacy, student diversity, teacher roles, challenges of game-based learning

1 Educational games and teachers

As the body of research that points out the potential educational value of games grows, the interest for including more game-based learning in educational processes has increased (Wastiau, Kearney & Van de Berghe, 2009). The discussions on the topic frequently highlight games' intrinsic educational value, such as their experiential nature or their ability to encourage players to master domains through scaffolding and *flow*-evoking designs. However, while games' educational values keep being lauded, examples of games being integrated into educational settings are relatively few (Egenfeldt-Nielsen, 2010; Linehan et al., 2011).
Previous research on the topic of educational games has heavily emphasized the game artefact and the player-game relationship when discussing the viability and efficacy of digital games as tools for learning (Young et al., 2012). From this epistemological perspective, games are often claimed to have high educational potential, and studies tend to show a positive correlation between gaming activities and learning (Backlund & Hendrix, 2013; Connolly et al., 2012). While conclusions drawn from those types of studies may say something about games' and e-solutions' ability to produce learning outcomes, they do not say much about their viability and usefulness as teaching tools in formal settings. As put by Noesgaard and Ørngreen (2015) "only using the fulfilment of pre-defined learning objectives as an effectiveness parameter does not allow developers and researchers to see unexpected and unintended changes in practice that occur as a result of the e-Learning program".

In the broader field of game research, games have increasingly been studied and described on their qualities as situated activities rather than artefacts in later years (e.g. Eklund, 2012; Stenros, 2015). A similar shift has started to emerge in educational games research, where the structures and components that surround the game artefact are starting to get more attention. For example, studies such as the ones conducted by Greener and Wakefield (2015) and Bourgonjon and Hanghøj (2011) focus more on understanding how organizational cultures and teachers' literacies needs to be supported if game-based learning and other e-Learning solutions are to be seen as accessible for all teachers and schools. Even though interest is increasing, and the current

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understanding of games' viability as teaching tools is becoming more nuanced, the knowledge surrounding the processes that are involved in implementing and using games in formal educational settings is still limited. Calls for more examinations of how e-Learning and games affect teachers' and students' processes of working and learning have been made frequently throughout the past decade (e.g. Kirriemuir & McFarlane, 2003; Ross, Morrison & Lowther, 2010; Young et al., 2012). However, examples of empirical work done to understand the practicalities involved in using educational games, such as the tasks teachers need to perform when integrating games into formal educational contexts, remain comparatively rare (Alklind Taylor & Backlund, 2012; Bourgonjon & Hanghøj, 2011; Chee, Mehrotra & Ong, 2014).

This paper aims to address that knowledge gap, and provide a pragmatic explanation of the lack of widespread game integration in the education sector; namely that games are laborious and resource intensive to use, and that there are few standards established to guide educators through the complex process of integrating games into their working environments. The paper specifically focuses on examining the roles that teachers need to take on when implementing and using computer games in their classroom activities. This is achieved through the execution of two case studies conducted during two five month long projects where the researchers collaborated with K-12 teachers to integrate a commercially available educational game intended for classroom use, *MinecraftEdu*, into their curriculum. It is important to highlight that the paper does not discuss the educational effectiveness of the used game. Instead it focuses on examining the tasks and roles that teachers need to take on when they include game-based activities as a fundamental part of a curriculum. This includes the more practical tasks that are necessary when teachers establish a "game-ready" classroom environment in which gaming activities can take place, but also the ones involved in supervising and guiding a class of students as they engage with a school subject through game play.

2 Method

This research employs case studies to examine the processes teachers need to go through when implementing and using digital educational games in their working environments. The primary methods used during the case studies conducted for this research have been participatory observation protocols, transcriptions of classroom gaming sessions, and interviews with teachers.

2.1 Case study designs

This paper takes the stance that examinations of games' actual usefulness and viability as educational tools requires empirical real-world studies on the actors that are to utilize them and the systems in which they are to be used. To that aim, this research employs case studies to examine the processes teachers need to go through when implementing and using digital educational games in their working environments. Case studies are, according to Yin (1984) "… preferred when studying contemporary events, but when the relevant behaviors cannot be manipulated." That is to say, case studies are potent when it comes to describing not fully fleshed out phenomena in their real-life context. Yin further points out organizations and processes, and the way interventions are implemented and impact them especially ripe targets for case study research (1984, p.19-25). It is primarily due to these traits of case studies that we deemed them appropriate to examine the complex, and in many ways little understood, processes that are involved in the implementation and use of games in formal educational settings. This section will provide the broad outline of the research context and the employed methodologies, but a more comprehensive account can also be found in (Berg Marklund, 2015).

The methods were employed during two five-month long instances of educational games use in a Swedish K-12 environment. During the case studies, one researcher collaborated with three different teachers, one teacher working with a class of 7th graders and two working with a class of 5th graders, throughout a game-based learning project. The projects entailed initial discussions of educational goals and how games related to them, acquiring game software and implementing it in the classroom environments, and orchestrating gaming sessions. The first projects meetings were conducted in November 2014 and concluded in March 2015, where the initial month was spent on preparatory discussions and hardware and software preparations, and the remainder was spent on conducting weekly classroom gaming activities. During each of these activities, the researcher kept a protocol of observations, and interviews as well as classroom gaming sessions were recorded and transcribed. After the game-based curricula had been concluded, follow-up interviews were held with the involved teachers to debrief and summarize their experiences.

The two different cases constitute two different types of classroom setups. The students in the 7th grade were all part of a national program that supplied them with one laptop per individual, whereas the 5th graders had a limited number of computers to share within their class. The classroom sessions were thus structured differently, as the older students had enough hardware to play games as a whole class (all 24 students could play simultaneously), and the younger students played in smaller groups (dividing 24 students into two groups of 12, that shared six computers). Figure 1 shows the different classroom setups.

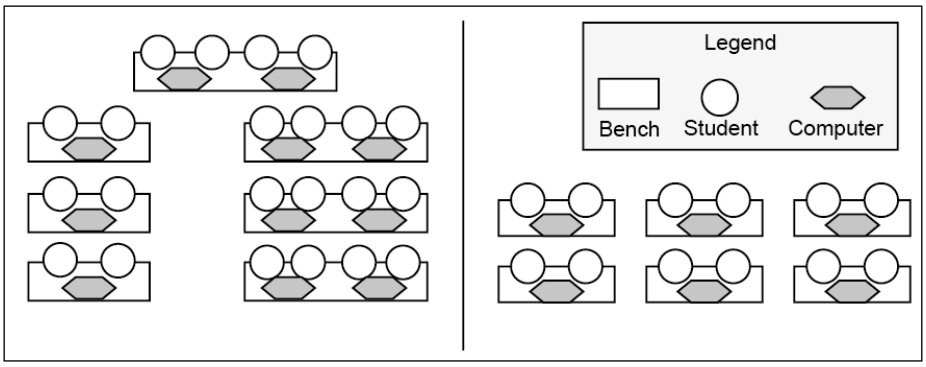

Figure 1: Though the 7th grade students (left) owned one laptop each, they were divided into groups of two and shared one laptop. The 5th grade students (right) worked in groups of two on communal laptops

The two different classes also worked within different subject matters, as the 7th grade class worked with mathematics and geometry, and the 5th grade class worked with medieval history. This informed the structure of the activities the two classes participated in. The purpose of the game-based learning activities with the 7th graders was to let them experiment with length, area, and volumetric scaling in a three-dimensional environment. For the 5th graders, the game-based activities revolved around the research, re-creation, and re-enactment of iconic structures and communities from a specific historical time period (the Middle Ages). As such, the mathematic gaming curriculum focused on heightening students' understanding of geometrical objects and calculations by letting them manipulate and construct those objects first-hand, and the historical curriculum focused on letting students experience and reflect on the taught subject matter through re-creation and re-enactment. Figure 2 shows a snapshot of how these lessons were manifested in the game environment.

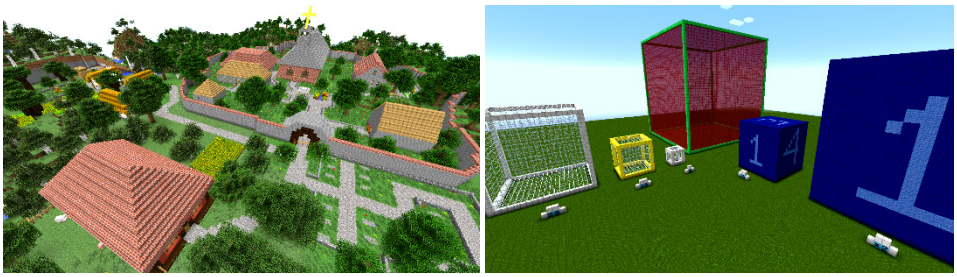

Figure 2: In the history curriculum (left), the students built iconic structures and rudimentary societies from the Medieval Ages (like a monastery and adjoining farms, as pictured). In the mathematics curriculum (right), the students calculated scale ratios, drew blueprints, and built simple geometric objects and scale models of real-world objects (like the large die on the right side).

The authors would like to emphasize the thoroughly collaborative nature of these game-based learning projects. The field researcher did not passively observe the projects as they unfolded, and played an important part in their execution at several junctures. However, this paper argues that the interventions made by the researcher are interventions that any teacher would need to make in order to integrate games into their classroom environment as well. All interventions were discussed with teachers before they were made, and the interventions served project goals established by the teachers. Since they are likely to be necessary steps in any game-based learning project, the tasks performed by the researcher will thus be analyzed as teacher tasks. The outcomes of the studies will be presented below, and examples of the different challenges the teachers and researcher faced, and the roles they needed to take on during the game-based learning projects, are coupled with excerpts from transcripts and observation protocols.

2.2 Data collection and analysis

During the study, a total of classroom sessions 17 game-based classroom exercises were executed; 8 with the 5th grade class, and 9 with the 7th grade class. All but the initial classroom activities were recorded through the use of three voice recorders placed throughout the classrooms. The most extensive data set for the studies were the transcriptions made from these recordings.

After a classroom exercise had been conducted and recorded, the audio was uploaded to software in which the three different recordings could be synchronized to allow for easier manipulation (e.g. muting tracks of the recordings to focus on specific discussions). To make the transcription process more manageable, a transcription protocol was established. According to the protocol, transcriptions were to begin with the first 10 minutes of exercises, and would be followed with subsequent transcriptions that were based on the 'points of interests' identified in the participant observation protocol.

The reasoning behind the simplification of the transcription process was that the first 10 minutes often contained the widest variety of activities throughout the classroom. During the first 10 minutes, the teachers and the researcher would make many different types of interventions to assist students in starting the game and in planning their execution of the exercise. Furthermore, the first few minutes would often contain most of the technical difficulties that the teachers would need to resolve. Finally, the general classroom atmosphere and tone of student collaborations would often be established within the first ten minutes as well, which was helpful for contextualizing discussions during the points of interest found in the observation protocols.
When the transcripts of all the exercises were completed, they were collated and subject to thematic analysis, according to guidelines provided in Braun and Clarke (2006). After the researchers had familiarized themselves with the transcribed data, discussions and student behaviors were coded into broader categories (e.g. excitement, frustration, subject matter discussion, game mechanic discussions, etc.). After a first round of coding, the data set was revisited, and the codes were collated into themes – which was ultimately used to choose excerpts that exemplified certain types of behaviors of relevance to the research question.

3 Results

In this section, the different roles that the teachers had to manage during two core 'phases' of the game-based learning projects will be presented. The first phase covers the process of integrating the game into the educational setting, and the second phase covers what the process of using the game as a classroom activity entails.

3.1 The conditions of formal education, and their impact on game-based learning processes

An essential step teachers need to take before embarking on any game-based learning project is to assess what they might be able to do given the conditions they are working under. Any formal educational environment consists of elements that can either facilitate or complicate game-based learning processes. In the initial stages of the two case studies, teachers and researchers discussed some of the conditions that were likely to complicate their work, as well as the resources and structures available in their environments that could be valuable assets.

3.1.1 Designing the game-based curriculum

One of the more pressing questions that an educator needs to ask in the initial stages of a game-based learning project is what kinds of gaming sessions their schedule and curriculum allows for. In the studied cases, the curriculum demands and the availability of hardware informed both the choice of game and the plans of how gaming sessions were to be scheduled and conducted. In the class of 7th graders, the abundance of laptops, short classroom periods (45-60 minutes), and the stricter demands and educational goals established in the curriculum made the teacher gravitate towards shorter stand-alone sessions. In the stand-alone session setup, students collaborated in groups of two or played individually on assignments with fixed starting- and end points, which allowed for easier assessments of students' progress. Viewing each classroom session as a stand-alone exercise also had the benefit of allowing for changes in the design of the game assignments according to the rate with which the students mastered both gameplay and details of the taught subject matter. The conditions were quite different in the 5th grade class where the period times were longer (90 minutes), the curriculum goals were less strict, but there was significantly less hardware available. For the

younger class, a more long-form collaborative classroom exercise was chosen. Figure 3 shows the basic differences in project structures between the two working processes.

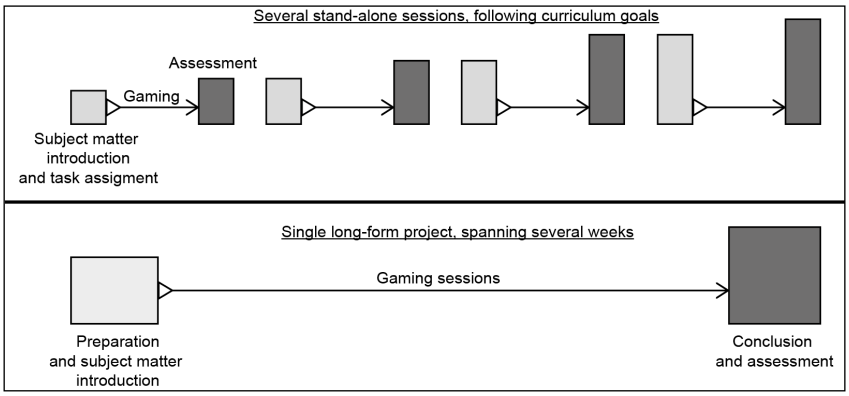

Figure 3: Overviews of the game-based learning projects. The long-form project spanned several weeks of gaming sessions, and more work was done before and after the project to contextualize game content in the subject matter. The stand-alone sessions were more beholden to curriculum demands, and was characterized by smaller assignments, progressively increasing challenge, and continuous assessments

The constraints imposed by curriculum demands and scheduling also play a deciding role when it comes to choosing the type of game to work with. In the studied cases, *MinecraftEdu* was chosen due to its modular nature and accessibility; the game's focus on emergent 'sand-box' play makes it possible for teachers to model gaming challenges after their own educational goals and working conditions (i.e. the game is easily customizable); it runs adequately even on older computers; and it is a title many students are familiar with, thus lowering the barrier to entry for many students. These benefits outweighed the potential drawbacks of the game, such as its low physical, functional, and visual fidelity. For example, it is difficult to create spherical objects in the game (due to its blocky nature), and objects sometimes have little visual resemblance to their real-world counterparts. However, while these types of drawbacks presented some challenges, they were not a major source of concern for the teachers.

3.1.2 Establishing the infrastructure to enable gaming sessions

When it came to integrating the game into the classrooms, the primary concerns for both cases were: the uncertainty of hardware reliability; the teachers' self-admitted low gaming- and technology literacy; and the limited amount of working hours they could feasibly spend on preparing for classroom gaming sessions. In the cases studied, the low game- and technology literacy of the teachers would make it highly unfeasible to start any type of game-based learning if it were not for a couple of ameliorating circumstances: the presence of the researcher, and the teachers' students themselves as both classes had several students who were very proficient with both computers and the used game. The process of game integration thus relied primarily on the researcher, and when the researcher was not present the teachers could get some assistance from the more technology proficient students in the classes.

Establishing an infrastructure that supports gaming involves taking inventory of the resources currently available in the environment and organization, procuring resources that are currently lacking, and making sure that the needed software and hardware is available and prepared for gaming sessions (these steps are outlined below, in Table 1). The details of this process are likely to differ between schools and classrooms since organizational support structures, technological infrastructures, and teachers' technology literacy is different for each individual case. However, comparing the statements from teachers and observations from this study to previous research indicates that these unfavourable conditions for game-based learning are not uncommon (Egenfeldt-Nielsen, 2008; Linehan et al., 2011; Wastiau, Kearney & Van de Berghe, 2009). Thus, establishing a solid infrastructure that allows for reliable and efficient gaming sessions is likely a task that is not specific to the cases studied here, and it is a task that should not be underestimated as it requires significant investments in resources and effort.

3.1.3 Administrative tasks during and around gaming sessions

An inescapable and integral part of using games for educational purposes is the continuous management of the tools that make gaming sessions possible. Computer games are complex pieces of software that require advanced hardware to function reliably and efficiently. Setting up and orchestrating these components in a classroom environment, even for rudimentary game-based learning activities, constitutes a significant time investment and requires a high level of technological proficiency.

Since the characteristics of the two studied cases differed in many ways, the administrative efforts needed to set up and conduct gaming sessions were different. However, while the specific details of the process differed between the cases, there are definite phases that both needed to go through: taking inventory of their current educational environment and processes, implementing the chosen game into their environment, and conducting maintenance between and during gaming sessions. Each of these phases consisted of several smaller activities. The necessity of performing the individual activities varied between cases as a result of the classroom setups and the availability of hardware, as shown in Table 1.

Table 1: A summary of the steps involved in the three different phases of integrating and using game technology into an educational environment. Some steps were not applicable to both cases (the X marks whether a step were necessary in the corresponding case)

	Activities	7th grade classroom	5th grade classroom
Inventory	Take inventory of available hardware/resources	●	●
	Evaluate student profiles		●
	Examine curriculum goals	●	●
	Examine game software	●	●
	Establish educational goals for the game-based project	●	●
	Pull in organisational support structures	●	●
Implementation	Prepare the technology infrastructure		●
	Purchase game licenses	●	●
	Installation of software	●	●
	Prepare the classroom environments		●
	Prepare the game environments		●
Maintenance	Maintenance	●	●
	Setting up game servers		●
	Preparing in-game subject matter content	●	
	Saving games and managing backups		●
	Tech-support during game sessions	●	●
	Closing down lessons		●
	Hardware maintenance		●
	Patching and software maintenance	●	●

To provide a few concrete examples of how steps differed between the two cases, the stand-alone exercise design chosen by the 7th grade teacher alleviated the need to prepare the game environments students played in. As the students in those classes also worked on their own computers, the classroom and hardware did not need any notable preparation before game exercises, nor was setting up servers or saving and keeping backups of game data necessary. However, due to the higher amount of computers, the process of installing the game software was longer, more intricate, and more prone to errors. As the stand-alone sessions followed a steady progression of challenges, the classes required preparations of in-game examples of different mathematical expressions in *Minecraft*. That was not necessary in the 5th grade class, since they worked on a long-form creative exercise where students mainly followed their own building plans.

3.2 Conducting classroom sessions

Once the foundation for game-based classroom activities have been built, the teachers can start becoming more focused on conducting said activities. During the case studies, it quickly became apparent that classroom gaming requires the teacher to be versatile as they both need to carry out the necessary preparations before gaming sessions, but also act as game administrators during them. In this section, some of the more common challenges that teachers faced in during the classroom exercises will be presented through the use of excerpts from researcher and teacher observations, as well as student discussions and behaviours, that encapsulate how these different challenges arose during the game-based exercises will be provided.

3.2.1 Managing the diverse preferences and proficiencies among students

The classes of students proved to be highly heterogeneous when it came to their gaming proficiencies and preferences, and these differences often caused problems when it came to students' collaborative behaviours. Tutoring novice students in how to play the game, as well as the proficient students in directing their gaming expertise towards solving assignments, was arguably the most time-consuming responsibility for the teachers during the game-based exercises.

The heterogeneity of a K-12 classroom as a gaming audience cannot be understated. Each individual student has their own levels of gaming literacy, gaming preferences, subject matter knowledge, motor skills, motivations to play and learn, socio-economical background, and general interests. In both of the studied cases, a large portion of the teachers' and researcher's classroom interventions consisted of helping students launch the game, and subsequently to understand the basic interface and concepts of *Minecraft*. As an example, in an observation protocol from a gaming session with the 7th grade class on the 22nd of January, the researcher described their role the following way: "*A lot of students (around a fourth of the class) still don't know how to start the game or how to play, how to interpret 'blocks' as units of measurement, how to choose and place blocks in the game interface, or even how to steer their avatar (the combination of WASD steering and mouse movement is difficult for many), I spend a lot of time running around and managing those issues*." In this example, some students had problems launching their game and navigating a game interface that some might consider self-evident. Building on this, the collection of transcript excerpts below show how severely students' grasp and approach to the game can vary in a single class during the same gaming session (translated from Swedish, all students are given pseudonyms to ensure anonymity):

Excerpts from a 7th grade exercise on February 27th

Beatrix:	[To researcher] You have to help me! I don't know where I need to go [to start the game]… is it this one?
Peter:	[To classmate] What program are you using? WorldLevel?
Wallace:	It's spelled "WorldEdit" (the name of a popular *Minecraft* modification). But you have to know… you have to write it into google.
Wallace:	You can check out tutorials on YouTube on how to install it.
Peter:	Alright, WorldEdit. Here it is.
[A few minutes later, Peter still did not manage to get the modification to work]	
Wallace:	Go back *mouse clicks*… Yeah, you need to put it in the 'Versions' folder if you want it to work. You need to put it in 'Versions'.
[Rose is building a cube in Minecraft, and is placing blocks down – she encounters some issues when she needs to erase blocks that she misplaced]	
Rose:	I'm getting pretty good at this!
Rose:	Wait, I forgot how to do this…
[…]	
Rose:	This is the SECOND time I'm playing Minecraft!

The heterogeneity of K-12 students can make classroom sessions difficult to design and monitor as the students who have never played a computer game before needs to be able to collaborate and communicate with students who are very proficient players. As the excerpt shows, students' proficiency in using technology and playing games can differ severely in a classroom. While some students are struggling with the basic interface, others are advanced enough to complain about hardware performance, or will start to modify the game in order to elevate their gameplay further since the basic game is not engaging enough.

As might be expected, the gap between individual students' gaming proficiency varied the most during the earlier game-based exercises. As the game-based curricula progressed, and novice students were tutored in the basics of the educational game's interface, the proficiency gap lessened, and a wider range of students were able to participate more effectively and autonomously in the exercises. The being said, the proficiency gap never shrunk to the degree where it didn't noticeable affect the way the students collaborated and played together, and game tutoring remained a time consuming task for the teachers even towards the very end of the curricula.

The proficiency gap would sometimes cause or exacerbate unproductive or exclusionary patterns of collaboration in the student cohorts. In the examples below, for example, proficient students were noticeably nonchalant or dismissive towards their less proficient classmates' wishes to engage with the game or the class assignment:

Excerpt from 7th grade exercise on February 27th:
[It is several minutes into the game-based exercise and the class has been given their geometry assignment for the day. Anne has been mostly quiet, while James is focusing intently on the game.
Anne: But like… this is boring as sh*t.
James: Not… not for me, because I know how I'm going to build. Check this out. [James then proceeds to invent a lava-based animal-murdering machine]

Excerpt from 7th grade exercise, 20th of February:
[Aaron and Sarah are working on an exercise where they are assigned to create up- and down-scaled versions of certain geometric shapes. Aaron is a proficient player, whereas Sarah plays at a low-to medium-level proficiency. I've noticed a lack of communication in the group, and Sarah looking disengaged with the task.]
Researcher: Are you building a cube each?
Sarah: No! I'm going around killing pigs.
Researcher: Alright, has something happened?
Sarah: Not really. First we started working on [my computer], but then he wanted to, um… do things his way.
Researcher: Oh, but this pink shape you have, is that one of your versions at least?
Sarah: Mhmmm. I worked on that one.
Researcher: So that's your Area-version?
Sarah: Yes, that was mine.
Aaron: Nooo, I need to get one that has Strike [Strike is an enhancement for weapons that increase their damage]

As such, the novice students' were not the only ones that required guidance during the game-based curricula, as more proficient players also frequently needed to be guided towards more productive collaborations with their classmates. Similar observations have been made by previous scholars as well. Frank (2012), for example, has shown that proficient players can become overly focused on self-actualization through mastery of game mechanics or achievement of game goals, to the exclusion of engaging with the subject matter that the game is intended to represent. Frank (2012) dubbed this type of behavior during game-based exercises as 'gamer mode', and state that it can be detrimental to collaboration as well as learning, as players start focusing on exploiting and manipulating game mechanics instead of focusing on the subject matter details that the game is intended to convey. A constructive and focused student-to-student discourse is reliant on the gaming activity remaining 'framed' as an educational activity that students partake in by playing with a reflexive and analytical mind-set. During both studied cases, student groups frequently became unfocused when the act of gameplay separated itself from the educational goals of the classroom sessions. After a classroom activity on the 20th of March, the 7th grade teacher reported that: "*Sometimes the game is more enticing than working and focusing on the assignment. For example, a friend might look for facts about the [subject matter topic], so meanwhile [the other student] can play around freely in the Minecraft world*." These behaviors emerged quite frequently in the transcripts as well:

Excerpt from a 7th grade gaming exercise on February 27th
[Anna and James are meant to be building a scale replica of a real-world object of their choosing inside of *Minecraft*. The exercise has been going on for nine minutes and James has been spending most of the time using TNT to blow up things in their *Minecraft* world, while Anna has been trying to get him to focus more on the assignment]
James: I'm going to do an awesome thing.
Silence, with lots of mouse-clicks in the background
Anna: Teacher! Can we get some help?
Pause, the teacher comes over
Anna: What do you mean by "Settle on a scale"? (She is referring to a part of the assignment, where the students need to decide what scale their model of the real-world object will be in)
Teacher: Have you decided how to scale the object you're building?
Anna: Yes.
Teacher: Have you decided how 'large' your blocks are [in Minecraft]?
Anna: … No.
[…]
Teacher: You need to decide the measurements of your blocks.
James: Oh, how large they're going to be?
[From this point, James joins the teacher and Anna in the discussion of the assignment, and they start planning how to conduct the exercise together.]

In situations such as these, the teacher's presence seemed to help reinforce the educational framing of the gaming activity. There are several other examples in the transcripts of the teacher being called upon to mediate these situations. In many of the examples, the teacher is utilized by some students as a 'technique' to get their more game-focused working partners to focus on the class assignment. These situations most frequently occurred in groupings where students with clear "gamer" personalities were matched with less

game-proficient students. As a final example of how these mismatches could affect students' collaborations, the below excerpt shows how students' opinions of game objects' appropriate use could differ:

Excerpt from a 5th grade classroom exercise on February 17th

[Felicia and Miley are building a storage room and Miley is stacking chests on top of each other to fill the room with storage compartments. Felicia is an inexperienced player while Miley is very adept with the game. Felicia is commenting on how illogical it is to stack chests on top of each other – realistically, it woul be impossible to open the lid of the bottom chest if another object sits right on top of it.]

Felicia: I don't think they had… um. Chests like that.
Pause
Felicia: I don't think they had the technology to do things like that.
Miley: Whaaat?
Felicia: I don't quite think that they had that technology – like, how are you going to open them?
Miley: *Unintelligible retort*
Felicia: *Laughs* … the one that's on the bottom?
Miley: *In a silly voice* Felicia you can build like that in *minecraaaaaaaft*.
Felicia: *Giggles* But if you put a thing down, super close to the other thing that can be opened. why... [Miley interrupts]
Miley: Oh come on, it- it- it- it's lagging!
Felicia: … can you open it? [Felicia finishes her sentence]
Miley: Like it- it- it double-clicks when you only click once…
Felicia: Shouldn't we also put in a monastery citizen? [Felicia keeps talking parallel to Miley]
Miley: … sometimes!

In this example, Miley and Felicia are of different opinions when it comes to how game objects should be used. Miley, the more proficient player, operates within the bounds of "game logic", which in this case clashes with the reality that they are assigned to represent. Felicia, the less proficient student, objects to the unrealistic use of the chests. This is swiftly followed up by Miley turning her focus to the performance of the hardware, while Felicia tries to keep the discussion focused on the assignment. In summary, the mismatches between students' gaming proficiencies gave rise to two challenges that teachers needed to be able to supervise and negotiate; the one of exclusionary and controlling student behaviours (i.e. a proficient player starts to exercise control over a situation and other players, thus limiting other players' ability to engage with the game content), and the one of students entering 'gamer mode'.

3.2.2 Contextualising game content in the taught subject matter

Miley's and Felicia's interactions also relate to a second challenge involved in conducting game-based classroom activities: encouraging students to keep the taught subject matter in mind when choosing how to interact with, and interpret, game content. One commonly recurring challenge the teacher tackled during gaming sessions was to bridge the gap between the game content and the details of the subject matter the game is intended to teach. By necessity, games often make compromises in physical-, task-, and functional fidelity (Liu, Macchiarella & Vincenzi, 2009). Games rely a lot on abstractions and representations, and players continuously interpret or 'translate' game objects and actions to real-world objects and actions – if the game action is very dissimilar to the real-world action, there is always a risk that things get lost in translation. If a game is not specifically designed to teach the details of the subject matter with a high level of authenticity and fidelity, the task falls on the teacher to draw connections between the game content and the subject matter (Alklind Taylor & Backlund, 2012).

To briefly summarise the difference between proficient and novice players when it came to interpretation, proficient players could think of game content (e.g. aesthetics and functionalities of game objects and different types of game mechanics) in figurative terms, whereas novice players tended to interpret them very literally. The proficient players' processes of interpreting game content were, for lack of a better word, 'fluid'. Depending on the situation and the context, game objects could simply be viewed according to all their immediate properties, with both their aesthetics and functionality treated as they were given in the game. They could also solely be interpreted according either exclusively based on their functionality or exclusively on their aesthetics. When working with complex themes and concepts (e.g. history, social sciences, ecology, biology, etc.) in games, students need to collectively 'pretend' that certain objects should be interpreted and used a certain way. For example, the students in the 5th grade class used "Spider Webs" as puffs of smoke due to their visual similarity to tiny white clouds, even though the mechanics of the object share no similarities to smoke. Conversely, students sometimes disregarded an object's visuals if the functionality it represented was in line with what they aimed to convey. For example, students relied on the "Chest" object as a universal

symbol for 'storage', and used it as such even when its visuals clashed with the setting. Some students are very adept at negotiating what qualities of objects they should 'see' and which ones they should disregard, but just as is the case with gaming proficiency – this skill varies radically between individual students.

Novice players often displayed less fluidity when it came to interpretation, which significantly limited the ways in which they chose to interact and engage with the game mechanics. If game objects did not accurately represent the looks and function of its real-world counterpart, novice students would have a difficult time using them at all – this often led to frustration and disappointment as the students felt like their tools of representing what they wanted to were very limited. The low-fidelity nature of *Minecraft*, both in terms of visuals and object functions, may have exacerbated these issues during these studies, and disconnects between game objects and the real-world objects they were meant to represent occurred rather frequently. The modes of interaction presented by the game are very rudimentary, and the objects the players interact with are also visually and functionally minimalistic. The below transcript excerpt contains a situation in which students have trouble seeing past small disconnects between game content and the subject matter:

Excerpts from 5th graders' exercises on February 3rd
[Louise and Julie, two novice players, have finished the foundation of their building (a sleeping cabin), and are looking for ways to decorate it further]
Louise: Maybe there should be bookshelves, then? That's…
Julie: Did they have those back then?
Louise: What?
Julie: Did they have those?
Julie: Yeeees. They had a tonne of bookshelves.
[… the students discuss placement for a few seconds, until they finally start placing bookshelves in the game world]
Louise: If it looks too colourful we'll remove it.
Julie: Should we put it on this side?
Pause, mouse-clicks are heard
Julie: Okay, so umm *laughs*… this is, like…
Louise: Looks a bit colourful.
Julie: Yeah.
Pause
Julie: Let's remove them.
Julie: Yeah.
[… the teacher comes over]
Teacher: Why did you remove [the bookshelf]?
Louise: Because it looks a bit weird.

In this example, the visual representation of bookshelves in the game (being slightly modern) clashes with the subject matter (medieval history). This can be viewed as an example of limited physical fidelity being troublesome to negotiate and challenging the collective act of 'pretending'. These issues were also sometimes quite persistent, and some students could have a really difficult time developing the gaming literacy needed to start treating game objects like representations or abstractions. Louise and Julie's issue with the bookshelves, for example, persisted across several game-based classroom exercises:

Excerpt from 5th grade exercise, 2nd of March
[Louise and Julie are revisiting the subject of bookshelves and decoration for their sleeping cabin]
Louise and Julie: *Unintelligible* but, nooo, what…
Louise: It's just so darn boring.
[The teacher hears the students and walks over from the other side of the room]
Teacher: What's boring, Louise?
Louise: Um, Umm. A little… *unintelligible*
Louise: Like, it's like *unintelligible* when we are trying to spruce it up a bit.
Teacher: Alright, how are you visualising it?
Louise: Like bookshelves, but they must be… they are just so darn big.

Even after having dealt with the issue of "sprucing up" the sleeping cabin they were building for a month, the students were still unable to get past the small incongruities that they saw between the game objects and the real-world objects they were meant to represent.

These examples from the 5th graders' gaming sessions, where they worked with recreations of historical buildings and societies, are but a few of many. As previously described, the simplistic nature of *Minecraft* objects' aesthetics and functionality meant that game content often failed to correspond well with the subject

matter details they were intended to represent. These clashes sometimes challenged the collective act of 'pretending', but could be negotiated among students or with the help of the teacher. The teacher's task in these situations is to maintain the established 'contract' that state that the fiction of the subject matter is to be maintained, even when the game itself does not enforce it in any way or even tempts students to break it. The below excerpt exemplifies that type of subject matter-centric behaviour, and how students could collaborate to maintain the authenticity of the subject matter they were recreating in the game:

Excerpt from a 5th grade classroom gaming exercise on February 24th

[During an exercise, Dan is working on a stable for a farmhouse near the group's monastery. A couple of other students, Peter and Adam, note that Dan is filling the stables up with horses]

Peter:	Dan, the horses were super expensive.
Teacher:	Expensive?
Dan:	Yeah…
Adam:	Yeah, and we have a whole bunch of horses.
Peter:	Don't you remember that, Dan?
Adam:	We have them in the stables too.
Peter:	They cost like 200 pigs or something like that.
Adam:	Or five cows.
Teacher:	Yes, they were really expensive.
Adam:	Yes, it was probably more common to have like three or four horses.

In this example, horses are functionally infinite and the students could easily place several dozens of them in their medieval monastery. But by discussing the subject matter, the students started imposing their own constraints based on their interpretation of how game objects corresponds to the subject matter. The above example occurred towards the end of the game-based curriculum, and it took several exercises for the teachers to cultivate the educational framing necessary for students to start collectively contextualizing the game objects in the taught subject matter on their own.

3.3 Summarizing remarks on conducting a game-based curriculum

At the end of the five-month game based curricula, concluding interviews were held with the involved teachers where the outcomes and their experiences of the projects were discussed. Although the interviews focused on many different aspects of the conducted game-based curricula, two key points were brought up by the teachers that well encapsulate the challenges that the teachers and researcher went through during their five-month long collaboration; the challenges involved in ensuring that game-based exercises remained focused on the taught subject matters, and the challenges of establishing and maintaining a sound technological infrastructure in which gaming sessions could be reliably conducted.

The 7th grade and 5th grade teachers all stated that they had experienced some difficulties when it came to making sure that the students participated in the game-based exercises with the taught subject matter in mind. Here, the teachers noted that there was a conflict between how the students were used to playing games at home, and how they were "supposed" to play it during classroom hours. Although this conflict could be difficult to manage, as evident by the numerous instances of students being distracted by game elements irrelevant to the taught subject matter found in transcripts and observation protocols, the researcher and the teachers had found some ways in which to alleviate its effects. One way was to make the classroom gaming experience as different from the students' own gaming habits as possible, for example by disabling some game features (e.g. the monsters in the game), or enabling others. In an interview held after their game-based curriculum had concluded, one of the 5th grade teachers noted that: "*I think, just as you have switched [some game components] off, there needs to be a focus on [the school subject]… Because, when they play on their own, a part of the whole thing, a part of the whole game is to survive, or avoid zombies coming to get you, or something else. But now we didn't have that, because now 'it was school', kind of. Because you need to feel that difference, that 'now the focus is on [school, and not the game]'*." In essence, clearly demarcating that the gaming sessions held in the classrooms were different from the ones students had at home was an important part in establishing an educational "framing" for the exercises. This was done both by ensuring that the game sessions and the game components were clearly contextualized within the broader curriculum goals, and by ensuring that the game itself was different from the one the students played at home.

The second important takeaway from the concluding interviews with teachers were their perspectives on how feasible the use of educational games was in their day-to-day work. The teachers all clearly stated that it

would not have been possible to conduct the game-based curricula without the support of the researchers. The teacher of the 7th grade class, for example, stated that the issue both related to technological aspects of game-based learning and his own ability to work with game environments, and implementing and using educational games were, even after the five-month long collaboration, seen as unattainable without outside support:

> **Excerpt from post-curriculum interview with 7th grade teacher:**
> Researcher: Now that we've concluded the curriculum. Does it feel as if… do you feel as though you could have conducted this work on your own?
> 7th grade teacher: No. No, I could not have sorted it out.
> […]
> Researcher: So do you feel as if you would be able to work with games now, after the project?
> 7th grade teacher: No. No. *Laughs* No no.

The teachers' overall experience was that games were too labor intensive, and too unreliable, to be made an integral part of their working processes. Without the extensive involvement of a third party (which in this case was the assisting researcher), the teachers would not have had the resources to be able to establish the technological infrastructure required to make gaming sessions possible. Without a solid foundation of well maintenance technology, games can quickly become unruly to use, and technical difficulties can quickly start piling up. Since classroom hours are finite and highly valuable, a teaching tool that requires a lot of preparation only to ensure that it functions reliably for each classroom session is rather risky, and planning an entire curriculum around it even more so.

4 Conclusion and discussion

By collaborating with teachers during a game-based learning project, this research revealed that teachers need to take on a wide variety of important roles when integrating and using games in their educational environment. The skill sets needed to perform the roles well were also found to be quite diverse as they involved technological know-how, gaming literacy, subject matter expertise, and naturally a strong pedagogical foundation.

At the outset of a game-based learning project, the teacher needs to be able to review the conditions of their educational environment. Organizational support structures, availability of hardware and software, and the availability of other resources or obstacles, need to be considered before the game-based learning curriculum is designed. Basic practicalities like class schedules, educational goals as stated by national curricula, and technological infrastructure all inform what type of game can (or should) be used, as well as the design of gaming sessions and assignments. These findings, in contrast to the ones made by Chee, Mehrotra and Ong (2014) whom suggests that "*the key challenges teachers face are not technology centric but practice centric*" (p. 313), identify technology availability and literacy as a major bottleneck and guiding factor in the integration of digital game-based learning in schools. A fundamental issue with game-based learning in formal education is that games, in their current state, are not particularly reliable as teaching tools. Establishing a technological infrastructure in which digital games can function reliably and efficiently, and conducting regular maintenance to ensure that they keep doing so for every classroom activity, requires large time and resource investments. The schools involved in the case studies presented in these papers were, comparatively speaking, fairly well structured in terms of available technology and organisational structures and resources – but even so, the use of the educational games were wholly dependent on the authors' involvement and support.

When actually conducting the classroom gaming sessions, the teachers need to take on an additional set of roles. During a typical gaming session, teachers need to act as game administrators, lecturers, game tutors, subject matter anchors, and authority figures that keep students in an educational mode of play. In a big classroom, it can be difficult for teachers with low gaming literacy to spot situations where novice students are struggling with the game interface, or when students are not working towards educational goals. However, being game literate does not necessarily entail game mastery, but rather that the teacher can understand gaming and game content in order to make use of it. As put by Bourgonjon and Hanghøj (2011), "*teachers don't necessarily need to become experts with every new medium, but at the very least need to know what is going on […] in order to participate"* (p. 71). Gaming literacy was thus not only important for monitoring gaming sessions, but also for the teacher to be able to plan and conduct contextualising activities surrounding their gaming sessions. For example, the 5th grade teachers introduced the students to the medieval history

concepts they were going to be working on in *Minecraft* long before the gaming sessions started. After the gaming project was over, the teachers also pulled aspects of the buildings and societies the students had created into other school-work. Although these surrounding exercises were not highlighted in this research, they played an important role in exploring more intricate details of the subject matters. Constructive learning situations arose occasionally during gameplay as well, but the surrounding exercises provided the necessary contextual knowledge that allowed such situations to occur. The gameplay itself did not have much intrinsic educational value, but when it was contextualized appropriately and executed purposefully, it played an interesting and valuable part of larger learning processes.

On the topic of gaming literacy, the conducted case studies also clearly showed that individual proclivities, skills, and preferences vary dramatically even among students who are of similar ages and backgrounds. This is an indicator that the notion of 'digital nativity' (Prensky, 2001), which is still treated as a truism by many practitioners and scholars in the field of game-based learning (e.g. Annetta, 2010; Malliarakis et al., 2015; Vanderhoven et al., 2015) despite being discredited by many researchers (c.f. Guthrie, 2014; Jones et al., 2010), is deeply flawed. The concept of digital natives is detrimental to the discourse of educational games, as it is a way of consolidating individuals with varying needs and backgrounds into a more easily managed monolithic entity, the description of which only applies to persons of very specific proclivities and favourable socioeconomic standing where technologies and games are easily available. Of the students observed during these studies, only a relatively small segment of students were able to navigate computers and the used educational game with high proficiency, and many students needed tutoring in some very basic tenets of computers and games to be able to participate in the exercises. Digital nativity sweeps the complex diversity of today's students under the rug, and developers who design games with digital natives in mind are at risk of producing educational products that may work well for the subset of students that have the characteristics of a 'digital native', but excludes the ones that do not.

The studies presented in this paper showed the many processes and tasks involved in creating and designing a game-based curriculum, as well as implementing and using educational game software in a classroom setting. Game-based learning places a lot of demands on teachers and requires them to take on many different roles, each of which requires a specific skillset. Integrating games into formal educational settings is a laborious and complex process, and as indicated by the teachers that participated in these studies it involves too heavy investments in resources and time to be considered a feasible part of their working processes. This is partly due to the fact that schools are not structured for game-based learning, but it is also due to games not being sufficiently accommodating for the needs of teachers or the many characteristics an educational context may have. For game-based learning to move forward, teachers need to have a better understanding of games and how to work with them, and game creators need to understand teachers' working conditions and know how to accommodate for the varying characteristics of formal educational settings with their products.

References

Alklind Taylor, A.-S. and Backlund, P. (2012) "Making the implicit explicit: Game-based training practices from an instructor perspective", *6th European Conference on Game Based Learning*, Cork, Ireland, pp 1-10.

Annetta, L.A. (2010) "The "I's" Have It: A Framework for Serious Educational Game Design", *Review of General Psychology*, Vol. 14, No. 2, pp 105-112.

Backlund, P. and Hendrix, M. (2013) "Educational Games - Are They Worth the Effort? A Literature Survey of the Effectiveness of Serious Games", *Games and Virtual Worlds for Serious Applications (VS-GAMES), 2013 5th International Conference on*, 11-13 Sept. 2013, pp 1-8.

Berg Marklund, B. (2015) "Unpacking Digital Game-Based Learning: The complexities of developing and using educational games", Doctoral thesis, University of Skövde, Skövde, Sweden.

Bourgonjon, J. and Hanghøj, T. (2011) "What does it mean to be a game literate teacher? Interviews with teachers who translate games into educational practice", *the 5th European Conference on Games-Based Learning*, Athens, Greece, October 20-21, 2011, pp 67–73.

Braun, V. and Clarke, V. (2006) "Using thematic analysis in psychology", *Qualitative Research in Psychology*, Vol. 3, No. 2, pp 77-101.

Chee, Y.S., Mehrotra, S. and Ong, J.C. (2014) "Facilitating dialog in the game-based learning classroom: Teacher challenges reconstructing professional identity", *Digital Culture & Education*, Vol. 6, No. 4, pp 298–316.

Connolly, T.M., Boyle, E.A., MacArthur, E., Hainey, T. and Boyle, J.M. (2012) "A systematic literature review of empirical evidence on computer games and serious games", *Computers & Education*, Vol. 59, No. 2, pp 661-686.

Egenfeldt-Nielsen, S. (2008) "Practical barriers in using educational computer games", in D. Drew (ed.), *Beyond Fun*, ETC Press, pp 20-26.

Egenfeldt-Nielsen, S. (2010) "The Challenges to Diffusion of Educational Computer Games", *the European Conference on Games Based Learning*, Copenhagen, Denmark.

Eklund, L. (2012) "The Sociality of Gaming: A mixed methods approach to understanding digital gaming as a social leisure activity", PhD dissertation thesis, Stockholm University.

Frank, A. (2012) "Gaming the Game: A Study of the Gamer Mode in Educational Wargaming", *Simulation & Gaming*, Vol. 43, No. 1, pp 118-132.

Greener, S. and Wakefield, C. (2015) "Developing confidence in the use of digital tools in teaching", *The Electronic Journal of e-Learning*, Vol. 13, No. 4, pp 260-267.

Guthrie, C.H. (2014) "Who Are We Teaching? The Learning Expectations of "Digital Tribes" in the Classroom", *International Journal of e-Education, e-Business, e-Management and e-Learning*, Vol. 4, No. 2.

Jones, C., Ramanau, R., Cross, S. and Healing, G. (2010) "Net generation or Digital Natives: Is there a distinct new generation entering university?", *Computers & Education*, Vol. 54, No. 3, pp 722-732.

Kirriemuir, J. and McFarlane, A. (2003) "Use of Computer and Video Games in the Classroom", *Level Up Conference*, Utrecht, Netherlands.

Linehan, C., Kirman, B., Lawson, S. and Chan, G. (2011) "Practical, appropriate, empirically-validated guidelines for designing educational games", *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, Vancouver, BC, Canada, pp 1979-1988.

Liu, D., Macchiarella, N.D. and Vincenzi, D.A. (2009) "Simulation Fidelity", in D.A. Vincenzi, J.A. Wise, M. Mouloua & P.A. Hancock (eds), *Human factors in simulation and training*, CRC Press, Boca Raton, pp 61-73.

Malliarakis, C., Tomos, F., Shabalina, O., Mozelius, P. and Balan, O.C. (2015) "How to Build an Ineffective Serious Game: Worst Practices in Serious Game Design", *The 9th European Conference on Games Based Learning*, Steinkjer, Norway, pp 338-345.

Noesgaard, S.S. and Ørngreen, R. (2015) "The Effectiveness of E‑Learning: An Explorative and Integrative Review of the Definitions, Methodologies and Factors that Promote e‑Learning Effectiveness", *The Electronic Journal of e-Learning*, Vol. 13, No. 4, pp 277-289.

Prensky, M. (2001) *Digital Game-Based Learning*, McGraw-Hill, New York, NY.

Ross, S.M., Morrison, G.R. and Lowther, D.L. (2010) "Educational Technology Research Past and Present: Balancing Rigor and Relevance to Impact School Learning", *Contemporary Educational Technology*, Vol. 1, No. 1, pp 17-35.

Stenros, J. (2015) "Playfulness, Play, and Games: A Constructionist Ludology Approach ", Doctoral thesis, University of Tampere, Tampere, Finland.

TeacherGaming LLC (2012) *MinecraftEdu [Video game]*, TeacherGaming LLC, New York, NY.

Vanderhoven, E., Willems, B., Van Hove, S., All, A. and Schellens, T. (2015) "How to Evaluate Educational Games: Lessons Learned From the Evaluation Study of Master F.I.N.D.", *The 9th European Conference on Games Based Learning*, Steinkjer, Norway, pp 548-553.

Wastiau, P., Kearney, C. and Van de Berghe, W. (2009) *How are digital games used in schools? Complete results of the study - Final report*, Brussels, Belgium.

Yin, R.K. (1984) *Case Study Research: Design and Methods*, Sage Publications, London.

Young, M.F., Slota, S., Cutter, A.B., Jalette, G., Mullin, G., Lai, B., Simeoni, Z., Tran, M. and Yukhymenko, M. (2012) "Our Princess Is in Another Castle: A Review of Trends in Serious Gaming for Education", *Review of Educational Research*, Vol. 82, No. 1, pp 61-89.