Digital game-based learning in secondary education

Huizenga, J.C.

Publication date
2017
Document Version
Other version
License
Other

[Link to publication](#)

Citation for published version (APA):
Huizenga, J. C. (2017). *Digital game-based learning in secondary education*. [Thesis, fully internal, Universiteit van Amsterdam].

CHAPTER 1

INTRODUCTION

Tell me and I forget,
Show me and I remember,
Involve me and I understand.
Ancient Chinese proverb
Confucius (551-479 BC)

In the 1970s, the first digital games emerged that were played by a public beyond that of computer scientists. Simple games such as the digital ping pong game called Pong and the game Breakout (where bricks are destroyed by bouncing a ball) reached mainstream. Nowadays, home gaming has become a popular pastime, the games have become more complex and interest has grown in developing the use of digital games for education (Kirriemuir & McFarlane, 2004). This interest in games is based on the observation that children become totally immersed in the games and can play them for hours. The children are enthusiastic and motivated to make progress. Secondary education teachers would like to see this enthusiasm in their students' learning because research shows that students' motivation to learn decreases when they transition from primary to secondary education (Peetsma & Van der Veen, 2015). Low motivation might also play an important role in student drop-out in secondary education (Fan & Wolters, 2012). One of the causes of low student motivation in schools is the incongruity between students' school environments and their personal worlds, in which peer interaction and the use of new media have a more central role compared to schools (Shaffer, 2008; Thoonen, Sleegers, Peetsma, & Oort, 2011; Van der Veen & Peetsma, 2009). The use of games in education might thus help to enhance students' motivation by making learning more enjoyable in a way that fits with students' personal worlds (cf. Charsky & Ressler, 2011; Gee, 2003; Klopfer, Osterweil, Groff, & Haas, 2009). Games have the potential to not only motivate students but also support student learning because they have been found to promote students' active learning (Gee, 2014; Shaffer, 2006; Wideman et al., 2007). Therefore, implementing games as a teaching method in secondary education could help to motivate students' learning in school by increasing their active involvement with the school content.

When I started my dissertation in 2007, expectations of the value of digital games for education were high, and many claims were expressed on the benefits of digital games for teaching and learning. While these claims indicated the possible benefit of using games in education, thorough research supporting these claims was often lacking (Mishra & Foster, 2007). This dissertation aims to contribute to the

growing body of research on digital game-based learning (DGBL) by providing insights into the benefits of DGBL on motivation and learning.

1.   DGBL AND THE SCOPE OF THIS THESIS

The aim of this dissertation is to contribute to insights in the benefits of DGBL. However, as we need to establish what constitutes a digital game, I first define digital games and then present a review of the existing literature on DGBL and its rise. Finally, I elaborate on the scope of this thesis and explain the choices I made in the focus on *motivation* and *learning*.

1.1 Definition of digital games

There are many definitions of games and discussions about the differences between games and simulations. A simulation is generally understood as a virtual world, model or system that simulates the real world, model or system, whereas in games elements such as fantasy and competition play a role. Based on Dempsey, Lucassen, Haynes, and Casey (1996) and Prensky (2007), I define games as follows: 'organized play, involving one or more players, with goals, constraints, rules, interaction, challenges, pay-offs and their consequences, and aspects of competition (with another player or oneself). A narrative, story or fantasy elements are involved and the game should provide enjoyment and pleasure'. While researchers agree on many elements of games, according to Van Eck and Dempsey (2002), competition is not always seen as an integral element of games. I consider a game digital if it is being played on a computer, game console or mobile device.

1.2   DGBL

I speak of DGBL when the goal of using a digital game is to promote learning. One of the first persons to use the word DGBL was Marc Prensky in his book, *Digital Game-Based Learning*, published in 2001. Prensky (2001) saw great potential in the use of digital games for student motivation and learning, and while there seems to be some scientific basis for his writing (e.g. research in the military), his references to quotations from individual persons outnumber those to empirical studies. This type of literature (anecdotal evidence, lacking descriptions of methods,) was omnipresent in the late 1990s and early 2000s. However, with the growing interest in DGBL, the amount of empirical studies examining this subject also grew, and many case studies were carried out, such as that by Barab and colleagues (Barab, Sadler, Heiselt, Hicky, & Zuiker, 2007), which showed that the multi-user virtual environment Quest Atlantis engaged students and supported the process of learning science content. Several researchers conducted a quasi-experimental study. For example, Annetta, Minogue, Holmes, and Cheng (2009) conducted a quasi-experimental study, which showed that students did not learn significantly more from reviewing genetics information by playing a genetics game than from reviewing the information using traditional instruction. However, the authors found that students playing the game

were significantly more engaged than those receiving the traditional instruction (Annetta et al., 2009). Recent reviews tend to confirm the potential of DGBL for learning and motivation (e.g. Clark, Tanner-Smith, & Killingsworth, 2016; Connolly, Boyle, MacArthur, Hainey, & Boyle, 2012; Wouters, Van Nimwegen, Van Oostendorp, & Van der Spek, 2013). For example, Wouters et al. (2013) confirmed their hypotheses that the serious games yield higher learning gains and a higher level of retention than conventional instructional methods. However, in contrast to what they expected, learners playing individually or in a group learn more than those in the conventional teaching group, and learners playing games in a group learn more than those playing individually. Additionally, although motivational appeal is mentioned as an important reason to use serious games, serious games were not found to be more motivating than conventional instructional methods. Wouters et al. (2013) raised the question whether the way motivation is measured, usually by questionnaires and surveys after gameplay, is a sensible method of measurement. Wouters et al. (2013) thus proposed measures, such as eye tracking and skin conductance, which can be used during game play.

Wouters et al. (2013) also researched several moderator variables and found that serious games are more effective when played in groups. They also mentioned that with an effect size of $d = 0.66$ "serious games are particularly effective in language" (Wouters et al., 2013, p.10). Games that used to be played behind a computer, can now be played on handheld devices (such as Nintendo) or other mobile devices (such as a smartphone). The context sensitivity of mobile devices (i.e. their capacity to gather data that is unique to the current time and location and may be either real or simulated) is one of the properties – according to Klopfer, Squire, and Jenkins (2002) – that makes mobile devices so well-suited to the support of learning activities. Four other properties that are assumed to make mobile devices particularly useful for educational purposes concern their portability; their social interactivity, because face-to-face interaction and the exchange of data between learners is made possible; their connectivity; and their individuality, because the support for different activities can be tailored to the needs of specific learners (see Klopfer et al., 2002). The properties of mobile games allow the incorporation of real world factors into a game. For example, mobile games that make use of the location where they are played, such as historical or geographical sites, are called mobile location-based games. Several researchers have conducted research into these kinds of games to show the their potential for learning, motivation and/or engagement (e.g. Squire & Jan, 2007; Squire & Klopfer, 2008; Rubino, Bharberis, Xhembulla, & Malnati, 2015). Ardito, Costabile, De Agneli, and Lanzilotti (2012) investigated an excursion game called Explore! in which archaeological parks were enriched with contextual sounds and mobile technology. Data were collected on gameplay strategies, engagement and learning. Regarding engagement and learning, the results showed that students were engaged and enjoyed the collaborative nature of the game, stating that they learned historical facts and notions related to life in Roman times. Students also answered significantly more test questions correctly after they were debriefed than before, showing the importance of a debriefing phase. Additionally, contextual sounds helped players to orient, navigate and understand the ancient functions of degraded places. However, the students explained that they often ignored 3D recon-

structions of places and objects because of time constraints; their first goal was to win, and the game stimulated their competitiveness.

Up to now, I have talked about DGBL by discussing the use of playing games in education, but there is also a growing amount of literature on creating games. Hayes and Games (2008) identified four main purposes of making games for learning:
1) to learn computer programming,
2) to interest girls in computer programming,
3) as a route to learning other academic domains, and
4) to understand design concepts.

Several studies have shown that having students create games can be beneficial for learning and motivation (e.g. Akcaoğlu, 2013; Greenhill, Pykett, & Rudd 2008; Robertson & Howells, 2008; Thomas, Xe, & Greene, 2011). Vos, Van der Meijden, and Denessen (2011) showed that creating games might be more beneficial than playing games. In their study comparing playing games with creating games, Vos et al. (2011) found that students constructing games had a higher intrinsic motivation (measured by Ryan and Deci's subscales competence, interest and effort, 2011) than students playing the game (on each subscale), and they scored higher on the use of deep learning strategies.

1.3   The use of games in education

Despite the apparent benefits of using games for teaching and learning, the application of games in education is not yet widespread. Horizon reports in 2009 and 2010 forecasted the time to adoption of using games in education in two to three years from the publication (Johnson, Levine, Smith, & Smythe, 2009; Johnson, Smith, Levine, & Haywood, 2010). However, in several studies, a minority of the teachers reported using games or an intention to use them in the near future (e.g. Bourgonjon et al., 2013; Proctor & Marks, 2013), but other studies report more positive figures. For example, Allsop, Yildirim, and Screpanti (2013) reported that 57% of Turkish teachers and 89% of teachers in the UK incorporate games into their classroom activities. Egenfeldt-Nielsen (2011) also found that 60% of the teachers they surveyed in Denmark, Finland, Norway, Portugal and the United States use computer games in their teaching (mostly in lower grades), while Wastiau, Kearney, and Van den Berghe (2009) found that 71% of the teachers they surveyed from 27 different European countries use games. However, according to Proctor and Marks (2013) and Sandford et al. (2006), the game adoption rate is slower in secondary education.

1.4   Scope of this thesis

The aim of this thesis is to contribute to research that is useful for the context of secondary education and focus on DGBL in formal educational settings. As DGBL research has indicated that the use of digital games has potential for learning and motivation, I focus on these concepts in this dissertation. Garris, Ahlers, and Driskell (2002) considered learning a multi-dimensional construct comprising three main learning outcomes.

1) Skill-based learning outcomes: the development of motor skills or technical skills.
2) Cognitive learning outcomes: knowledge of a fact and data required to perform a task, knowledge about how to perform a task and the ability to apply rules and strategies to general, distal or novel cases.
3) Affective learning outcomes: beliefs or attitudes regarding an object or activity.

Motivation can be seen as an affective learning outcome (Wouters, Van der Spek, & Van Oostendorp, 2009). However, because motivation is a broad, multifaceted term (see e.g. Fredricks, Blumenfeld, & Paris, 2004; Perry, Turner, & Meijer, 2006), when people refer to games being motivating, often it is not clear what kind of motivation is meant. In this dissertation, I examine two ways in which games can be seen as motivating:

1) Students being engaged in the game (enjoying it, having fun, not being distracted, wanting to play). In this dissertation, this type of motivation is called *engagement*.
2) Students having a positive attitude towards the game content or the school subject in which the game is used. In this dissertation, this type of motivation is referred to as *motivation for learning* or *motivation to learn*.

I therefore focus on engagement and motivation to learn.

2.   RESEARCH AIM AND QUESTIONS

This dissertation, which comprises five studies on DGBL, aims to gain insight into the benefits of DGBL. My main research question is 'How do digital games contribute to learning, engagement and motivation to learn?'

The main research question is divided into five sub-questions, each addressed by a specific study.

1) How does existing literature describe the effects of DGBL on students' engagement in the game, motivation for the subject and learning outcomes? (Study 1)
2) What are the motivational and learning effects of DGBL? (Study 2)
3) Do students' game activities explain the differences in students' motivation for learning, perceived learning outcomes and game performance? (Study 3)
4) How do teachers use game creation in their teaching practice, and does creating games affect students' classroom motivation and their perceived learning outcomes? (Study 4)
5) What are teachers' practice-based perceptions of the value of digital games with respect to students' engagement with the games, their motivation to learn and their cognitive learning outcomes? (Study 5)

3.   OUTLINE OF THE THESIS

The following chapters present each of the five studies on DGBL, and the final chapter discusses these studies and presents the conclusions.

Chapter Two presents the literature review. This systematic review provides an overview of the effects of DGBL learning outcomes and motivation. I analysed 92 studies and examined the claims made by authors regarding engagement in game-play, motivation for the content of the game and the school subject, and learning outcomes of games (factual knowledge and cognitive and metacognitive skills). The review aimed to ascertain whether the claims are substantiated and whether the re-ported effects were positive, negative or non-significant.

Chapter Three describes the results of the first field study (Study 1) on playing games in education to show the motivational and learning effects of DGBL. A quasi-experimental design was used to compare students playing the mobile history game Frequency 1550 with students receiving regular project-based lesson series. Of 458 students involved in this study, 232 were in the experimental group and 226 were in the control group. The study investigated whether the students in the experimental group had higher motivation for History and particularly the topic of the Middle Ages, as well as whether they had higher knowledge gains, compared to the students in the control group. Motivation and historical knowledge of Amsterdam was meas-ured using a questionnaire with a knowledge test and by observing whether the stu-dents were engaged when playing the game.

Chapter Four presents the results of the second field study (Study 2) on playing games in an educational setting, which in this case was a mobile city game about debt. The aim of this study was to investigate whether students' game activities could explain the differences among students' motivation to learn the subject of debt, their perceived learning outcomes and their team game performance. In total, 181 students took part in the study. Questionnaire data on motivation to learn and perceived learning outcomes were examined in relation to the student game activi-ties to establish whether a relationship exists with the outcomes on learning and mo-tivation.

Chapter Five presents the results of a third field study (Study 3), which required students to create games in an educational setting. Students created mobile games during 12–14 lessons. The aim of this study was to investigate how teachers use game creation in their teaching practice and whether creating games affects stu-dents' classroom motivation and their perceived learning outcomes. In total, 74 stu-dents and two teachers participated in this study. Questionnaire data were used to measure the students' perceived learning outcomes, motivation for learning and atti-tudes. Of the 74 students, 27 were also interviewed briefly about motivation and perceived learning. The two teachers were interviewed to establish why they worked with the game creation platform 7scenes and to find out their opinions about student learning and motivation.

Chapter Six reports the results of an interview study with teachers to investigate teachers' practice-based perceptions of the value of digital games. Forty-three teach-ers participated in the study, and data were collected through semi-structured inter-views. The analysis of results focused on what teachers said they saw in the class-room when students were working with games to elicit what teachers perceive as effects of digital games on engagement, motivation to learn, learning about the sub-ject and learning general skills.

Finally, Chapter Seven presents a summary of the findings of the studies followed by my reflections on the outcomes of the thesis. This chapter also includes a discussion of the strength and weaknesses of the methodology used, practical implications of the outcomes of this thesis and suggestions for future research.