



Acceptance of game-based learning by secondary school teachers

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ABSTRACT

The adoption and the effectiveness of game-based learning depend largely on the acceptance by classroom teachers, as they can be considered the true change agents of the schools. Therefore, we need to understand teachers' perceptions and beliefs that underlie their decision-making processes. The present study focuses on the factors that influence the acceptance of commercial video games as learning tools in the classroom. A model for describing the acceptance and predicting the uptake of commercial games by secondary school teachers is suggested. Based on data gathered from 505 teachers, the model is tested and evaluated. The results are then linked to previous research in the domains of technology acceptance and game-based learning.

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1. Introduction

Whilst the use of video games in education has been studied for several decades (Wu, Chiou, Kao, Hu, & Huang, 2012), academic interest in the topic only became widespread in the 2000s (Kebritchi & Hirumi, 2008). Based on the seminal work of – among others – Lepper and Malone (1987), Papert (1980), and Rieber (1996), new media and literacy scholars have linked video gaming to dominant learning theories and cognitive science (Garris, Ahlers, & Driskell, 2002; Gee, 2003). Since then, the relation between games and learning has been studied from different perspectives: focusing either on the informal learning that occurs during play (e.g. Steinkuehler, 2005; Williams, 2006) or on the integration of games in formal education. According to Van Eck (2006), the research on using games for formal learning centers on three different approaches: (a) using commercial games such as Civilization, The Sims or RollerCoaster Tycoon as learning tools (Egenfeldt-Nielsen, 2007; Miller & Hegelheimer, 2006; Sandford, Ulicsak, Facer, & Rudd, 2006; Squire, 2004), (b) integrating serious games, games for learning and multi-user virtual environments in the learning process (Barab, Thomas, Dodge, Carteaux, & Tuzun, 2005; Ke, 2008; Kebritchi, Hirumi, & Bai, 2008; Ketelhut & Schifter, 2011), and (c) designing games with the students in which the practice of designing serves as a learning process (Kafai, 1995; Robertson, 2012). As Van Eck (2006) identified the use of commercial games as the most suitable approach to digital game-based learning, the present study focuses on the practice of using commercial video games as learning tools in the classroom.

Positive claims have been made about the educational potential of and learning opportunities provided by commercial games, such as increased motivation, raised interest in specific subjects, multiple representations, open-ended approach to information, students in control of their own learning processes, and peer collaboration (for an extensive overview of these claims, see Egenfeldt-Nielsen, 2007, p. 84). However, despite this plethora of theoretical claims, research has been slow to provide hard empirical evidence (Hays, 2005; Papastergiou, 2009; Wrzesnien & Alcañiz Raya, 2010). A notable exception is the recently published meta-analysis by Connolly, Boyle, MacArthur, Hainey, and Boyle (2012). Based on a study of 129 papers, the authors found evidence for all learning and behavioral outcomes, including “knowledge acquisition, perceptual and cognitive, behavioral, affective, motivational, physiological and social outcomes, but with the exception of soft skills” (p. 671). Surprisingly, while they also found more papers addressing *commercial games in education* than *games for learning*, they considered it a challenge to identify empirical papers in which actual use of commercial games by in-service teachers was

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described. If it is true that entertainment video games offer promising opportunities for learning and teaching, an important question comes up: Why are commercial games still underutilized in practice?

Research has already partially answered this question, by showing that the adoption (Bakar, Inal, & Cagiltay, 2006; Din & Caleo, 2000) and the effectiveness (Baek, 2008; Egenfeldt-Nielsen, 2007) of game-based learning largely depend on the acceptance by classroom teachers. This is in line with findings in the broader field of information technology integration and implementation (Albirini, 2006; Ghaith & Yaghi, 1997; Kao & Tsai, 2009) in which the importance is shown of how teachers perceive and think about the educational use of new technologies (Usluel, Askar, & Bas, 2008). In fact, as the success of any technology integration project in schools is closely linked to teachers' perceived values, teachers can be considered the true change agents of the schools (Teo, 2008). Consequently, it has been suggested that we need to understand teachers' perceptions and beliefs that underlie their decision-making processes (Kriek & Stols, 2010).

This paper aims at contributing to the analytical understanding of teachers' decision-making processes. Its goal thereby is not so much to promote the use of commercial video games in education per se as to understand, explain and predict changes in teachers' behavior with regard to adopting these tools (see also Compeau, Higgins, & Huff, 1999). To attain those goals, a careful research design is set up. Firstly, previously validated scales are used to measure teachers' acceptance beliefs. Secondly, as there are many inconsistencies within the literature regarding teachers' acceptance of game-based learning, special attention is paid to the careful collection of data, in order to avoid any type of bias and to increase the generalizability of the results. Thirdly, a model-based approach to teachers' beliefs is presented and evaluated, based on the understanding that "teachers are faced with many variables that interact with each other to either facilitate or discourage the acceptance of technology" (Teo, 2009). Thus, this study contributes to an established body of research that has examined general reasons for playing video games (Ryan, Rigby, & Przybylski, 2006), the play behavior of teachers and teachers-in-training (Jones, Copeland, & Kalinowski, 2007; Kenny & McDaniel, 2011); and teachers' acceptance of educational computer games (Ketelhut & Schifter, 2011).

2. Literature study

2.1. Teachers' acceptance of technology

The issue of technology adoption has been tackled from a variety of disciplinary perspectives. There is a large body of research dedicated to the discrepancy between the advances in hardware and software capabilities and the relative lack of implementation (Venkatesh & Davis, 2000). Within this research tradition, the measurement of potential adopters' perceptions of innovations is common practice in order to assess uptake (Moore & Benbasat, 1991). This practice is now making its way in educational research as well, as concerns are raised about the "peripheral and minimal" uptake of computers in classrooms and the ineffective use of technology by teachers (Teo, 2009, p. 302).

Cuban (1986) pointed out that many top-down attempts to integrate technology in education have failed to impose a long-term effect on teaching and learning, in part because they ignored the perceptions of teachers. Albrini (2006) concurs, stating that technology implementation plans are focused too much on the technology aspect and its effect on students' achievement. This can be considered a flaw, because teachers are in many areas the true change agents of schools in terms of modes of education (e.g. Fullan, 2001; Teo, 2008; Usluel et al., 2008; Van Driel, Verloop, Van Werven, & Dekkers, 1997).

Recent studies have attempted to fill this gap by applying research models that originated in behavioral theory and information system research (Kiraz & Ozdemir, 2006). These models allow examining and predicting the actions of teachers. According to a recent meta-analysis on e-learning acceptance (Sumak, Hericko, & Pusnik, 2011), the most popular theory among these models is the technology acceptance model (TAM, Davis, 1989). This TAM model was developed based on the assumption that the acceptance of any technology can be predicted by (a) the perceived usefulness, and (b) the ease of use. In addition, it hypothesizes a direct relationship between these two user beliefs; according to TAM, people will consider a technology to be more useful when it is easier to operate. This can be related to the observation from educational research that teachers will not use a technology in the classroom, unless they understand how it will help their current practice by offering either administrative or teaching advantages (Hord, Rutherford, Huling-Austin, & Hall, 1987; Schifter, 2008).

The problem with TAM-research is that the findings have been rather inconsistent (Legris, Ingham, & Collette, 2003; Mathieson, Peacock, & Chin, 2001). Two explanations have been recurrent in the literature. Firstly, the effect sizes of the different paths in the model appear to vary depending on the types of users and the type of technology, especially in educational settings (Sumak et al., 2011). Not only were inconsistencies found between students and teachers, but the acceptance process is also different when studying educational technologies or more office-oriented tools (Sumak et al., 2011, p. 2076). Secondly, a major problem of the traditional technology acceptance model is its inability to account for individual, organizational, and contextual characteristics (McFarland & Hamilton, 2006; Mathieson, 1991).

In the context of game-based learning, Bourgonjon, Valcke, Soetaert, and Schellens (2010) have tried to overcome these problems when studying students' acceptance of game-based learning using TAM-hypotheses by including technology-, user-, and context-specific antecedents such as learning opportunities, experience, and gender to the model. By attributing these additional concepts, their video games acceptance model was able to explain 63% of the variance in students' preference for video games in the classroom. The goal of the present paper is similar, however, based on the earlier discussion about inconsistent findings in TAM-research, the relationships between factors and the effect sizes are expected to be quite different for teachers than for students. As there is a need for a grounded theoretical teacher-oriented model to describe and explain the adoption of digital game-based learning, it is therefore important to examine the available literature on teachers' acceptance of games first. This will provide evidence-based insight in the crucial factors affecting game-based learning acceptance.

2.2. Teachers' acceptance of video games

Over the last ten years, teachers' perceptions of the use of digital games in the classroom have been studied mainly in two ways. Firstly, in questionnaire research both the willingness of the teachers to try out games and the different factors contributing to the acceptance or refutation of game-based learning have been addressed (Baek, 2008; Becker & Jacobsen, 2005; Can & Cagiltay, 2006; Pastore & Falvo, 2010;

Schrader, Zheng, & Young, 2006). Often, these studies also elaborate on the gaming history of teachers. More specifically, they look at how familiar teachers are with games and if and to what extent experience with games affects their beliefs. Secondly, researchers have confronted teachers with different types of games in field studies, exploring what happens to their perceptions and attitudes about games in general and game-based learning in particular (Bakar et al., 2006; Barbour & Evans, 2009; Kennedy-Clark, 2011; Kenny & McDaniel, 2011; Ketelhut & Schifter, 2011). In this section, examples of both types of research are examined aiming to identify important factors that can enrich and contextualize a TAM-based model for studying teachers' acceptance of commercial games in the classroom.

2.2.1. Cross-sectional questionnaire studies

Becker and Jacobsen (2005) surveyed 109 Canadian K-12 teachers about the use of games and game-like systems in the classroom. The general goal of their research was to identify teachers who implement games and to explore whether a correlation exists between teachers' self-efficacy in dealing with new technologies and the use of games in the classroom. Surprisingly, the authors could not confirm the latter. They did find, however, that 37.5% of the teachers have had experience with playing games in their spare time (less than 5 h a week) and that an almost equally large group of teachers (36.7%) were willing to try out a commercial off-the-shelf game in their teaching practice. While these figures may appear quite high, the authors argue that they fall within the range that is to be expected in this age cohort based on previous research. Nevertheless, these results should be regarded with caution, as the study does not differentiate between teachers' intentions to use games as a reward system or as a pedagogical tool (Schrader et al., 2006), and because the results also show that at the same time 35.7% of the teachers are not willing to use commercial games in the classroom. Another important finding in the study by Becker and Jacobsen (2005) is that students and nearby colleagues are designated by teachers among the major facilitators for game-based learning together with the teachers themselves and professional development initiatives. Lack of time and technical issues on the other hand are perceived as the most important barriers to the use of games in education.

Schrader et al. (2006) performed a similar study in the United States, surveying a convenience sample of 203 undergraduate students in pre-service and credential programs in three different universities. With respect to gaming experience, the authors found that the majority of the teachers-in-training had played games (76.4%), most of them even playing on a weekly basis. But despite the considerable amount of time spent playing games, only 36% owns a contemporary gaming console, and nine out of ten reported not to belong to a gaming community. In addition, the teachers report having very little experience with educational games. Nevertheless, the teachers could see different qualities in each type of game, enlisting first-person shooter characteristics more often than cognitive skills such as problem-solving, clear rules, authenticity, and feedback to describe commercial games and vice versa for educational games. Furthermore, Schrader et al. (2006)'s research shows that experience with video games affects teachers' perceptions about games in culture and education.

In a Turkish context, Can and Cagiltay (2006) confronted prospective information technology teachers with positive and negative statements about "computer games with educational features". Given this conceptualization, which comprises both educational games and commercial games that could potentially have a positive effect on students' learning or development, it comes as no surprise that the majority of the teachers supported the idea that these games can exhibit cognitive and affective learning opportunities. More than 80% of the prospective teachers even expressed the intention to use games in their future practice, although mostly as additional learning material or as a reward, and less as a primary teaching tool. Can and Cagiltay (2006) also clarify that some of the participants are concerned about classroom management issues and the learning opportunities of the available games.

In his study involving 444 Korean teachers, Baek (2008) identified six barriers that hinder the uptake of computer and video games. These factors include the inflexibility of the curriculum, the perceived negative effects of gaming, unprepared students, the lack of supportive materials, fixed class schedules and limited budgets. Baek (2008) also found that both gender and teaching experience affect the type of limitations teachers consider when they think about using games in the classroom.

In a 2010 survey among American pre- and in-service teachers by Pastore and Falvo, the relatively broad support for the idea that games can enhance learning and motivate students was confirmed, as the authors found that about 50% of the teachers either had used or intended to use games in their practice. The research did not distinguish between different types of games. Both groups of teachers described games as fun, motivating and 'the future'. Indeed, the majority of the teachers were under the impression that the adoption rate of game-based learning will continue to speed up in the next couple of years. This belief was supported more broadly by in-service teachers than by pre-service teachers.

Proctor and Marks (2013) interviewed 259 teachers from the United States who won the Milken Educator Award between 1996 and 2009. The authors examined both primary and secondary school teachers' perceptions of the core TAM-factors, namely usefulness and ease of use. Their findings show that teachers believe games to be easy to implement and useful, even though the teachers scored higher mean values on ease of use than on usefulness scale. Proctor and Marks also noticed a trend in perception over time as educators who had won the Milken Educator Award in the later years (2005–2009) scored higher on both scales for usefulness and ease of use than the other educator year groups (1996–1999 and 2000–2004). No differences were found for subject areas, but for grade level subtle differences with regards to usefulness emerged as apparently K-5 educators perceived games as more useful for classroom use than 6–12 educators. In general, the best predictors for classroom game use were the level of access teachers had to computer games and their beliefs about the usefulness of implementing games.

2.2.2. Field studies

Bakar et al. (2006) confronted teachers-in-training with three types of commercial games in the teacher training programme: a puzzle game, a strategy game and a first person shooter. Their goal was to explore whether teachers could discover learning opportunities in each of these games. After a brief hands-on introduction, 49 student teachers were asked to write a report on how to use games in the classroom, on their preferred type of games for learning, on the opportunities and threats, and on the difference between single and multiplayer games. The results showed that teachers were very concerned with selecting the right games for the right classroom and curriculum context, even suggesting that inappropriate games might be counter-productive. While there were gender differences concerning the teacher preferences, in general the students preferred *The Incredible Machine* as a teaching tool. Apparently, the clear puzzle elements and lack of violence carry more weight than the pre-service teachers' beliefs that multiplayer games offer better learning opportunities than single player games.

In a comparable study performed by [Barbour and Evans \(2009\)](#), pre-service teachers were asked to play a video game in the social science classroom. The students had to keep a video game journal in which they discussed their gaming experiences and answered questions derived from game-based learning literature. Seven themes emerged from the journal data: game preference, educational value, learning and game play, the characteristics of both good and bad games, game components, and gender issues. Most importantly, the study showed that pre-service teachers were able to see the merits of commercial games for social studies, but also that they were uncertain whether and how they could use these advantages in their future practice.

[Kenny and McDaniel \(2011\)](#) had 58 undergraduate pre-service teachers play the Tiger Woods PGA Tour 07 golf game on either a Nintendo Wii or an Xbox 360. The pretest–posttest quasi-experimental research design allowed them to examine whether easier game mechanics could change the students' perceptions about games and their usefulness in education. From the pre-test it became clear that only a small minority played video games on a regular basis: in fact only 17% of the teachers appeared to be “very familiar” with video games. This lack of experience may explain why most of the pre-service teachers admitted that they consider video games as too complicated. After the test, however, they reported that the Wii version was more pleasurable, which indicates that ease of use did affect the students' perceptions of the game. Nevertheless, this did not have an impact on their beliefs about the relevance of games in general.

[Kennedy-Clark \(2011\)](#) studied the current knowledge of and attitudes about the use of multi-user virtual environments (MUVes) in secondary education inquiry learning among 28 pre-service teachers. Using the theory of planned behavior ([Ajzen, 1985](#)) as a guiding framework, [Kennedy-Clark \(2011\)](#) interviewed 28 teachers in order to map their knowledge of virtual worlds, their current behavior and attitudes toward using game-like environments in the classroom. Specifically, his analysis tried to elicit the behavioral beliefs (attitudes toward the outcome of game-based learning), normative beliefs (social norms and pressure to use games) and control beliefs (ease or difficulty to use games). [Kennedy-Clark \(2011\)](#) found that most pre-service teachers only had a basic understanding of what virtual worlds are. Nevertheless, the pre-service teachers held positive behavioral beliefs toward the educational value of virtual worlds. The most cited advantages were the ability to visualize, to motivate students and to place the learner back at the center of education. Despite the concerns that students can be distracted while playing, 71.4% of the pre-service teachers indicated that they intend to use the MUVe in the future.

[Ketelhut and Schifter \(2011\)](#) also analyzed responses to the use of the MUVe River City, but their study focused on in-service teachers in K-12 education. By mapping the teachers' acceptance of game-based learning based on two renowned acceptance theories ([Fullan, 2001](#); [Schifter, 2008](#)), the authors examined the explanatory power of both theories. In addition, they were attentive to different ways in which teachers could be supported throughout the project. Based on a qualitative analysis of their data, they found that [Fullan's \(2001\)](#) interactive factors for educational change, namely characteristics of the change, local characteristics and external factors, were able to explain the success and failure of the cases, but only to a limited extent. What is lacking from Fullan's theory are “more subtle issues of efficacy in using technology” ([Ketelhut & Schifter, 2011](#), p. 544), which relates in part to [Schifter's \(2008\)](#) model of technology integration. The authors conclude that teachers' perception of efficacy in using games is at the center of the adoption process, which points to the need for carefully designed and continuous teaching, technical and peer support for teachers.

2.2.3. Conclusion

A close reading of these studies presented reveals a number of key issues that affect teachers' acceptance of games as educational tools. Most importantly, the degree to which teachers consider video games to be relevant for their educational practice appears to be a crucial factor for change ([Bakar et al., 2006](#); [Barbour & Evans, 2009](#); [Can & Cagiltay, 2006](#); [Hord et al., 1987](#); [Proctor & Marks, 2013](#); [Schifter, 2008](#)). Thus, it could be argued that both usefulness and learning opportunities should be accounted for in a model that aims to describe and predict the uptake of commercial games by secondary school teachers. Such a model should also address teachers' concerns about the complexity in using games in the classroom, although its relation to the other factors remains unclear ([Kennedy-Clark, 2011](#); [Kenny & McDaniel, 2011](#); [Proctor & Marks, 2013](#)).

Another topic that emerged from the literature was the personal experience of teachers with games in their spare time ([Barbour & Evans, 2009](#); [Kenny & McDaniel, 2011](#); [Schrader et al., 2006](#)), which is closely linked to the discussion about whether teachers differ from other people in their age cohorts on the level of innovativeness. In addition, aspects in the social environments of the teachers should be considered as it was shown that students and colleagues could be considered facilitators for game-based learning ([Becker & Jacobsen, 2005](#); [Kennedy-Clark, 2011](#); [Pastore & Falvo, 2010](#)).

In the next section of this article, a TAM-based model for describing and explaining the uptake of commercial games by secondary school teachers will be proposed based on these findings. In order to consider the directions of the relations between the factors, both behavioral theory and information systems research are further explored.

3. Hypothetical model

3.1. Technology acceptance model (TAM)

In this study, acceptance of game-based learning is operationalized as teachers' behavioral intention to use video games. The reason is twofold. Firstly, rather than actual use, behavioral intention is selected as a dependent variable in most previously mentioned studies on teacher acceptance of technology. Secondly, a pre-test showed that game-based learning was still new to most teachers in Flanders (e.g., [De Backer, 2009](#)). From a pragmatic perspective, the selection of behavioral intention as the dependent variable is therefore an obvious choice ([Hu, Clark, & Ma, 2003](#)).

Moreover, it was decided to rephrase the concept of “ease of use”. In an exploratory study conducting focus groups with teachers about the use of games in education, it was observed that teachers speak about video games in terms of how difficult it would be to implement them, rather than in terms of ease of use ([Eloot, 2010](#)). Similarly, [Ketelhut and Schifter \(2011\)](#) also report that teachers in the River City project are often anxious to break the game or do something wrong. Therefore, in this study we opted to use the construct of complexity ([Rogers & Shoemaker, 1971](#); [Thompson, Higgins, & Howell, 1991](#)), rather than ease of use ([Davis, 1989](#)) to measure the concerns of the teachers regarding the difficulty of using games in their teaching practice. [Venkatesh, Morris, Davis, and Davis \(2003\)](#) have pointed out that there is a substantial similarity between both constructs. Whereas ease of use is defined as “the degree to which a person believes that using

a particular system would be free from effort” (Davis, 1989, p. 985), complexity can be considered as “the degree to which a system is perceived as relatively difficult to understand and use” (Rogers & Shoemaker, 1971, p. 154) or, in other words, “the opposite of ease of use” (Thompson et al., 1991, p. 129).

An important remark concerning the hypothesis that complexity/ease of use affects teachers’ behavioral intention, is that the meta-analysis of Sumak et al. (2011) could not trace any previously published articles in which this hypothesis was studied using professors/teachers as subjects (p. 2072).

Hyp. 1. Usefulness (U) positively relates to behavioral intention (BI).

Hyp. 2. Complexity (C) negatively relates to behavioral intention (BI).

Hyp. 3. Complexity (C) negatively relates to usefulness (U).

3.2. Additional hypotheses

3.2.1. Experience

An interesting concept that potentially affects teachers’ acceptance of game-based learning is experience. In the field of information systems research, Thompson et al. (1991) have shown that prior experience can potentially influence technology acceptance in three ways: (1) directly, (2) indirectly through attitude and belief components, and (3) by exerting a moderating influence on the relations between antecedent constructs and intention. These relations are found and confirmed in educational research where computer experience appears to be a valuable predictor of attitudes toward computers (van Braak, Tondeur, & Valcke, 2004; Potosky & Bobko, 2001; Rozell & Gardner, 1999).

Within the field of game-based learning, it is often claimed that teachers’ lack of video game experience is problematic as it supposedly creates a divide between the teachers and their tech-savvy students. In this respect, authors like Becker and Jacobsen (2005), Prensky (2001) argue that experience with playing games increases teachers’ willingness to use games in their classrooms. However, not all researchers agree that the relationship is necessarily positive (Schrader et al., 2006; Selfe & Hawisher, 2007). Authors have expressed their concerns that teachers’ personal experiences could affect their adoption decision negatively. For instance, teachers could use games inefficiently (e.g. use playing games as a reward), or not at all (e.g. because of the violence in the game play). In other words, the literature with regard to teachers is inconclusive. Bourgonjon, Valcke, Soetaert, De Wever, and Schellens (2011) found, however, that parents – a user group that shares a common goal with teachers – who play video games more often in their spare time, score higher on a video game acceptance scale. In order to provide more clarity about the impact of experience, this variable was included in our research model.

Hyp. 4. Video game experience (Experience) positively relates to usefulness (U).

Hyp. 5. Video game experience (Experience) positively relates to complexity (C).

Hyp. 6. Video game experience (Experience) positively relates to behavioral intention (BI).

3.2.2. Learning opportunities (LO)

The technology acceptance model has its origins in (research in) business and commercial settings where the objectives are different as compared to the goals in education (Hu et al., 2003; Teo, Lee, & Chai, 2008; Wolski & Jackson, 1999). Therefore, it can be argued that the original TAM variables do not fully reflect educators’ motives (Sánchez-Franco, Martínez-López, & Martín-Velicia, 2009). The concept of usefulness, for example, focuses on job performance, rather than the process of teaching. As Schifter (2008) has argued, technologies will only be used when teachers believe that it can help them reach curriculum goals. In this respect, Bourgonjon et al. (2010) introduced the construct of perceived learning opportunities (LO), which examines whether users share the belief expressed by experts that video games can indeed be considered operational translations of contemporary educational theories. This construct reflects teachers’ views on a number of advantages and benefits as identified in previous research (Egenfeldt-Nielsen, 2007; Kennedy-Clark, 2011). It can be hypothesized that teachers believe that video games are more useful for education when they are perceived as tools that offer learning opportunities (see also Bourgonjon et al., 2010).

In addition, it is to be expected that learning opportunities can be successfully predicted based on the experience teachers have with playing games. This is in line with the assumptions presented earlier (3.2.1. Experience; Thompson et al., 1991). Therefore, it can be hypothesized that experience will be positively associated with learning opportunities.

Hyp. 7. Video game experience (Experience) positively relates to learning opportunities (LO).

Hyp. 8. Learning opportunities (LO) positively relates to usefulness (U).

3.2.3. Personal innovativeness in the domain of information technology (PIIT)

According to Rogers (1995), the rate at which an innovation is adopted depends on the personality traits of the group members. To account for this in model-based innovation acceptance testing, Agarwal and Prasad (1998) developed and validated the construct of personal innovativeness in the domain of information technology (PIIT). It has been defined as “the willingness of an individual to try out any new information technology” (Agarwal & Prasad, 1998, p. 206) or as “a form of openness to change” (van Raaij & Schepers, 2008, p. 841). Previous research has shown that personal innovativeness in the domain of information technology is an important factor in technology acceptance, not just in general (Lewis, Agarwal, & Sambamurthy, 2003), but also for studying teachers’ acceptance of learning management systems (De Smet, Bourgonjon, De Wever, Schellens, & Valcke, 2011) and parents’ preference for using video games in their children’s classrooms (Bourgonjon et al., 2011). In addition to these general concerns, there are two main reasons to include innovativeness in a model for explaining the uptake of commercial video games in education. The first is the nature of video gaming as an activity constantly pushing

the boundaries of computer hardware (Jenkins, 2005). Under impulse of new technological developments, video games are constantly changing and evolving, making it hard to define and get a complete understanding of the medium. The second reason is related to this ever changing character of games. In order to stay informed about video gaming, teachers need to be willing and curious enough to try out new technologies.

Hyp. 9. Personal innovativeness in the domain of IT (PIIT) positively relates to video game experience (Experience).

Hyp. 10. Personal innovativeness in the domain of IT (PIIT) positively relates to usefulness (U).

Hyp. 11. Personal innovativeness in the domain of IT (PIIT) negatively relates to complexity (C).

3.2.4. Subjective norm (SN)

Davis' technology acceptance model (1989) is based on the theory of reasoned action (TRA, Fishbein & Ajzen, 1975). One of the concepts of TRA that was not incorporated into TAM was social influence. However, because of the empirical support and the inclusion of subjective norm in the TAM2 model, it was later accepted as a "core construct" (Sun & Zhang, 2006; Venkatesh et al., 2003), especially in the domain of education (Wolski & Jackson, 1999). As teachers exhibit close bonds with their colleagues, it is to be expected that they will turn to their peers for advice and suggestions regarding the usefulness when they are confronted with a new type of technology that could potentially serve as a new teaching tool (Hu et al., 2003; Triandis, 1971; Venkatesh & Davis, 2000).

In the context of game-based learning, evidence shows that subjective norm – the perceived social pressure to use games or not – is an important factor influencing teachers' beliefs. Firstly, in the study by Becker and Jacobsen (2005), teachers enlisted students and colleagues among the most helpful facilitators for game-based learning. Secondly, Kennedy-Clark (2011) indirectly questioned subjective norm as perceived by pre-service teachers. However, their study was unable to provide clarity on this issue, because pre-service teachers do not yet experience the social pressure that exists within a school environment.

Subjective norm can affect behavioral intention either directly through compliance with organizational demands, or indirectly through its effect on beliefs because of internalization (Sun & Zhang, 2006, p. 65). Given the voluntary character of game-based learning, it can therefore be expected that subjective norm will affect behavioral intention only indirectly through usefulness and learning opportunities.

Hyp. 12. Subjective norm (SN) positively relates to usefulness (U).

Hyp. 13. Subjective norm (SN) positively relates to learning opportunities (LO).

3.2.5. Critical mass (CRIT)

In adoption research, the concept of "critical mass" refers to the idea that the adoption rate of technology is often slow until a certain number of people have accepted and use the technology. This is the tipping point at which the adoption process accelerates (Mahler & Rogers, 1999; Rogers, 1995). Based on Metcalfe's law, which states that the value of a network is proportional to the square of the number of users that are connected (Hsu & Lu, 2004), it is believed that the value of a technology increases with the number of adopters (Mahler & Rogers, 1999). Consequently, critical mass has been studied in relation to the acceptance of groupware systems (Lou, Luo, & Strong, 2000), online games (Hsu & Lu, 2004), and mobile gaming (Kleijnen, 2004).

Digital game-based learning however is not necessarily a networked activity, so it could be hypothesized that critical mass affects teachers' belief structure in another manner. An often-heard argument in the digital game-based learning debate is that adoption in education is almost inevitable as today's students (and tomorrow's teachers) are growing up with video games (e.g., Becker & Jacobsen, 2005). It is believed that this generational divide will lead to educational reform as the new generation of students demands teaching strategies that are better adapted to their learning preferences (Oblinger & Oblinger, 2005; Prensky, 2001). Empirical research has shown that it is hard to support this type of generational thinking (Bennett, Maton, & Kervin, 2008) and/or the idea that all students desire video games in their classrooms (Bourgonjon et al., 2010). Therefore there is reason to assume that the popular belief of "critical mass" will affect teachers in their decision to use games in their classrooms.

Hyp. 14. Critical mass (CRIT) positively relates to video game experience (Experience).

Hyp. 15. Critical mass (CRIT) positively relates to learning opportunities (LO).

Hyp. 16. Critical mass (CRIT) positively relates to usefulness (U).

Hyp. 17. Critical mass (CRIT) positively relates to behavioral intention (BI).

3.2.6. Research model

Fig. 1 depicts the hypothetical model, comprising the interrelations between factors as discussed in the theoretical background.

4. Method

4.1. Research design and participants

In order to improve the (external) validity of this study, the focus is on teachers-in-practice. Secondary schools were contacted based on their denomination (i.e. community/subsidized public schools, and subsidized private schools), type of education (general, technical, and vocational) and geographical distribution. One contact person in each school – the IT administrator or principal – was visited personally to explain the two-fold purpose of the study (the data collection for this study happened in close collaboration with a project on the acceptance of learning management systems). Anonymity was assured. In turn, the contacts distributed both paper questionnaires and the link to an

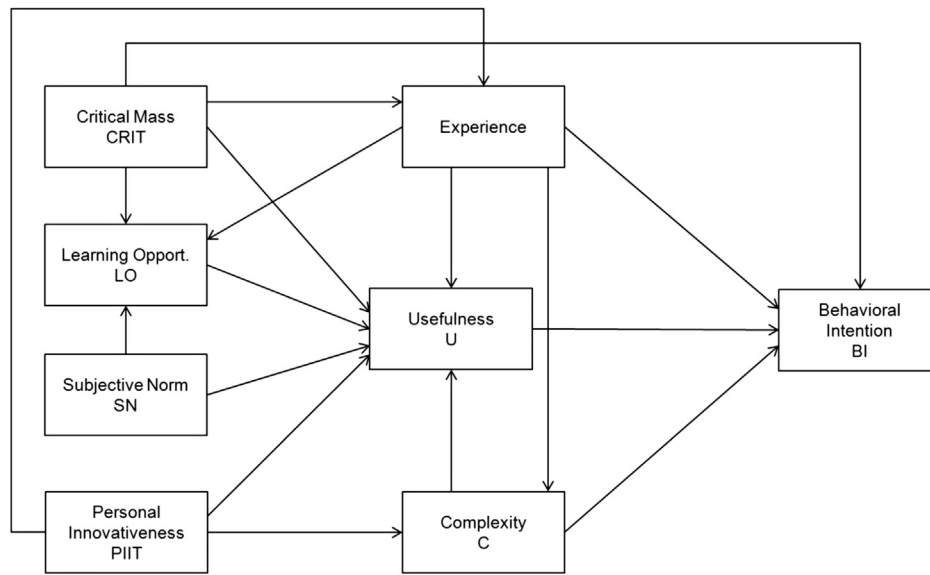


Fig. 1. Hypothetical model.

online version among the teaching staff of the school. The teachers could fill in the questionnaires using their medium of choice. This way, 505 teachers could be involved ($n_{\text{paper}} = 376$; $n_{\text{online}} = 129$). All entries were scanned for irregularities. Average teacher age was 40 (ranging from 22 to 61); 42.7% of the respondents was male, 57.3% was female. Independent sample *t*-tests showed no significant differences in answer patterns between both versions of the survey.

4.2. Instruments

The questionnaire consisted of three parts, examining demographic information, teacher related variables and the constructs of the research model. Demographic information included variables such as age and gender (0 female – 1 male). The teacher-related variables included teaching experience (years), grade, and subject. The latter two questions appeared to be problematic, as most teachers work in different grades, teaching a variety of subjects. Wherever possible, previously validated scales were used. To measure general experience with games and game learning opportunities, scales developed by Bourgonjon et al. (2010) were slightly adapted and included. Subjective norm and personal innovativeness in the domain of information technology were measured with the scales from Agarwal and Prasad (1998) and Fishbein & Ajzen (1975) respectively. Behavioral intention was measured with items from Venkatesh et al. (2003). For usefulness, complexity and critical mass, existing scales (Davis, 1989; Thompson et al., 1991) were adapted. Adaptations helped to reflect video game-based learning, the school context and the teacher profession, were based on remarks of teachers participating in focus group research (Elout, 2010). Secondly, the adaptation helped to ground the items in the teachers' vocabulary. By using adaptations of previously validated measures, we hope to validate and extend available research to new research contexts (see the suggestion of Venkatesh et al., 2003, p. 468). All scale items were rated on a five-point Likert scale (0 totally disagree – 5 totally agree). The scale focusing on teachers' beliefs regarding game-based learning was preceded by a one page explanation about "the use of commercial games in education". This incorporated two case studies (Civilization, RollerCoaster Tycoon) of games used in a classroom setting.

4.3. Instrument validation

To study the psychometric quality of the adapted survey instruments, we adopted a combined exploratory (EFA) and confirmatory factor analysis (CFA) approach.

4.3.1. Exploratory factor analysis

For the exploratory factor analysis, principal axis factoring with oblimin rotation was carried out to reconstruct the suggested eight factor structure. All criteria for factor analysis are met: the sample size is adequate, the Kaiser–Mayer–Olkin (KMO) measure of sphericity exceeds the threshold of 0.60 ($KMO = 0.907$), and the Bartlett's test of sphericity is significant at $p < .001$ level. In addition, the five factor structure explains 75.37% of the variance among the items – each item loading high on its own, and low on other factors (see Table 1).

4.3.2. Confirmatory factor analysis

Confirmatory factor analysis was performed with the open source package Lavaan for R (Rosseeel, 2011) to test the factor structure stability and internal consistency. Firstly, the fit measures for the measurement model were calculated to determine the stability of the factor structure. Error terms were not allowed to correlate. However, as the modification indices suggested a refinement of the model, correlation between the error terms for U4 and U5 was deemed acceptable. It was found that all fit measures meet the requirements for satisfactory fit (Byrne, 2001): $\chi^2/df = 2.16$; $RMSEA = 0.049$; $SRMR = 0.046$; $CFI = 0.95$; and $TLI = 0.95$. In addition, all items loaded significantly on the latent factors (ranging from 0.49 to 0.97). The low loadings of two items for critical mass were considered unproblematic

Table 1
Principal axis factoring – oblimin rotation ($N = 505$).

Item	Factor							
	1	2	3	4	5	6	7	8
LO4	0.87	-0.02	-0.02	0.02	-0.02	-0.06	0.01	0.10
LO3	0.86	0.04	-0.04	0.03	-0.01	-0.04	-0.03	-0.01
LO5	0.80	-0.09	0.00	0.02	-0.05	0.02	-0.01	0.05
LO2	0.72	-0.03	-0.02	-0.03	0.00	-0.01	-0.03	-0.09
LO7	0.70	0.10	0.10	-0.01	0.04	0.03	0.05	-0.05
LO1	0.69	0.02	-0.02	0.01	0.01	-0.08	0.00	-0.09
LO6	0.66	-0.03	-0.01	-0.04	-0.04	0.06	0.04	-0.10
EOU2	0.03	0.85	0.01	0.01	0.04	-0.05	-0.04	-0.02
EOU3	0.02	0.79	-0.10	-0.05	-0.03	0.02	0.02	0.01
EOU4	-0.02	0.78	0.09	0.07	-0.02	0.02	0.03	0.08
EOU1	-0.04	0.78	-0.09	-0.12	-0.02	0.02	-0.01	-0.08
Experience3	0.06	-0.02	0.90	0.00	0.01	-0.06	-0.01	0.03
Experience2	0.00	-0.04	0.85	0.02	-0.04	-0.04	0.09	0.00
Experience4	-0.04	0.01	0.81	0.02	0.00	-0.05	-0.05	-0.04
Experience1	0.06	-0.05	0.40	0.14	-0.07	0.08	0.36	0.03
PIIT2	0.02	-0.01	0.01	0.89	-0.01	0.00	-0.06	-0.02
PIIT4	0.01	-0.03	0.01	0.82	0.02	0.01	0.06	-0.01
PIIT1	-0.02	-0.03	-0.02	0.82	0.00	-0.01	0.06	0.00
PIIT3r	0.01	0.01	0.02	0.78	0.01	0.03	-0.06	-0.04
SN1	-0.01	0.01	-0.02	-0.02	-0.94	0.01	-0.01	-0.04
SN2	0.02	0.02	0.05	-0.01	-0.93	-0.01	-0.02	-0.02
BI3	0.04	-0.01	0.06	-0.02	-0.03	-0.85	0.04	-0.05
BI2	-0.01	0.00	0.06	0.00	-0.05	-0.83	0.06	-0.06
BI1	0.13	-0.02	0.07	-0.01	-0.03	-0.59	0.00	-0.15
CRIT2	-0.05	0.00	0.18	0.01	0.08	0.03	0.71	-0.09
CRIT4	0.03	-0.04	-0.06	0.03	-0.06	-0.12	0.57	0.04
CRIT3	0.01	0.01	-0.09	0.11	-0.02	-0.15	0.55	-0.01
CRIT1	0.03	0.01	0.06	-0.08	0.01	0.07	0.49	-0.05
U3	-0.02	-0.02	0.01	0.02	-0.09	0.05	0.01	-0.86
U4	0.05	0.00	0.00	0.04	0.02	-0.09	-0.01	-0.83
U1	0.04	-0.02	-0.03	0.02	0.00	0.02	0.05	-0.82
U2	0.03	-0.03	0.01	0.00	-0.05	-0.12	0.02	-0.77
U5	0.11	0.05	0.02	0.04	-0.03	-0.13	-0.01	-0.68

Note: LO = learning opportunities; C = complexity; BI = behavioral intention; U = usefulness. Factor loadings exceeding the threshold of 0.40 are highlighted in bold.

given the specific nature of this scale: teachers come into contact with video games through rather distinct peers (family members, colleagues...).

4.3.3. Reliability analysis

After both the EFA and CFA, the internal consistency of the scales was examined based on a reliability analysis on the entire dataset ($N = 505$). It was found that all scales demonstrate a high level of internal reliability, as all Chronbach's alpha coefficients exceed the common threshold of 0.70 (Hair, Anderson, Tatham, & Black, 1998): behavioral intention ($\alpha > 0.91$), experience ($\alpha > 0.84$), learning opportunities ($\alpha > 0.92$), usefulness ($\alpha > 0.94$), complexity ($\alpha > 0.88$), personal innovativeness in the domain of information technology ($\alpha > 0.90$), critical mass ($\alpha > 0.70$) and subjective norm ($\alpha > 0.95$).

Based on these findings, it was concluded that the instruments can be considered reliable and valid. The descriptive statistics can be consulted in Table 2.

5. Results

5.1. Correlations

As indicated in Table 3 – depicting the Pearson product-movement correlation coefficients – most research variables are positively related. A notable exception is complexity, which relates negatively to personal innovativeness ($r = -0.385$, $p < .01$), behavioral intention

Table 2
Descriptive statistics.

Construct	Mean (SD)
Behavioral intention	2.73 (1.07)
Experience	1.68 (0.84)
Learning opportunities	3.33 (0.76)
Complexity	2.93 (0.92)
Usefulness	2.48 (0.92)
Subjective norm	2.25 (0.89)
Personal innovativeness toward IT	3.03 (0.99)
Critical mass	2.32 (1.00)

Note. All scales range from 1 to 5.

Table 3
Pearson bivariate correlation coefficients.

		PIIT	BI	CRIT	Exp	LO	U	SN	C
PIIT	Personal innovativeness	1							
BI	Behavioral intention	0.189**	1						
CRIT	Critical mass	0.210**	0.386**	1					
Exp	Experience	0.362**	0.287**	0.492**	1				
LO	Learning opportunities	0.144**	0.558**	0.269**	0.209**	1			
U	Usefulness	0.195**	0.703**	0.331**	0.230**	0.714**	1		
SN	Social norm	0.028	0.449**	0.144**	0.106*	0.413**	0.539**	1	
C	Complexity	-0.385**	-0.100*	-0.126**	-0.243**	-0.110*	-0.084	0.053	1

Note. * $p < .05$ (2-tailed); ** $p < .01$.

($r = -0.100, p < .05$), critical mass ($r = -0.126, p < .01$), experience ($r = -0.243, p < .01$) and learning opportunities ($r = -0.110, p < .05$). While this negative relation was expected, considering the literature, the interrelations appear to be rather weak.

High interrelations were found among behavioral intention, learning opportunities and usefulness. Because the preceding factor analysis confirmed that these scales represent distinct constructs, it follows that a high score on usefulness is related to a high score on learning opportunities ($r = 0.714, p < .01$) and behavioral intention ($r = 0.703, p < .01$) and vice versa. The same remark can be made about the relationship between usefulness and social norm ($r = 0.539, p < .01$). When examining the significance levels of the correlation coefficients, it becomes clear that most of the research hypotheses can be confirmed. However, no relationship is found between complexity and usefulness ($r = -0.084, n.s.$). In addition, the strength of the interrelation between variables is not always as expected, as a number of hypotheses are only supported by low to moderate Pearson correlation coefficients (e.g. Hyp. 7, experience and learning opportunities, $r = 0.209, p < .01$; Hyp. 10, personal innovativeness and usefulness, $r = 0.144, p < .01$; Hyp. 15, critical norm and learning opportunities, $r = 0.269, p < .01$; Hyp. 16, critical norm and usefulness, $r = 0.331, p < .01$).

While these results provide preliminary insight into the relationships between the variables, bivariate correlation measures do not provide sufficient information to make final conclusions about the research hypotheses. Structural Equation Modeling is a more adequate approach to examine the interconnections between variables as elements of a complex research model.

5.2. Structural Equation Modeling

Structural Equation Modeling was conducted using the open source Lavaan library in R (Rosseel, 2011). Based on the analysis of the goodness-of-fit indices (Table 4), it was concluded that the data fit the hypothesized model reasonably well. The model is presented in Fig. 2, which includes the path coefficients and the percentage of explained variance for the dependent variables.

As expected based on the TAM theory, usefulness strongly affects behavioral intention (Hyp. 1, $\beta = 0.66, p < .01$). However, the effect of complexity on both behavioral intention (Hyp. 2, $\beta = 0.00, n.s.$) as well as usefulness (Hyp. 3, $\beta = 0.00, n.s.$) appeared to be statistically insignificant. In contrast, learning opportunities appears to predict usefulness well (Hyp. 8, $\beta = 0.58, p < .01$).

A remarkable finding is that experience does not affect usefulness (Hyp. 4, $\beta = 0.04, n.s.$), behavioral intention (Hyp. 6, $\beta = 0.06, n.s.$) and learning opportunities (Hyp. 7, $\beta = 0.02, n.s.$), and while it does influence complexity, the relation is rather weak (Hyp. 5, $\beta = -0.11, p < .05$).

All hypotheses concerning personal innovativeness could be confirmed. Firstly, it was found that personal innovativeness is a good predictor for experience (Hyp. 9, $\beta = 0.21, p < .01$). Secondly, it had a profound negative effect on complexity (Hyp. 11, $\beta = -0.42, p < .01$). Thirdly, although the relation between personal innovativeness and usefulness appeared to be rather weak (Hyp. 10, $\beta = 0.08$), it was found to be statistically significant ($p < .05$).

Stronger effects were found when examining the path coefficients from subjective norm on usefulness (Hyp. 12, $\beta = 0.30, p < .01$) and on learning opportunities (Hyp. 13, $\beta = 0.40, p < .01$). Critical mass emerges as a crucial variable in the model as well, as all hypotheses including critical mass were confirmed. Most notably, the effect of critical mass on experience is strong (Hyp. 14, $\beta = 0.51, p < .01$), but the other relations – on learning opportunities, usefulness and behavioral intention respectively – were also found to be statistically significant (Hyp. 15, $\beta = 0.23, p < .01$; Hyp. 16, $\beta = 0.16, p < .01$, Hyp. 17, $\beta = 0.16, p < .01$).

The model is able to explain 56.4% of the variance in teachers' behavioral intention to use commercial video games in the classroom.

An examination of the path coefficients shows that the share of both experience and complexity in the explanation of behavioral intention is low and statistically insignificant. This was to be expected, given the Pearson product-movement correlation coefficients. For matters of parsimony, the model was therefore adapted by removing all references to experience and complexity. The choice for eliminating both variables from the model is legitimized from an empirical perspective on the one hand, and because of the ongoing debate about the role of ease of use/complexity in educational settings on the other. Goodness-of-fit indices were calculated for the parsimonious model ($\chi^2/df = 2.15$; RMSEA = 0.049; SRMR = 0.041; CFI = 0.97; and TLI = 0.96) and compared to the previous findings. Given the increase to 57.1% of explained variance in behavioral intention, and the slight improvement of the fit indices (Table 5), the parsimonious model could be retained. This model can be consulted in Fig. 3.

Table 4
Fit indices for the full model based on the $N = 505$ sample (used $N = 480$).

	Chi ² (df)	CMIN/df	RMSEA	SRMR	CFI	TLI
Sample	1023.515(474)	2.16	0.049	0.050	0.953	0.948

Note. CMIN = Minimum function Chi²; df = degrees of freedom; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual; CFI = comparative fit index; TLI = Tucker-Lewis index.

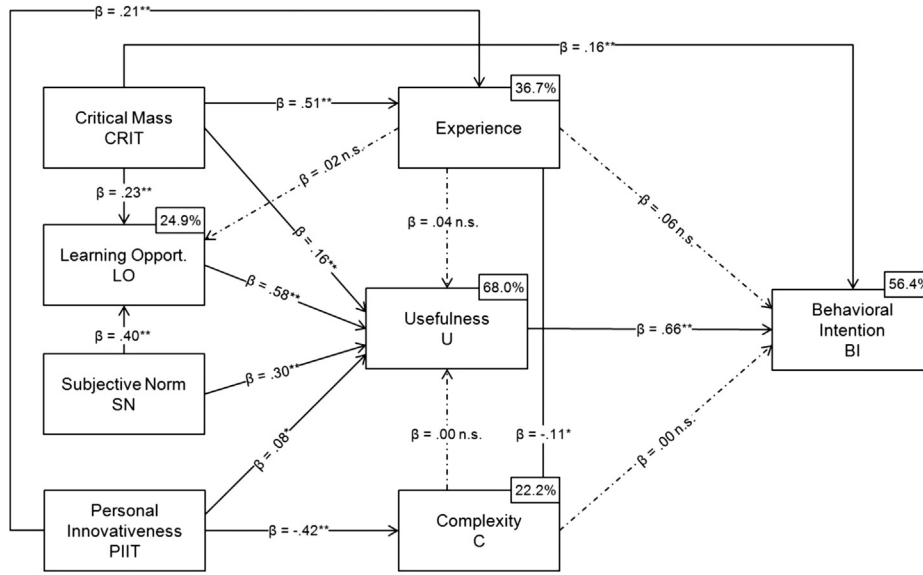


Fig. 2. Full model with path coefficients and percentage explained variance.

Table 5
Fit indices for the parsimonious model based on the N = 505 sample (used N = 480).

	Chi ² (df)	CMIN/df	RMSEA	SRMR	CFI	TLI
Sample	564.175(263)	2.15	0.049	0.041	0.967	0.962

Note. CMIN = Minimum function Chi²; df = degrees of freedom; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual; CFI = comparative fit index; TLI = Tucker-Lewis index.

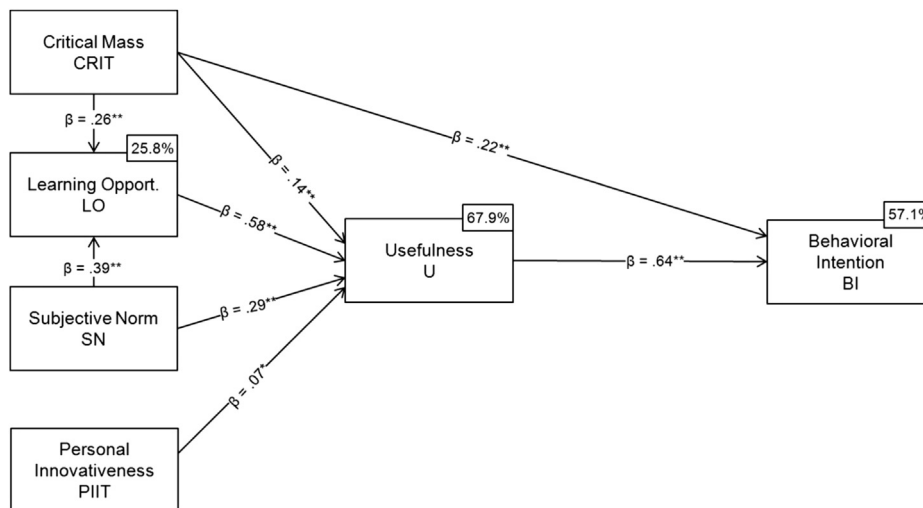


Fig. 3. Parsimonious model with path coefficients and percentage explained variance.

The parsimonious model includes two direct predictors for behavioral intention: usefulness ($\beta = 0.64, p < .01$) and critical mass ($\beta = 0.22, p < .01$). In addition, it provides a clear perspective on the different predictors for usefulness and learning opportunities. Firstly, learning opportunities strongly affects usefulness ($\beta = 0.58, p < .01$). Secondly, subjective norm and critical mass predict usefulness moderately ($\beta = 0.29, p < .01$ and $\beta = 0.14, p < .01$ respectively). Thirdly, personal innovativeness has a weak but significant effect on usefulness ($\beta = 0.07, p < .05$). Finally, learning opportunities is predicted well by both critical mass ($\beta = 0.26, p < .01$) and subjective norm ($\beta = 0.39, p < .01$).

6. Discussion and conclusion

6.1. Descriptive statistics

The descriptive statistics show that the teachers in this study hardly have any experience with video games ($M = 1.68, SD = 0.84$), which is similar to earlier findings about teachers (Kenny & McDaniel, 2011; Sandford et al., 2006) and adults (cf. parents, see Bourgonjon et al.,

2011). The latter contradicts “anecdotal” beliefs that significantly fewer teachers play video games as compared to adults in general (Becker & Jacobsen, 2005; Shaffer, Squire, & Gee, 2005).

Concerning the merits of video gaming, teachers’ beliefs are rather complex. On the one hand, teachers are not really convinced that video games are very useful for enhancing their job performance ($M = 2.48$, $SD = 0.92$). On the other hand, they believe that video games provide opportunities for learning ($M = 3.33$, $SD = 0.76$) in a similar way that teachers perceive the merits of ICT in the classroom (Balanskat, Blamire, & Kefala, 2006; Kennedy-Clark, 2011). In other words, while the majority of the teachers under study do not perceive commercial video games as a waste of time, as was found in earlier research (Becker, 2001; Virvou, Katsionis, & Manos, 2005), they do not perceive video games as tools that can help them improve their job performance. Moreover, apparently, neither do their significant others, as the mean score for subjective norm is below average ($M = 2.25$; $SD = 0.89$).

Also surprisingly, a relatively low score was found concerning the complexity of using games in the classroom ($M = 2.93$, $SD = 0.92$). According to Kenny and McDaniel (2011), a potential explanation is that teachers’ frame of reference is limited to games like Pacman and Tetris, which are not as complex as some of contemporary commercial video games. Another explanation is that teachers were thinking about specific strongly marketed console (games), such as those for Nintendo Wii. It has been shown that these types of consoles have the potential for reducing or increasing the perceived complexity of games (Kenny & McDaniel, 2011).

Based on the examination of the descriptive statistics, it also appears that on average teachers do not intend to use video games in the near future ($M = 2.73$, $SD = 1.07$). This is comparable to what Sandford et al. (2006) found in the United Kingdom. However, it is much lower than what the pre-service teachers reported in the Kennedy-Clark (2011) study. Of course, (the choice of) the type of games in both studies (commercial games versus game-like environments) will have contributed to this difference. In Kennedy-Clark’s (2011) research, pre-service teachers were asked about their willingness to use MUVes in their classrooms. Given that the content of MUVes is more closely aligned with curricular goals, it is to be expected that teachers are more willing to try out MUVes than commercial-off-the-shelf games – for which curriculum alignment requires more effort from the teacher.

In order to explain the variance in behavioral intention and to clarify the interrelation between variables, model tests are performed in a next step.

6.2. Model testing

The SEM-test results indicate that the model for studying video game acceptance by teachers fits the data well. A similar model was used at an earlier stage to study educational video game acceptance by students (see Bourgonjon et al., 2010). It is not surprising that the study of the model involving teachers shows different results. In particular, not all hypotheses could be confirmed. While usefulness emerges as the strongest predictor for teachers’ behavioral intention to use video games in the classroom, complexity did not yield a significant effect on behavioral intention. This not only contradicts the traditional TAM (Davis, 1989) hypotheses, but also the widespread idea that complexity is one of the main adoption barriers.

Furthermore, it appears that complexity and also experience with playing commercial video games are weak predictors for behavioral intention, both directly and indirectly through the other antecedents. This is remarkable as Becker and Jacobsen (2005) assumed it to be reasonable that an increase of teachers’ willingness to play games would have an effect on the integration in the classroom. It also contradicts the findings of Fortugno and Zimmerman (2005) and Kenny and McDaniel (2011) that familiarity with video games is an important factor in relation to the perceived usefulness for classroom use. The incongruence between this study and the available literature on video game acceptance could potentially be attributed to the current adoption phase of digital game-based learning. The descriptive statistics show that teachers are inexperienced with regard to video gaming. Therefore, it is reasonable to assume that their choices regarding complexity and adoption are more strongly tied to what they themselves and their significant others think about the usefulness of game-based learning.

Indeed, social influences play an important part in the acceptance of game-based learning. This can be explained by teachers’ lack of familiarity with this type of educational tool, as this article deals with initial acceptance (Hu et al., 2003). In previous research into the acceptance of online gaming, Hsu and Lu (2004) found that social norms affected behavioral intention directly whereas critical mass only had an indirect effect through attitude. In this study, the importance of social factors is underscored to an even larger extent in that subjective norm and critical mass affect teachers’ perceived learning opportunities as well as usefulness. Hence it is important for future research to focus on these social influences in order to improve our understanding of game-based learning acceptance. Both the insignificance of the effect from complexity and the profoundness of the effect from usefulness on behavioral intention support the idea that implementation strategies in this adoption phase should not so much focus on developing ready-to-use lesson preparations as on how teachers perceive the merits of video gaming for education and job performance.

In the present study, the theoretical model is able to explain 57% of the variance in teachers’ behavioral intention to use commercial video games in class. However, it could be argued that the potential of video games should be found in transforming school practices, rather than in supporting established – and sometimes ineffective – “patterns of behavior” (Gee, 2011; Schön, 1983). While curriculum-related issues could be important in relation to teacher acceptance, they are possibly counter-productive in that they support teachers’ “conservative bias” (Papert, 1980).

6.3. Implications for research

The purpose of this study was to understand the perceptions and beliefs that underlie teachers’ initial acceptance of video game-based learning. By specifically focusing on the use of commercial video games as learning tools in secondary school, this paper depicts a more detailed picture of teachers’ initial acceptance than previous papers making more general claims about game-based learning. In addition, because of the careful sampling approach, this study presents a refined view on the general uptake of video games in education. Based on the descriptive statistics it is apparent that few teachers have used games in their teaching practice. The low adoption rate is in stark contrast with some of the figures raised in other studies (Sandford et al., 2006; Wastiau, Kearney & Van den Berghe, 2009). This could point to regional differences. Another possible explanation is that educational games researchers’ perspective is biased, because of their more

frequent contact with teachers who are participating in projects involving game-based learning. Either way, this study shows that figures regarding the use of games in education should be treated with caution.

This paper also contributes to a body of research that examines the use of the technology acceptance model to explain technology adoption in educational settings (Teo, 2011). Most notably, this study found that complexity, which was operationalized as the opposite of ease of use, did not explain behavioral intention very well. This contradicts traditional TAM hypotheses that stress the central role of ease of use in technology acceptance. While it could be that the respondents' answers suffered from social desirability bias (having to admit that a certain task is complex yields less social approval than stating that something is easy for you), it is remarkable that a recent meta-study on the use of TAM in education reported a lack of papers that examined the relationship between ease of use and behavioral intention specifically with regard to teachers' and professors' beliefs toward information technology in education (Sumak et al., 2011). This could be a symptom of a publication bias. More research is required to explore the precise role of ease of use within an educational context.

By differentiating between usefulness and learning opportunities, this paper further refines our understanding of the concept of usefulness within an educational context. Unlike many employees in a professional setting, most teachers do not strive toward personal effectiveness, but rather take on the role of a facilitator who stimulates students to reach their personal, but also externally determined learning goals. This double concern shared by all teachers is something that deserves further attention in educational research.

In addition, this study underlines the importance of social influences (both subjective norm and critical mass) on initial acceptance of games by secondary school teachers. This is congruent with alternative adoption theories such as the Theory of Reasoned Action (Fishbein and Ajzen (1975)), as well as with earlier findings within related games research (Hsu & Lu, 2004).

6.4. Implications for practice

The results of this study have practical implications for teacher educators, because it increases our understanding of how game-based learning (using commercial video games) could be introduced in teacher training programs, especially in early adoption phases. Surprisingly, ease of use is not as influential on teachers' game acceptance as expected. Therefore it appears that teachers need information first and foremost before practical issues should be considered. Other factors that did not affect teachers' acceptance of games are their personal experiences with video games nor their predisposition toward information technology. Even though personal innovativeness is directly related to usefulness, its share in the model is rather modest. This implies that blindly promoting games as a new technological panacea or a popular teaching method will probably not be as effective as taking a critical position toward game-based learning. Teacher educators should address in which specific cases and under which particular circumstances video games can increase the quality and effectiveness of the teacher profession. If teacher educators focus on the quality of education, teachers will be more inclined to accept game-based learning as a merit for their practice.

The importance of the social influences in the model also suggests that teachers are sensitive to worked examples and showcases of good practice (Barab, Dodge, & Gee, 2009). This implies that teacher trainers should increase the visibility of successful game-based learning projects such as the use of *Civilization* and *Europa Universalis* in history education (Egenfeldt-Nielsen, 2007; Squire, 2004), the use of *Neverwinter Nights* by the Adventure Author project (Robertson & Howells, 2008), the implementation of adapted *Sims* games for language learning (Miller & Hegelheimer, 2006), or the case studies described in Sandford et al. (2006).

Last but not least, this study shows that game-based learning is not just a case of teachers who have experience of playing video games in their spare time. Instead, it further promotes the idea that game-based learning requires the careful orchestration of different knowledge domains.

7. Limitations and future research

There are a number of limitations to this study. Firstly, a challenge to all user acceptance studies is the limited knowledge of the users about the proposed technology under study (Davis, Bagozzi, & Warshaw, 1989). While this study has tried to partially overcome this issue by including vignettes, the question remains whether this study really measured well-formed beliefs or rather propositions toward this new teaching approach that can/will change over time. Indeed, because of the cross-sectional nature of the present study, future research – preferably based on a longitudinal approach or qualitative research on teachers with game-based learning experience – is necessary in order to make conclusions about the stability of the beliefs under study (Kenny & McDaniel, 2011; Ma, Andersson, & Streith, 2005).

Secondly, user acceptance research tends to focus on the grounds for using a technology. It does not, however, ask how these technologies affect performance (Goodhue, 2007). While this study provides a view on the position of teachers toward the use of commercial games in education, future research is needed that examines the different ways in which video games could potentially affect and reshape teachers' professions, their performance, and even education in general (Selwyn, 2007). What is it exactly that teachers consider being useful about applying this particular technology in their practice (Straub, 2009)? This type of research has to go beyond the focus on explanations of teachers' low technology acceptance in education (Kriek & Stols, 2010).

Thirdly, while this study did not focus on the feasibility and effectiveness of using video games in secondary education, any paper discussing the acceptance of a certain type of technology risks strengthening the subjective norm that video games are an important and academically accepted new educational medium. While we believe that games – much like any major influence in young people's lives – deserve attention both in education and research, our goal was not to uncritically promote the use of video games in secondary education. On the contrary, we believe that more research is necessary, to show whether and how specific types of games can help us to tackle certain challenges in education. Hopefully, our research can help more experienced teachers, school administrators and researchers to better understand the initial adoption decisions of teachers in those cases where video game-based learning can offer a fresh perspective or a new and effective methodological approach.

Finally, there are some limitations that are inherent to TAM-based acceptance studies. Due to the pre-implementation timing of the study, behavioral intention was selected as the dependent variable. This could be a matter of concern. Although previous research has shown that behavioral intention can be considered a good predictor for actual use (Lau & Woods, 2008; Sheppard, Hartwick, & Warshaw, 1988), this type of research is yet to be replicated in educational contexts. We therefore recommend future studies – in later implementation stages – to

include observed measures for actual use. Similar remarks can be made about the use of complexity as a construct in this study. Conceptually, complexity is the opposite of ease of use; however, statistically the results of this study contradict the traditional hypotheses of the TAM model comprising ease of use. Within educational contexts it is advisable that the role of ease of use is examined cautiously. In addition, this paper does not distinguish between different types of use. Even though the teachers were presented vignettes that described examples of good practice, they were only asked whether they intend to use games in the future. They were not consulted about the specific ways in which they plan to implement games. Qualitative research, using a case study or focus group approach could provide more insight in the specific ways teachers (want to) use games. Indeed, while implementation is an important issue, the main concern should be quality of education. In this respect, Lei and Zhao (2007) have argued that “When quality is not ensured, the time spent on technology should be limited” (p. 295).

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