Computers & Education 54 (2010) 1145–1156

Contents lists available at ScienceDirect

Computers & Education

journal homepage: www.elsevier.com/locate/compedu

Students' perceptions about the use of video games in the classroom

Jeroen Bourgonjon *, Martin Valcke, Ronald Soetaert, Tammy Schellens

Department of Educational Studies, Ghent University, H. Dunantlaan 2, 9000 Ghent, Belgium

ARTICLE INFO

Article history:
Received 17 July 2009
Received in revised form 15 October 2009
Accepted 31 October 2009

Keywords:
Multimedia/hypermedia systems
Interactive learning environments
Media in education
Pedagogical issues
Secondary education

ABSTRACT

Video games are often regarded as promising teaching and learning tools for the 21st century. One of the main arguments is that video games are appealing to contemporary students. However, there are indications that video game acceptance cannot be taken for granted. In this study, a path model to examine and predict student acceptance of video games is proposed, and empirically tested by involving 858 secondary school students. The results show that students' preference for using video games in the classroom is affected directly by a number of factors: the perceptions of students regarding the usefulness, ease of use, learning opportunities, and personal experience with video games in general. Gender effects are found as well, but appear to be mediated by experience and ease of use.

1. Introduction

A growing number of authors believe that the new generation of students is fundamentally different from former generations, mostly because of changes in their media consumption patterns. Contemporary students – also referred to as "*digital natives*" (Prensky, 2001), "*the net generation*" (Oblinger & Oblinger, 2005), "*screenagers*" (Rushkoff, 1997), "*millenials*" (Howe & Strauss, 2000), and even as the "*gamer generation*" (Beck & Wade, 2004) – have never experienced a world without ICT. They grow up with hypertexts, social networking programs and video games. Thus it is claimed that these students have gained specific technical skills, new ways of thinking, and different learning preferences, which require a new educational approach (Oblinger & Oblinger, 2005; Prensky, 2001).

Video games are often considered as embodiments of this new educational approach, as they represent operational translations of contemporary learning theories: they situate learning in meaningful contexts, empower students to become self-regulated; present them with ill-structured problems; integrate several knowledge domains; promote inquiry-based and discovery learning (Gee, 2003; Papert, 1980; Rieber, 1996; Watson, 2007). Additionally, it is believed that video games are able to promote a positive attitude toward learning and school (Durkin & Barber, 2002), mainly because of their intrinsically motivating character (Annetta, Minogue, Holmes, & Cheng, 2009; Fengfeng, 2008; Malone, 1980; Papastergiou, 2009).

However, a growing number of researchers contest both the assumption that youngsters are constantly immersed in new technologies, as well as the claim that dramatic changes in our educational system are needed: "*[i]f one lumps together leisure goals, media usage, usage motivation and functions, this ensemble comprises a thoroughly classical picture of growing up*" (Schulmeister, 2008, Socialization section, para. 1). According to these critics, the immersion of students in technology needs to be put into perspective. The usage of media rather reflects the desire of students to communicate with friends, to search for meaning, to create their own place in society, and of course to relax and have fun (Bourgonjon, Rutten, Vanhooren, & Soetaert, 2008). Therefore, it could be argued that the need for video games in education is somewhat exaggerated. Bennett, Maton, and Kervin (2008) even refer to the digital natives debate as a form of academic moral panic. In their view, arguments about digital natives are in need of critical inquiry, to resolve the "*clear mismatch between the confidence with which claims are made and the evidence for such claims*" (Bennett et al., 2008, p. 782). In this regard, there is a need for studying students' acceptance of video games for learning. Students are important actors, but they are often overlooked in the e-learning adoption process (Seddon & Biasutti, 2009). This is a serious shortcoming, as understanding students' perspectives could help instructors to integrate instructional technology in the classroom, thereby improving and enhancing the learning process (Selim, 2003).

* Corresponding author. Tel.: +32 9 264 8676; fax: +32 9 264 8688.
E-mail address: jeroen.bourgonjon@ugent.be (J. Bourgonjon).

0360-1315/$ - see front matter © 2009 Elsevier Ltd. All rights reserved.
doi:10.1016/j.compedu.2009.10.022

In the current article, the objective is to empirically examine whether all students are as immersed in video gaming – and if they prefer digital game-based learning – as is suggested in the digital natives debate, and to identify critical issues in the video game adoption process. A model for understanding and predicting students' acceptance of video games is proposed. This model is based on an extension of the technology acceptance model (TAM, Davis, 1989), which will be explained, tested and validated in the next sections of the article.

2. Literature review

2.1. Technology acceptance

Fishbein and Ajzen (1975) introduced the theory of reasoned action (TRA), a model to study individuals' intended behavior. According to TRA, an individual's perception of attitude toward behavior and the perceived social pressure to engage in an action, are the main predictors for a behavioral intention, which in turn is the primary determinant of actual behavior. Davis (1989) adapted the TRA in view of computer acceptance behavior. His technology acceptance model (TAM) identifies two user beliefs: perceived usefulness and perceived ease of use, as the main determinants for individuals' behavioral intention to use information systems. The model further assumes a direct relation between ease of use and usefulness, in other words, people will perceive a technological artifact to be more useful when it is easy to operate.

In about 20 years, the TAM has become one of the most widely used and empirically validated models within information systems research (King & He, 2006; Legris, Ingham, & Collerette, 2003). It has been applied to different technologies and has been tested in various contexts (Legris et al., 2003). Comparative studies also endorse the supremacy of the TAM over other intentional behavior theories (Mathieson, 1991), since it explains (on average) about 40% of the variance in usage intentions and behavior (Venkatesh & Davis, 2000). Summarizing, the TAM is considered as a reliable, simple and parsimonious model to predict and explain user acceptance of technology.

However, TAM findings are not always consistent (Legris et al., 2003). One of the major problems is the inability of the model to account for individual, organizational, contextual, technology and task characteristics (Mathieson, 1991; McFarland & Hamilton, 2006). Several scholars have tried to solve this problem by extending the model with prior factors suggested by other theories and context (King & He, 2006). These extended models not only contributed to a more full understanding of usefulness and ease of use, but they also help to explain larger proportions of variance (Legris et al., 2003).

2.2. Video game acceptance

TAM-based models have already been used in a number of studies to understand and predict video game acceptance in a non-educational context. These studies were able to explain large proportions of variance. Kwang and Kim (2006 in Ha, Yoon, & Choi, 2007), for example, studied the acceptance of mobile games with a TAM-based model that was enriched with variables as visibility, self-expression, innovativeness, and ease of use as determinants for usefulness; and innovativeness and facilitating conditions as predictors for ease of use. They found that the traditional TAM determinants; usefulness and ease of use, are indeed key determinants to predict mobile game usage and acceptance.

In the case of online gaming acceptance, Hsu and Lu (2004) were able to explain about 80% of the variance with an extended TAM that incorporated social norm and flow experience. Ease of use appeared to be the key determinant to predict online game play instead of usefulness. In Ha et al. (2007), it was found that perceived enjoyment was a better predictor than usefulness in the case of mobile video game acceptance. They also stress the importance of age as a key moderator for game acceptance in a mobile broadband wireless access environment.

2.3. Video game acceptance in education

It is clear that the research available in the field of video game acceptance is focused predominantly on video games as hedonic systems, their value is considered "*a function of the degree to which the user experiences fun when using the system*" (van der Heijden, 2004, p. 696). In the current study, the focus and context are clearly different, as video games are studied as learning tools in a school context. Of course, theoretically, games and learning are connected (Gee, 2003; Rieber, 1996), but previous research has shown that students do not acknowledge this. They hold the (false) belief that play is in fact irrelevant to learning (Fengfeng, 2008; Rieber, 1996). So far, no TAM research could be traced that studied the acceptance of video games as learning tools. In the next section, a TAM is proposed in view of this context and aim.

3. Research model and hypotheses

3.1. Dependent variable: preference for video games (PVG)

In certain studies – for example in pre-implementation research – it is impossible to measure the respondents' actual use of information systems. A common solution to this problem is to study the respondents' behavioral intentions instead (Chau, 1996; Hu, Clark, & Ma, 2003). Despite the likely criticism on this construct (Straub & Burton-Jones, 2007), measuring the intention to use a certain information system does not need to be a serious limitation for user acceptance research (Mathieson, 1991). Moreover, several studies demonstrate that behavioral intention can be a good predictor for actual use (Lau & Woods, 2008; Sheppard, Hartwick, & Warshaw, 1988).

However, in a school context even measuring students' behavioral intention is sometimes difficult, since it is not up to the student, but to the teachers, to decide whether or not to use specific learning tools. The construct of attitude – referring to the feelings of participants toward actual use (Fishbein & Ajzen, 1975) – could therefore be considered as an acceptable alternative dependent variable. In line with this alternative approach, Hsu and Lu (2007, p. 1648) introduced the concept of preference, which they define as "*the degree of users' positive feelings about participating* [*in online game communities*]". In the current study, we build on this position and try to get a clearer view of students' preferences about the use of video games in schools. The key dependent variable of this study, preference for video games (PVG), is defined as "*positive feelings about games for learning and predicted choice for video games in the classroom*". In other words, do students want video games in the classroom?

3.2. Usefulness (U) and learning opportunities (LO)

In the traditional TAM, it is hypothesized that individuals' intentions to use technology are heavily dependent on their evaluation of its usefulness. Davis defined usefulness (U) as "*the degree to which a person believes that using a particular system would enhance his or her job performance*" (Davis, 1989, p. 320). A close examination of the items measuring usefulness shows that "*performance*" is the keyword. From an educational perspective it might be argued that this conceptualization is too restrictive for the learning context, since it is too narrowly focused on results – on product – while it is generally agreed that education transcends mere outcome. The learning process has to be taken into consideration as well. Consequently, in order to account for these process outcomes in the current study, a new construct was added to the model: perceived learning opportunities (LO), defined as "*the degree to which a person believes that using video games in the classroom can offer him or her opportunities for learning*".

According to the advocates of the "digital natives debate" (Oblinger & Oblinger, 2005; Prensky, 2001), students will show greater preference for learning objects that address their changing mindsets; learning objects that allow interaction, critical thinking, control and experimentation. Therefore, it can be hypothesized that perceived learning opportunities will have a positive impact on preference for video games. Moreover, since theoretically the concept of learning opportunities is related to usefulness as process is related to product, it can be hypothesized that learning opportunities will positively affect usefulness as well.

- H1: Usefulness (U) positively affects preference for video games (PVG).
- H2: Learning opportunities (LO) positively affects preference for video games (PVG).
- H3: Learning opportunities (LO) positively affects usefulness (U).

3.3. Ease of use (EOU)

Perceived ease of use (EOU) is the second key determinant for behavioral intention in traditional TAM. It is defined as "*the degree to which a person believes that using a particular system would be free of effort*" (Davis, 1989, p. 320). Therefore, the TAM reasons that people will perceive a certain type of technology as more useful when it is easy to use. Based on the discussion about the relationship between usefulness and learning opportunities described above (Section 3.2.), it can be hypothesized that people will also perceive technology to offer more and better learning opportunities when it is easier to use.

Additionally, the TAM assumes a direct influence of ease of use on behavioral intention. However, this assumption is controversial, since several studies did not support a direct effect from ease of use on behavioral intention and actual technology use (Adams, Nelson, & Todd, 1992; Gefen & Straub, 2000; Venkatesh & Davis, 2000). Some theories state that the effect of ease of use on behavioral intention is more profound when the technology under study is still new and not yet implemented (Venkatesh, Morris, & Ackerman, 2000), while others hypothesize that people discount the importance of ease of use as long as they are making up their minds about a new technology (Taylor & Todd, 1995). Gefen and Straub (2000) suggest that the varying importance of ease of use could be related to the nature of the task. They argue that the influence of ease of use on behavioral intention increases if the task is an inherent part of information technology usage.

In this study, the concept of ease of use is further complicated because both learning and gaming have to be – among other things – "pleasantly frustrating" (Bandura, 1997; Gee, 2003). Students like games better when the level of sophistication is high (Virvou & Katsionis, 2008). Games that are too easy or too hard will put students off. This stresses the need to consider ease of use as a critical variable when studying video game acceptance in a learning context.

H4: Ease of use (EOU) positively affects preference for video games (PVG).
H5: Ease of use (EOU) positively affects usefulness (U).
H6: Ease of use (EOU) positively affects learning opportunities (LO).

3.4. Experience

Experience with the information system under study is considered to play a key role in research about technology acceptation. Within game studies, it is believed that experience with video games will influence both students' acceptance of working with video games in the classroom and their learning processes (Sell, Lillie, & Taylor, 2008; Silk et al., 2008; Virvou & Katsionis, 2008).

In information systems research experience is conceptualized in distinct ways. Some studies enter experience into the model as a feedback loop, for example from actual use to ease of use (Bajaj & Nidumolu, 1998). Other studies add extra variables like skill level, length of use and past usage to the model (Hartwick & Barki, 1994; Thompson, Higgins, & Howell, 1994). In the current study, experience is conceptualized as an additional variable, which combines time dedicated to playing video games, diversity in playing games and identification with game culture.

Building on the findings of Thompson et al. (1994), it is hypothesized that experience with games will influence students' preference for video games both directly, and indirectly through ease of use, learning opportunities and usefulness.

H7: Experience positively affects preference for video games (PVG).
H8: Experience positively affects ease of use (EOU).
H9: Experience positively affects learning opportunities (LO).
H10: Experience positively affects usefulness (U).

3.5. Gender

Previous research suggests that it is almost impossible to separate students' experience with video games from gender issues, as males not only tend to play games more often, but they also play different types of games (Bonanno & Kommers, 2005; Jean, Upitis, Koch, & Young, 1999), and they hold significantly different attitudes toward the use of video games (Bonanno & Kommers, 2008). Explanations for these gender differences are sought in the uses and gratifications theory, in biological determinants, in the violent content of games, in the representation of gender in games and in gender differences in ability (Boyle & Connolly, 2008; Hartmann & Klimmt, 2006; Lucas & Sherry, 2004). As these differences seem deeply rooted and persistent, a number of researchers express concerns that video games might actually alienate inexperienced and female students (Carr & Pelletier, 2008; Dawes & Dumbleton, 2002). However, recent studies refute this assertion, showing that games can be equally effective and motivating for both male and female students. The impact of gender on acceptance tends to disappear during the implementation phase (Fengfeng, 2008; Papastergiou, 2009). Therefore, it can be hypothesized that gender affects student acceptance of and preference for video games rather indirectly through experience and ease of use. For matters of comprehensiveness, the direct link between gender and preference for video games will be included in the hypothetical model.

H11: Gender affects experience.
H12: Gender affects ease of use (EOU).
H13: Gender affects preference for video games (PVG).

3.6. Research model

Based on the theoretical background and the 13 postulated hypotheses, a research model is proposed (Fig. 1).

4. Method

4.1. Research design

The data for this study were collected using a survey comprising questions on demographics and item scales for measuring the different variables in the research model. Descriptive statistics were used to explore the answers on both sections of the questionnaire. Likely associations and differences between various variables were tested both with the chi-square test for independence, as with the Student's *t*-test. Structural equation modeling (SEM) was used to analyze the different predictors for students' acceptance of video games and the interrelationships between these predictors.

4.2. Participants

In this study, 858 Flemish secondary school students (age 12–20, $M = 15.2$, $SD = 1.8$) from over 20 schools were surveyed. Collaboration was voluntarily. Informed consent was obtained from all students and their parents. Among the respondents, 48.1% was female ($n = 413$) and 51.9% was male ($n = 445$). In Flanders, secondary education comprises six grades, with an exceptional seventh grade in vocational training. Apart from this seventh grade, each grade level was represented by at least 85 subjects.

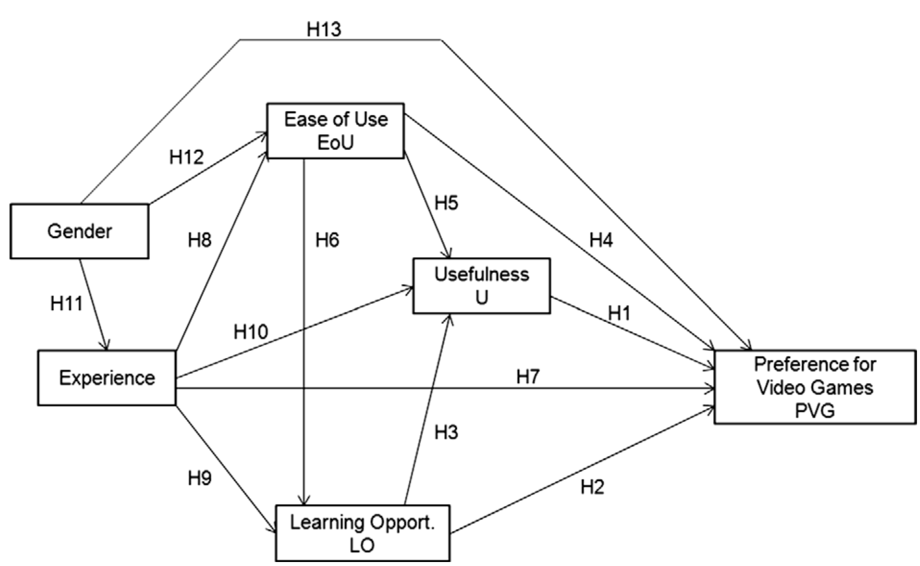

Fig. 1. Hypothetical model. (*Note*: Despite not being incorporated in the model, age is controlled for in the sampling procedure.)

4.3. Measures

The survey questionnaire was divided into two sections. The first section comprised questions about the demographic situation of the respondents (grade, age, type of education, mean hours of weekly playtime, and gender, coded 0 = female, and 1 = male). The second section of the survey consisted of items addressing the different variables in the research model: preference for video games, usefulness, learning opportunities, ease of use, and experience. The survey questionnaire was partly based on existing scales. However, because of the specificity of the research project (studying video game acceptance for learning purposes by secondary school students in the Dutch speaking region of Belgium), it was necessary to adapt the existing scales. For three constructs, no adequate item scales were available in the literature. Consequently, a new survey instrument was developed to meet the specific demands of the research project. The items for assessing ease of use and usefulness were selected from an item pool derived from previous TAM research, while the items for measuring learning opportunities were derived from the overview of commonly attributed positive learning effects of video games in Egenfeldt-Nielsen's (2007) *Beyond Edutainment*. Both for experience and preference for video games, new items were formulated.

The new instrument was presented to a formal expert panel consisting of two neutral and established researchers and two methodologists, and 128 in-service teachers who were participating in another research project. Based on their remarks, and in close consultation with the expert panel, a number of items were removed from the questionnaire, while other were rephrased.

All items are based on a 5 point Lickert scale, ranging from 1 ("Strongly disagree") to 5 ("Strongly agree"), except for one item measuring preference for video games, which was measured originally on a 10 point scale, but was rescaled to a 5 point scale in view of the data analysis. In Appendix A, the full list of items can be consulted.

5. Results

5.1. Descriptive statistics

The reported mean hours of weekly playtime was 4.6 ($SD = 6.5$). However, from both the skewness (2.7) and kurtosis (9.4) indicators it appeared that the distribution was not only peaked, but that it also had a very heavy right tail. Moreover, after removing the top and bottom 5% of the cases, the mean hours of weekly playtime dropped to 3.7. This suggested that the original mean was strongly influenced by extreme scores. Since closer examination of the extreme scores revealed possible gender differences, an independent-samples *t*-test was conducted to compare the reported playtime for males and females. It was found that males ($M = 6.96$, $SD = 7.42$) report significantly more playtime than females ($M = 2.16$, $SD = 4.15$); $t(707) = -11.82$, $p < .001$, Cohen's $d = .80$.

For purposes of clarification, the mean hours of weekly playtime variable was recoded into a new variable with four categories: nongamers (0 h of weekly playtime), rare gamers (]0, 1]), moderate gamers (]1–5]) and frequent gamers (]5, ∞[). 12.8% of the students reported not to play video games at all. More than a quarter of the students (26%) indicated to play maximum 1 h a week, 35.9% 1 h to 5 h a week, and another 25.3% reported to play more than 5 h a week. A chi-square test for independence indicated a significant association between gender and the experience groups (χ^2 (3, $n = 858$) = 193.1, $p < .001$, Cramer's $V = .47$).

The survey assessed more than mere hours of playtime, as students were asked to point out their preferred medium for video gaming as well (Table 1). Only students who reported to play games answered this question. Students chose the computer (47.2%) and television consoles (24.6%) as the preferred medium, over websites (13.9%), portable consoles (5.9%) and other media like cell phones and mp3 players (8.4%). The distinction made between computers and websites was necessary in order to get some insight in the type of video games students play in their spare time. A chi-square test for independence indicated a significant association between gender and preferred medium for video gaming (χ^2 (4, $n = 748$) = 83.6, $p < .001$, Cramer's $V = .33$). Although both groups prefer to play video games on the computer, the proportion of males favoring television consoles (31.8%) was almost twice as large as the proportion of females, who appear to be more favorable toward websites (21.9%) and other devices (15.1%).

Table 2 presents a summary of the descriptive statistics concerning the different constructs used in the model analysis, differentiated for female and male students. Male students reflect higher scores than female students in relation to most variables. This difference in scores is confirmed by *t*-tests (Table 2). From these results, it appears that female students do not prefer video games in the classroom ($M = 2.69$, $SD = 1.12$), where male students are more in favor of the idea ($M = 3.49$, $SD = 1.14$). However, despite this difference in preference both male and female students tend to believe that video games offer learning opportunities (female: $M = 3.09$, $SD = 0.78$; male: $M = 3.44$, $SD = 0.74$). This calls for a closer examination of the interrelationship between the different variables.

Table 1
Crosstabs.

Group	Gender				Total	
	Female		Male			
	N	%	*N*	%	*N*	%
Groups by playtime						
Nongamers	89	21.5	21	4.7	110	12.8
Rare gamers	160	38.7	63	14.2	223	26.0
Moderate gamers	130	31.5	178	40.0	308	35.9
Frequent gamers	34	8.2	183	41.1	217	25.3
Preferred medium						
Console	50	15.4	135	31.8	185	24.7
Portable console	23	7.1	21	5.0	44	5.9
Computer	131	40.4	221	52.1	352	47.1
Website	71	21.9	33	7.8	104	13.9
Other	49	15.1	14	3.3	63	8.4

Table 2
Descriptive statistics with students' *t*-test.

Construct	Mean			Student's *t*-test		
	Female (*SD*)	Male (*SD*)	Total	*t*	d*f*	Cohen's *d*
Experience	2.11 (0.74)	3.11 (0.90)	2.63 (0.97)	−17.76***	846	−1.21
EOU	2.96 (0.96)	3.67 (0.84)	3.33 (0.97)	−11.63***	821	−0.79
U	2.47 (0.94)	3.00 (1.05)	2.74 (1.03)	−6.76***	855	−0.53
LO	3.09 (0.78)	3.44 (0.74)	3.27 (0.78)	−7.80***	854	−0.46
PVG	2.69 (1.12)	3.49 (1.14)	3.10 (1.20)	−10.43***	855	−0.71

Note: EOU = ease of use; U = usefulness; LO = learning opportunities; PVG = preference for video games.
*** $p < .001$.

5.2. Psychometric quality of the research instruments

Because the survey consisted of newly constructed and adapted scales, it was necessary to check the psychometric quality of the research instruments. To that end, the total sample ($N = 858$) was divided randomly into two split-half samples ($n = 429$), which were still large enough to yield large subject to item ratios (19:1). Appendix B offers an overview on both samples. Exploratory factor analysis (EFA) was performed on the first split-half sample to determine the factor structure of the data, after which confirmatory factor analysis (CFA) was conducted on the second split-half sample to test the factor structure stability.

For the EFA, guidelines concerning "*best practice*" (Conway & Huffcutt, 2003; Costello & Osborne, 2005; Fabrigar, Wegener, MacCallum, & Strahan, 1999) were followed: principal axis factoring was used as the extraction method since the scores were not normally distributed, and oblique rotation was chosen because of the expected correlation between the underlying factors. The results in Appendix C show that all factors could be reconstructed: Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy was optimal (.947), the Bartlett's test of sphericity was – as required – significant at $p \leqslant .001$ level, and the five factor structure explained 74% of the shared variance. Moreover, all factor loadings exceeded .4 on their own, and not in other constructs. Appendix D shows the intercorrelations between factors.

After testing the factor structure with EFA, CFA was performed on the second split-half sample to test the factor structure stability. AMOS 17 was used to calculate several fit indices: chi-squared/degrees of freedom, the root mean square error of approximation (RMSEA), the goodness-of-fit index (GFI), the adjusted goodness of fit index (aGFI) and the comparative fit index (GFI). Error terms were not allowed to correlate. When compared with the cut off values for satisfactory fit as summarized in Byrne (2001), the results of the CFA – presented in Appendix E – show a reasonable match between the data and the hypothesized model. Moreover, the results point at significant loading of all items on the latent factors (all pattern coefficients between 0.60 and 0.92 and statistically different from zero at the .001 level).

Finally, the internal consistency of the scales was estimated for the whole dataset ($N = 858$). The test results are shown in Appendix F. As all Chronbach's alpha coefficients exceeded the threshold of .70 (Hair, Anderson, Tatham, & Black, 1998), it was concluded that all scales exhibited acceptable internal reliability.

5.3. Model fit

Based on the findings of the EFA, the CFA and the reliability analysis, it was concluded that the survey instrument is reliable and valid. In a next step, structural equation modeling (in AMOS 17) was performed to test the path model. Comparing the results with the requirements for acceptable and satisfactory goodness-of-fit indices, it was concluded that the data fit the hypothesized relationships between the different constructs (Table 3).

Fig. 2 depicts the model including path coefficients and the percentage of explained variance for the dependent variables. Moreover, all the hypotheses under study could be accepted, and the model appears to account for 63% of the variance in preference for video games. Therefore, it can be concluded that this extended TAM model can successfully predict secondary school students' acceptance of video games for learning.

5.4. Hypotheses testing and path analysis

Table 4 provides an overview of the path coefficients. Both perceived usefulness and perceived ease of use appear to be significant predictors for students' preference for video games. The positive effect of usefulness on preference for video games is strong (H1, $\beta = .44$, $p < .001$) and the effect of ease of use (H4, $\beta = .21$) is significant at .001 level. Additionally, ease of use influences usefulness as well (H5, $\beta = .20$, $p < .001$). Summarizing, all hypotheses constituting the original TAM theory (H1, H4 and H5) are confirmed in this study.

The results of the analysis also show that the new construct, perceived learning opportunities, positively affects usefulness (H3, $\beta = .49$, $p < .001$) and preference for video games (H2, $\beta = .17$, $p < .001$). Additionally, students' perceptions of learning opportunities are strongly influenced by ease of use (H6, $\beta = .47$, $p < .001$).

Although statistical significant, the relationship between gender and preference for video games is very weak (H13, $\beta = .05$, $p < .05$). In contrast, the impact from gender on game experience is high (H11, $\beta = .53$, $p < .001$). Moreover, experience is identified as an predictor for

Table 3
Goodness-of-fit Indices for the $N = 858$ Sample

	χ^2(d*f*)	χ^2/d*f*	*p*	RMSEA	GFI	aGFI	NFI
Sample	2.03(2)	1.02	.361	.005	.999	.992	.999

Note: RMSEA = root mean square error of approximation; GFI = goodness-of-fit index; aGFI = adjusted goodness-of-fit index; NFI = normed fit index.

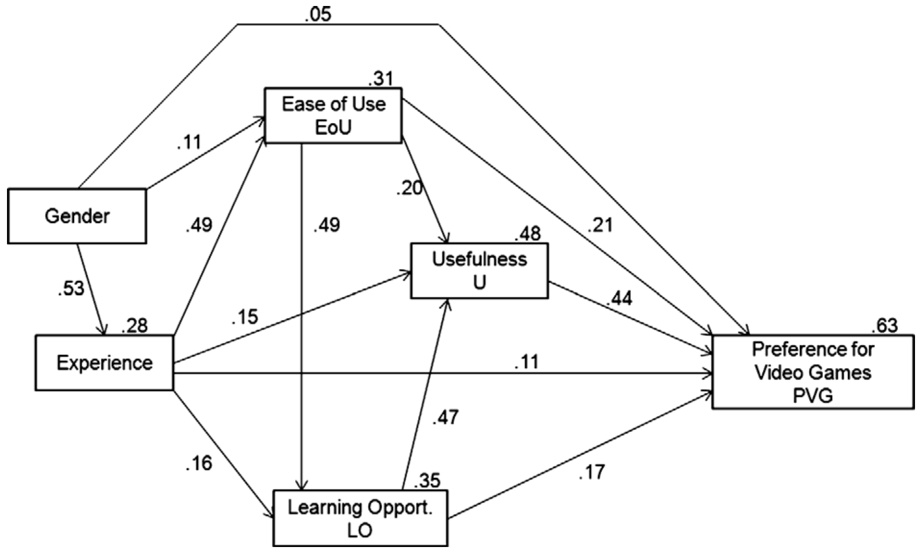

Fig. 2. The final model.

Table 4
Testing the hypotheses.

Hypothesis	Effect	Coefficient	S.E.
H1	Usefulness → preference for video games	.44***	.025
H2	Learning opportunities → preference for video games	.17***	.019
H3	Learning opportunities → usefulness	.47***	.023
H4	Ease of use → preference for video games	.21***	.036
H5	Ease of use → usefulness	.20***	.048
H6	Ease of use → learning opportunities	.49***	.063
H7	Experience → preference for video games	.11***	.021
H8	Experience → ease of use	.49***	.020
H9	Experience → learning opportunities	.16***	.038
H10	Experience → usefulness	.15***	.026
H11	Gender → experience	.53***	.281
H12	Gender → ease of use	.11***	.195
H13	Gender → preference for video games	.05*	.179

* $p < .05$.
** $p < .01$.
*** $p < .001$.

video game preference (H7, $\beta = .11$, $p < .001$). Experience also has a profound effect on ease of use (H8, $\beta = .49$, $p < .001$), and although its influence on learning opportunities (H9, $\beta = .16$) and usefulness (H10, $\beta = .15$) is more modest, it is still significant ($p < .001$). These results indicate that the conspicuous gender differences found in the descriptive statistics (Table 2) are in fact mediated by experience and ease of use (H12, $\beta = .11$, $p < .001$).

Given the theoretical issues with the direct link between gender and preference for video games (H13) and the empirical findings that this link is very weak, it was decided to retest the model after eliminating the direct effect between gender and preference for video games. The explained variance in preference for video games remained 63%, and the data fit the parsimonious model equally well ($\chi^2(df) = 5.87(3)$, $\chi^2/df = 1.96$, $p = .116$, RMSEA = .034, GFI = .998, aGFI = .984, and NFI = .997).

6. Discussion

Firstly, the results of this study support the use of the TAM (Davis, 1989) in the context of digital game-based learning, as both usefulness and ease of use appear to be important predictors for students' acceptance. These findings are similar to other research in the acceptance of technology in an educational context by both students (Lau & Woods, 2008; Selim, 2003) and teachers (Hu et al., 2003; Teo, Lee, & Chai, 2008). However, they contradict earlier video game research in a leisure context, which questioned the impact of perceived usefulness on acceptance (Ha et al., 2007). As described in van der Heijden (2004), it appears that different predictors for acceptance emerge, when games are used for different purposes (e.g., for education instead of fun).

Secondly, next to ease of use and usefulness, this study identifies learning opportunities as an important third user belief for predicting students' preference to use video games in the classroom. In the past, the concept of usefulness has been criticized for being too broadly based (Moore & Benbasat, 1991). According to Chau (1996), a review of the use of the TAM in a business organization context has shown that Davis' perceived usefulness can be of two distinct types: near-term usefulness and long-term usefulness. The current study shows that in an educational context, a distinction has to be made between the concepts of usefulness and learning opportunities. Both concepts relate to each other as process to product.

Thirdly, the conspicuous gender differences found in the descriptive statistics do not result from a direct relationship between gender and preference for video games. Instead, they appear to be mediated by ease of use and experience. The influence of experience in the model is apparent. Not only does experience have a direct impact on students' preference for video games, it also influences ease of use, learning opportunities and usefulness. This means that the protagonists within the digital natives debate are partially right: students who are more immersed in video game technology do prefer a different kind of education. However, the claim about the level of immersion can be questioned. In line with the findings of Bonanno and Kommers (2005), the current study shows that a large group of students – amongst whom many female students – do not have much experience with game technology. Both the large differences between students concerning their weekly playtime and their preferred medium for gaming, suggest that the student population is more diverse than it is usually hinted at in the digital natives literature. This could be a matter of concern, mainly for two reasons. First of all, students' resistance to using video games in the classroom could be a threat to the active participation which game-based learning requires (Squire, 2008), and secondly, research has shown that experienced users benefit more from the use of video games than their inexperienced peers (Egenfeldt-Nielsen, 2007; Sell et al., 2008; Silk et al., 2008; Verheul & van Dijck, 2009; Virvou & Katsionis, 2008). Therefore, the current study bears important implications for practitioners, as it not only demonstrates that students' initial acceptance cannot be taken for granted, but also because it provides insight in how to improve it. This does not necessarily imply that teachers should actually introduce video games into their teaching practice. This article merely offers support for acceptance if teachers have come to the conclusion that video games may prove helpful.

The central role of both experience, learning opportunities and usefulness indicates that students would benefit from lesson time dedicated to video game literacy. At least, this means that a teacher should not introduce video games to students as mere *fun*, but by explaining the specific advantages of video games over other teaching tools. At a more profound level, it could be useful to dedicate time to video game literacy in media education lessons, comparing (the rhetoric of) video games with other media, studying the content of video games or even designing a very own game (Buckingham & Burn, 2007). A re-citation of Umberto Eco (1979) is in place here: "*if you want to use television to teach somebody something, you first have to teach somebody how to use television*". But courses in video game literacy are not only necessary from a usefulness perspective, from an ease of use perspective they could enhance students' level of confidence to use video games in the classroom as well. As ease of use appears to be a significant predictor for both usefulness and learning opportunities, it is important that teachers offer sufficient support to students in the use of video games. This might sound contradictive to the digital natives theory, which is suggestive of the idea that students will be very skillful with video games in the classroom, just because they belong to the generation that grew up with technology. However, notwithstanding this study does provide empirical evidence for the claim that experience with (entertainment) games does influence the acceptance of games for learning, it also shows that addressing students' beliefs about the ease of use will benefit student acceptance.

7. Conclusions and limitations

The purpose of this study was twofold. Firstly, assumptions underlying the digital natives debate about students' immersion in video games and their preference for digital game-based learning were tested. Secondly, a model for explaining students' acceptance of video games, based on the technology acceptance model (TAM, Davis, 1989), was proposed, validated and tested based on data gathered from 858 Flemish secondary school students.

The results showed that students cannot be regarded as one homogeneous group of video game consumers, as there were large differences between groups of students in their video game consumption patterns. A substantial group even reported not playing video games at all. Gender differences were found. As expected, male students hold more positive beliefs toward the use of video games in education than female students. However, based on the model test results, it is important to make necessary differentiations.

The proposed model appeared to be reliable and valid for understanding students' acceptance of video games for classroom learning, as SEM proved the model fits the gathered data well. Moreover, 63% of the variance in students' preference for video games could be explained. In addition to the traditional TAM predictors usefulness and ease of use, it appeared that perceived learning opportunities and experience were important predictors too. Gender effects appeared to be mediated by experience.

The group of students involved was large and the results presented in this article are distinct. Nevertheless, a remark can be made about the cross-sectional character of this study. The main focus was on students' initial acceptance of video games in the classroom. Of course, as educational change can never be the case of student acceptance alone, future research should account for the perceptions and beliefs of other stakeholders (for example teachers, school managers, policy makers and parents) in the change process as well. Another limitation is that no distinction was made between different types of video game implementation in schools. Future research should include variables based on the nature of examined curricula undertaken by students, with a clear focus on particular learning outcomes.

Nevertheless, from both a methodological (Venkatesh et al., 2000) and a theoretical perspective, it looks promising to integrate the TAM measures in future experimental design research, in order to further elucidate the factors influencing perceptions over time. In addition, future research should also focus on the ultimate variable in video games use: the actual integrated use of video games in teaching and learning settings. The current study has helped to define crucial variables that should be considered when designing, developing and adopting a video game-based learning environment.

Appendix A. Items by construct

Usefulness – Using video games in the classroom

U1	would improve my performance
U2	would increase my learning productivity
U3	would enhance my effectiveness
U4	would help me to achieve better grades

Ease of use

EOU1	I would know how to handle video games in the classroom
EOU2	It would be easy to for me to use video games in the classroom
EOU3	My interaction with video games in the classroom would be clear and understandable

Learning opportunities – Video games offer opportunities to

LO1	experiment with knowledge
LO2	take control over the learning process
LO3	experience things you learn about
LO4	stimulate transfer between various subjects
LO5	interact with other students
LO6	think critically
LO7	motivate students

Experience with games

Experience1	I like playing video games
Experience2	I often play video games
Experience3	Compared to people of my age, I play a lot of video games
Experience4	I would describe myself as a gamer
Experience5	I play different types of video games

Preference for video games

PVG1	If I had the choice, I would choose to follow courses in which video games are used
PVG2	If I had to vote, I would vote in favor of using video games in the classroom
PVG3	I am enthusiastic about using video games in the classroom

Appendix B

See Table B1.

Appendix C

See Table C1.

Appendix D

See Table D1.

Table B1
Number of respondents.

Gender	Grade							
	First	Second	Third	Fourth	Fifth	Sixth	Seventh	Total
EFA sample ($n = 429$)								
Female	24	24	24	32	47	36	3	190
Male	20	26	46	45	43	53	6	239
Total	44	50	70	77	90	89	9	429
CFA sample ($n = 429$)								
Female	23	32	32	38	43	51	4	223
Male	19	29	24	47	40	42	5	206
Total	42	61	56	85	83	93	9	429
Total sample ($N = 858$)								
Female	47	56	56	70	90	87	7	413
Male	39	55	70	92	83	95	11	445
Total	86	111	126	162	173	182	18	858

Table C1
Principal axis factoring – oblimin rotation ($n = 429$).

Item	Factor				
	1	2	3	4	5
LO4	**.769**	−.057	.034	−.050	.053
LO3	**.749**	.007	−.017	.035	−.105
LO2	**.669**	−.025	.016	−.088	−.089
LO6	**.651**	.068	−.045	.017	.044
LO1	**.635**	.039	−.037	−.098	−.092
LO5	**.566**	.100	−.067	−.052	−.011
LO7	**.495**	.019	−.191	−.010	−.090
Experience2	−.051	**.883**	.040	−.104	−.053
Experience3	.099	**.874**	.025	.080	.040
Experience4	.061	**.802**	−.032	.064	.020
Experience1	−.023	**.660**	−.005	−.169	−.100
Experience5	−.111	**.517**	−.119	−.142	−.081
U4	−.060	−.052	−**.875**	−.083	.019
U2	.108	.063	−**.835**	.047	.004
U1	.037	.059	−**.834**	.005	−.006
U3	.116	−.027	−**.652**	−.014	−.183
EOU3	.082	−.017	−.005	−**.831**	−.011
EOU1	.118	.087	−.021	−**.710**	.030
EOU2	−.014	.027	−.047	−**.706**	−.060
PVG1	−.019	.055	−.046	.020	−**.903**
PVG2	.105	−.010	.029	−.036	−**.878**
PVG3	.078	.085	−.263	−.153	−**.469**

Note: EOU = ease of use; U = usefulness; LO = learning opportunities; PVG = preference for video games.

Table D1
Factor correlation matrix ($n = 429$).

Factor	LO	Experience	U	EOU	BI
LO	1.000				
Experience	.385	1.000			
U	−.640	−.455	1.000		
EOU	−.595	−.538	.578	1.000	
BI	−.556	−.482	.686	.631	1.000

Note: EOU = ease of use; U = usefulness; LO = learning opportunities; PVG = preference for video games.

Appendix E

See Table E1.

Appendix F

See Table F1.

Table E1
Goodness-of-fit indices for the $n = 429$ sample.

	$\chi^2(df)$	χ^2/df	p	RMSEA	GFI	aGFI	NFI
Sample	418 (199)	2.10	<.001	.051	.917	.894	.935

Note: RMSEA = root mean square error of approximation; GFI = goodness-of-fit index; aGFI = adjusted goodness-of-fit index; NFI = normed fit index.

Table F1
Internal consistency ($N = 858$).

Test	Scale				
	LO	Experience	U	EOU	PVG
Cronbach α	0.875	0.895	0.926	0.871	0.925

Note: EOU = ease of use; U = usefulness; LO = learning opportunities; PVG = preference for video games.

References

Adams, D. A., Nelson, R. R., & Todd, P. A. (1992). Perceived usefulness, ease of use, and usage of information technology – A replication. *MIS Quarterly, 16*(2), 227–247.

Annetta, L. A., Minogue, J., Holmes, S. Y., & Cheng, M. T. (2009). Investigating the impact of video games on high school students' engagement and learning about genetics. *Computers & Education, 53*(1), 74–85.

Bajaj, A., & Nidumolu, S. R. (1998). A feedback model to understand information system usage. *Information & Management, 33*(4), 213–224.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: Freeman.

Beck, J. C., & Wade, M. (2004). *Got game. How the gamer generation is reshaping business forever*. Boston, MA: Harvard Business School Press.

Bennett, S., Maton, K., & Kervin, L. (2008). The 'digital natives' debate: A critical review of the evidence. *British Journal of Educational Technology, 39*(5), 775–786.

Bonanno, P., & Kommers, P. A. M. (2005). Gender differences and styles in the use of digital games. *Educational Psychology, 25*(1), 13–41.

Bonanno, P., & Kommers, P. A. M. (2008). Exploring the influence of gender and gaming competence on attitudes towards using instructional games. *British Journal of Educational Technology, 39*(1), 97–109.

Bourgonjon, J., Rutten, K., Vanhooren, S., & Soetaert, R. (2008). Games als & in educatie. In E. D. Pauw, S. Pleysier, J. V. Looy, & R. Soetaert (Eds.), *Jongeren en gaming. Over de effecten van games, nieuwe sociale netwerken en educatieve kansen* (pp. 117–175). Leuven: Acco.

Boyle, E., & Connolly, T. (2008). Games for learning: Does gender make a difference? In 2nd European conference on games based learning, pp. 69–76.

Buckingham, D., & Burn, A. (2007). Game literacy in theory and practice. *Journal of Educational Multimedia and Hypermedia, 16*(3), 323–349.

Byrne, B. M. (2001). *Structural equation modeling with AMOS. Basic concepts, applications, and programming*. Mahwah, NJ: Lawrence Erlbaum Associates.

Carr, D., & Pelletier, C. (2008). Games, gender and representation. In E. R. Ferdig (Ed.). *Handbook of research on effective electronic gaming in education* (Vol. 2, pp. 911–921). Hershey, PA: Information Science Reference.

Chau, P. T. K. (1996). An empirical assessment of a modified technology acceptance model. *Journal of Management Information Systems, 13*(2), 185–204.

Conway, J. M., & Huffcutt, A. I. (2003). A review and evaluation of exploratory factor analysis practices in organizational research. *Organizational Research Methods, 6*(2), 147–168.

Costello, A. B., & Osborne, J. W. (2005). Best practices in exploratory factor analysis: Four recommendations for getting the most from your analysis. Practical Assessment. *Research & Evaluation, 10*(7), 1–9.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*(3), 319–340.

Dawes, L., & Dumbleton, T. (2002). *Computer games in education project*. UK: Becta.

Durkin, K., & Barber, B. (2002). Not so doomed: Computer game play and positive adolescent development. *Journal of Applied Developmental Psychology, 23*(4), 373–392.

Eco, U. (1979). Can television teach? *Screen Education, 31*, 15–24.

Egenfeldt-Nielsen, S. (2007). *Beyond edutainment: The educational potential of computer games*. Continuum Press.

Fabrigar, L. R., Wegener, D. T., MacCallum, R. C., & Strahan, E. J. (1999). Evaluating the use of exploratory factor analysis in psychological research. *Psychological Methods, 4*(3), 272–299.

Fengfeng, K. (2008). A case study of computer gaming for math: Engaged learning from gameplay? *Computers & Education, 1609*, 1620.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behavior: An introduction to theory and research*. Reading, MA: Addison-Wesley.

Gee, J. P. (2003). *What video games have to teach us about learning and literacy*. New York: Palgrave Macmillan.

Gefen, D., & Straub, D. (2000). The relative importance of perceived ease of use in IS adoption: A study of e-commerce adoption. *Journal of the Association for Information Systems, 1*(8), 1–30.

Ha, I., Yoon, Y., & Choi, M. (2007). Determinants of adoption of mobile games under mobile broadband wireless access environment. *Information & Management, 44*(3), 276–286.

Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. (1998). *Multivariate data analysis with readings*. Englewood Cliffs: Prentice-Hall.

Hartmann, T., & Klimmt, C. (2006). Gender and computer games: Exploring females' dislikes. *Journal of Computer-Mediated Communication, 11*(4), 910–931.

Hartwick, J., & Barki, H. (1994). Explaining the role of user participation in information system use. *Management Science, 40*(4), 440–465.

Howe, N., & Strauss, W. (2000). *Millenials rising*. The next generation. New York: Vintage Books.

Hsu, C. L., & Lu, H. P. (2004). Why do people play on-line games? An extended TAM with social influences and flow experience. *Information & Management, 41*(7), 853–868.

Hsu, C. L., & Lu, H. P. (2007). Consumer behavior in online game communities: A motivational factor perspective. *Computers in Human Behavior, 23*(3), 1642–1659.

Hu, P. J. H., Clark, T. H. K., & Ma, W. W. (2003). Examining technology acceptance by school teachers: A longitudinal study. *Information & Management, 41*(2), 227–241.

Jean, J. D., Upitis, R., Koch, C., & Young, J. (1999). The story of Phoenix Quest: How girls respond to a prototype language and mathematics computer game. *Gender and Education, 11*(2), 207–223.

King, W. R., & He, J. (2006). A meta-analysis of the technology acceptance model. *Information & Management, 43*(6), 740–755.

Kwang, H. H., & Kim, T. U. (2006). A model of user adoption of mobile games. *The Korea Society of Management Information Systems, 16*(2), 125–142.

Lau, S. H., & Woods, P. C. (2008). An investigation of user perceptions and attitudes towards learning objects. *British Journal of Educational Technology, 39*(4), 685–699.

Legris, P., Ingham, J., & Collerette, P. (2003). Why do people use information technology? A critical review of the technology acceptance model. *Information & Management, 40*(3), 191–204.

Lucas, K., & Sherry, J. L. (2004). Sex differences in video game play: A communication-based explanation. *Communication Research, 31*(5), 499–523.

Malone, T. W. (1980). What makes things fun to learn? Heuristics for designing instructional computer games. Paper presented at the 3rd ACM SIGSMALL symposium and the first SIGPC symposium on small systems.

Mathieson, K. (1991). Predicting user intentions: Comparing the technology acceptance model with the theory of planned. *Information Systems Research, 2*(3), 173–191.

McFarland, D. J., & Hamilton, D. (2006). Adding contextual specificity to the technology acceptance model. *Computers in Human Behavior, 22*(3), 427–447.

Moore, G. C., & Benbasat, I. (1991). Development of an instrument to measure the perceptions of adopting an information technology innovation. *Information Systems Research, 2*(3), 192–222.

Oblinger, D. G., & Oblinger, J. L. (2005). *Educating the net generation*. Online e-book: Educause.

Papastergiou, M. (2009). Digital game-based learning in high school computer science education: Impact on educational effectiveness and student motivation. *Computers & Education, 52*(1), 1–12.

Papert, S. (1980). *Mindstorms: Children computers and powerful ideas*. New York: Basic Books.

Prensky, M. (2001). Digital natives, digital immigrants, Part II: Do they really think differently? *On the Horizon, 9*(6), 1–9.

Rieber, L. P. (1996). Seriously considering play: Designing interactive learning environments based on the blending of microworlds, simulations, and games. *Educational Technology Research & Development, 44*(2), 43–58.

Rushkoff, D. (1997). *Ecstasy club*. San Francisco: Harper San Francisco.

Schulmeister, R. (2008). Is there a net gener in the house dispelling a mystification. *E-Learning & Education*.

Seddon, F., & Biasutti, M. (2009). Evaluating a music e-learning resource. The participants' perspective. *Computers & Education, 53*(3), 541–549.

Selim, H. M. (2003). An empirical investigation of student acceptance of course websites. *Computers & Education, 40*(4), 343–360.

Sell, K., Lillie, T., & Taylor, J. (2008). Energy expenditure during physically interactive video game playing in male college students with different playing experience. *Journal of American College Health, 56*(5), 505–511.

Sheppard, B. H., Hartwick, J., & Warshaw, P. R. (1988). The theory of reasoned action – A meta analysis of past research with recommendations for modifications and future research. *Journal of Consumer Research, 15*(3), 325–343.

Silk, K. J., Sherry, J., Winn, B., Keesecker, N., Horodynski, M. A., & Sayir, A. (2008). Increasing nutrition literacy: Testing the effectiveness of print, web site, and game modalities. *Journal of Nutrition Education and Behavior, 40*(1), 3–10.

Squire, K. D. (2008). Video games and education: Designing learning systems for an interactive age. *Educational Technology, 17*, 26.

Straub, D. W., & Burton-Jones, A. (2007). Veni, vidi, vici: Breaking the TAM logjam. *Journal of the Association for Information Systems, 8*(4), 223–229.

Taylor, S., & Todd, P. A. (1995). Understanding information technology usage – A test of competing models. *Information Systems Research, 6*(2), 144–176.

Teo, T., Lee, C. B., & Chai, C. S. (2008). Understanding pre-service teachers' computer attitudes: applying and extending the technology acceptance model. *Journal of Computer Assisted Learning, 24*(2), 128–143.

Thompson, R. L., Higgins, C. A., & Howell, J. M. (1994). Personal computing – Toward a conceptual model of utilization. *MIS Quarterly, 15*(1), 125–143.

van der Heijden, H. (2004). User acceptance of hedonic information systems. *MIS Quarterly, 28*(4), 695–704.

Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the Technology Acceptance Model: Four longitudinal field studies. *Management Science, 46*(2), 186–204.

Venkatesh, V., Morris, M. G., & Ackerman, P. L. (2000). A longitudinal field investigation of gender differences in individual technology adoption decision-making processes. *Organizational Behavior and Human Decision Processes, 83*(1), 33–60.
Verheul, I., & van Dijck, W. (2009). *Effectiviteit van een COTS game in het MBO: Oblivion. Eindrapportage*. Utrecht: CLU, Universiteit Utrecht.
Virvou, M., & Katsionis, G. (2008). On the usability and likeability of virtual reality games for education: The case of VR-ENGAGE. *Computers & Education, 50*(1), 154–178.
Watson, W. (2007). Formative research on an instructional design theory for educational video games. Unpublished doctoral dissertation, Indiana University.