The Effect of Age on Teachers' Intention to Use Educational Video Games: A TAM Approach

Antonio Sánchez-Mena[1,2], José Martí-Parreño[1] and Joaquín Aldás-Manzano[3]
[1]Universidad Europea de Valencia, Valencia, Spain
[2]Universidad Europea de Canarias, Tenerife, Spain
[3]Universitat de València, Valencia, Spain
antonio.sanchezmena@universidadeuropea.es
jose.marti@universidadeuropea.es
joaquin.aldas@uv.es

Abstract: Educational video games (EVGs) are gaining momentum as a means of increasing students' motivation in their learning process. Nevertheless, teachers might face several barriers that dissuade them from using educational video games in their courses. This study analyses factors affecting teachers´ behavioural intention to use educational video games in their courses using a Technology Acceptance Model (TAM) approach. The research model is tested via structural equation modelling (SEM) on a sample of 312 teachers in Higher Education institutions. Results suggest that perceived usefulness influences in a direct and positive way teachers' intention to use educational video games. Results also suggest that perceived ease of use indirectly influence intentions through perceived usefulness. Age was found to moderate the effect of teachers' perceived ease of use on perceived usefulness of EVGs. Regarding managerial implications, our findings highlight the importance of addressing specific Teacher Training Programmes focusing on teachers' age and perceived usefulness of EVGs in order to encourage teachers to adopting this educational innovation in their courses. Limitations of the study and future research lines are also addressed.

Keywords: Educational Video Games; TAM (Technology Acceptance Model); Higher Education; Behavioural intention; Age

1. Introduction

Educational video games (EVGs) represent a great opportunity to motivate and to engage students in their learning process and they are gaining momentum among teachers and educational researchers. In fact, game-based learning research has increased fivefold over the last five years (Martí-Parreño, Méndez-Ibáñez, and Alonso-Arroyo, 2016). Recent academic research on the topic has approached the subject from different angles including learning outcomes when using EVGs (e.g. Boyle et al. 2016), instructional effectiveness (e.g. Sitzmann, 2011), or citation analysis (e.g. Harman, Koohang & Paliszkiewicz, 2014) to name a few.

Academic literature suggests a wide variety of subjects in which a game-based learning approach to education has been successfully applied. These subjects include citizenship education (Lim and Ong, 2012), nanotechnology (Blonder and Sakhnini, 2012), energy education (Yang, Chien and Liu, 2012), health education (Sung, Hwang and Yen, 2015), veterinary education (De Bie and Lipman, 2012), Newtonian physics (Shute, Ventura and Kim, 2013) and language teaching (Reinders and Wattana, 2014) among others. Extant academic literature also suggests that game-based learning can be used to develop high order cognitive abilities such as problem solving skills (Oblinger, 2004; Klopfer and Yoon, 2005) and the so-called 21st Century skills such as teamwork, communication skills, and social/cultural skills (Romero, Usart, and Ott, 2015).

Although a game-based approach to education can be traced back to the sixties (Piaget, 1962), the benefits of using EVGs have been pointed out more recently (Prensky, 2001). These benefits include a higher learning motivation for digital natives who make an intense use of technology and digital interactivity and for whom traditional learning methodologies do not appeal or motivate anymore (Prensky, 2001). Video games also favour a trial-and-error process that makes mistakes recoverable (Hanus and Fox, 2015) and gives students the freedom to fail without fear when learning (Lee and Hamer, 2011). Moreover, video games provide immediate and frequent feedback (Kapp, 2012) and allow teachers to tailor difficulty progression that facilitates scaffolded instruction based on each individual student´s needs (Hanus and Fox, 2015). Students also benefit from the visual display of their learning progress for example through badges– (Kapp, 2012), and they can be motivated through competition for example through leaderboards– (Camilleri, Busuttil, and Montebello, 2011).

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Despite all these potential benefits of EVGs, a game-based approach to education has also been criticized because game-based learning competition can foster adverse effects in social interaction amongst students in the classroom (Brom et al, 2014). Gaming can also potentially cause anxiety and embarrassment among students (Henderson, 2005) especially when leaderboarders are used and students ranking in lower positions feel they are performing badly if compared to other students in the classroom. It has also been stated that game-based learning often concerns repetition of cyclic content that provokes persistent re-engagement which tends to address lower level learning goals rather than higher level goals (Ma et al, 2007).

EVGs also represent a challenge for teachers who are not familiar with this type of educational innovation. Previous research found that teachers can face new technological developments in education as a threat and technological innovations can be a cause of much anxiety (Goodwyn, Adams, and Clarke, 1997). Factors such as stress or anxiety towards technological innovations along with uncertainty in the expected outcomes of technological innovations can act as barriers to teachers adopting technological innovations such as EVGs. However, it has been stated that teachers are the true agents of change in schools (Teo, 2008) and the use of EVGs depends largely on the acceptance by classroom teachers (Bourgonjon et al., 2013; Niederhauser & Stoddart 2001).

Thus, the main goal of this research is to explore teachers' intention to use EVGs using the technological approach proposed by the Technology Acceptance Model or TAM (Davis, 1985). TAM (Davis, 1985) was developed to predict an individual's likelihood of accepting a technological innovation. Because EVGs can be considered a technological educational innovation using TAM is a suitable framework to exploring teachers' intention to use EVGs. In fact, a meta-analysis conducted by Sumak, Hericko, and Pusnik (2011) pointed out that TAM was the most popular theory among models exploring e-learning acceptance. Because age might affect attitude towards technological innovations the moderating role of age is also analysed.

This paper is structured as follows. First, a literature review of game-based learning and educational video games is presented. Second, we present TAM and set the hypotheses. Third, the method is explained. Then we discuss the results. Finally, conclusions, limitations of this study and future research lines are addressed.

2. Game-Based Learning and EVGs

A review of the literature clearly suggests that different constructs have been used to refer to game-based learning. These constructs include gamification and serious games. Gamification has been defined as "the use of game design elements in non-game contexts" (Deterding et. al. 2011, p. 9), and seems to broaden previous constructs such as serious games and educational games in the sense that a game (or video game) is not needed. Gamification focuses on game design and game mechanics, that is, contrasts "gamification" "against other related concepts such as serious games via the two dimensions of playing/gaming and parts/whole" (Deterding et. al. 2011, p. 5). Rather than using a (video)game in the classroom the teacher "makes the class itself a game" (Hanus & Fox 2015). Van Eck (2006) summarizes the use of video games in education in three main strategies: a) the use of commercial off-the-shelf videogames (COTS) that take advantage of the existence of contents in these games that can be used for educational purposes, b) the use of serious games – a type of video games developed with non-recreational purposes where learning is the primary goal–, and c) to make students build their own games allowing the development of problem-solving abilities, programming skills and game design skills. Examples of the use of commercial off-the-shelf videogames include the use of *SimCity* to strengthen leadership decision-making (Lin and Lin, 2014) and *RollerCoaster Tycoon* 3 which has been used to support student learning of systems thinking (Shah and Foster, 2014). Serious games have been defined as "video games (VGs) intended to serve a useful purpose" (Girard, Ecalle, and Magnant, 2012, p. 207) where the "useful purpose" is learning. Examples of the use of serious games include mass-market serious games like *Where in the World is Carmen Sandiego?* which was developed to teach geography (Sitzmann, 2011). Other examples of serious games are ETIOBE Mates which was developed to improve children's nutritional knowledge (Baños et al., 2013) and ECOPET which was developed to educate learners to use home-energy conservatively (Yang, Chien, and Liu, 2012). One example of making students build their own video games as part of their learning process is the case provided by Yang and Chang (2013) where students designed digital games based on biology course content to increase retention of both course content and critical thinking skills.

3. Hypotheses development and research model

The Technology Acceptance Model or TAM (Davis, 1985) was developed to predict an individual's likelihood of accepting a technological innovation. More specifically, TAM was developed to predict computer-based systems acceptance such as email services. Since its development TAM has been widely applied to different technological innovation including mobile commerce (Wu, and Wang, 2005), internet banking (Lai and Li, 2005), and the adoption of mobile internet (Hong, Thong, and Tam, 2006). TAM has also been applied to different educational contexts such as online education (Ngai, Poon, and Chan, 2007) and mobile learning (Liu, Li, and Carlsson, 2010). One of the main goals of TAM was to identify the major motivational variables that mediate between system characteristics and the actual use of the system. Davis (1985) identified two major variables influencing attitude towards a given technological innovation: a) perceived usefulness and b) perceived ease of use. Both perceived usefulness and perceived ease of use are directly influenced by design features. Finally, attitude influenced the adoption of the system, i.e. whether it was used.

3.1 Perceived usefulness

Perceived usefulness is defined as 'the degree to which an individual believes that using a particular system would enhance his or her job performance' (Davis, 1985, p. 26). Hence, this variable measures the utilitarian dimension of adopting the technology on the basis that users expect that the use of the technology will facilitate them in accomplishing the tasks to be developed. Specifically, perceived usefulness refers to effectiveness at work, productivity understood as time saving and the relative importance of the system for the individual's work (Davis, Bagozzi, and Warshaw, 1989). Within our conceptual framework, perceived usefulness of educational video games can be conceptualized as the degree to which teachers believe that using educational video games would enhance their job, that is, help them to improve students' learning (for example, students will learn faster). It is important to point out that we adopt a student-centric approach to perceived usefulness, this is, instead of asking teachers if they believe that educational video games enables them "to enhance their teaching" we ask them if they believe educational video games enhance students´ learning. The expectation-value model asserts that a relationship between perceived usefulness and attitude exists (Fishbein and Ajzen, 1975). Thus, the following hypothesis is posited:

H1: teachers´ perceived usefulness of educational video games has a positive influence on attitude towards educational video games.

3.2 Perceived ease of use

Perceived ease of use is defined as 'the degree to which an individual believes that using a particular system would be free of physical and mental effort' (Davis, 1985, p. 26). Hence, this variable can be used to measure both teachers' physical costs (e.g. time devoted to preparing gamified classes) and mental costs (e.g. switching from traditional teaching methodologies to new teaching methodologies). Perceived ease of use can affect attitude in two ways: perceived self-efficacy and instrumentality (Davis, Bagozzi, and Warshaw, 1989). Perceived self-efficacy refers to the expectancy of performing well when interacting with the system while instrumentality refers to the expectancy that performing well will lead to rewards. The easier the interaction within the system (for example EVGs) the higher an individual's sensation of efficiency and control (Bandura, 1982). If teachers experience difficulties working with educational video games they will show negative attitudes towards educational video game. Thus, the following hypothesis is posited:

H2: teachers' perceived ease of use of educational video games has a positive influence on attitude towards educational video games.

3.3 Perceived ease of use and Perceived usefulness

Perceived ease of use influences perceived usefulness because a system's simplicity can improve results and a technology is perceived as being more useful if it is easier to use (Davis, 1985). Later studies focused on e-learning services show evidence that perceived ease of use has influence on perceived usefulness (Okazaki and Renda Dos Santos, 2012). Therefore, if teachers perceive educational video games easy to use they will perceive educational video games useful. Hence, the following hypothesis is posited:

H3: teachers' perceived ease of use of educational video games has a positive influence on their perceived usefulness of educational video games.

3.4 Attitude and behavioural intention

Attitude is an individual's positive or negative evaluation of a given object or behaviour (Ajzen, 1991) and includes feelings or affective responses. Attitude also refers to an individual's general willingness to engage in a given behaviour. This attitude is the result of individuals' beliefs concerning the behaviour, the results of that behaviour and the importance attached to such beliefs. Social psychology literature clearly suggests that attitude has two components: affective and cognitive (Bagozzi and Burnkrant, 1979). The affective component refers to what extent a person likes the object of his thoughts (McGuire, 1985) and measures the degree of emotional attraction to the object. The cognitive component refers to an individual's specific beliefs about the object (Bagozzi and Burnkrant, 1985) and consists of a value-based assessment, judgment, reception or perception of the object (Chaiken and Stangor, 1987). Behavioural intention is defined as 'an individual's subjective probability that he or she will perform a specified behaviour' (Fishbein and Ajzen 1975, p. 288) and is a better predictor of actual behaviour than attitude when an intention has been formed (Warshaw and Davis, 1985). Literature review clearly shows a direct and positive relationship between a person´s attitude towards an object or behaviour and that person´s behaviour (Brown and Stayman, 1992) so the following hypothesis is posited:

H4: teachers' positive attitude towards educational video games will have a positive influence on teachers´ behavioural intention to use educational video games.

3.5 The moderating role of age

Older teachers are more experienced than newer teachers are and previous research found that prior experience influences teachers' actions (Pajares 1992). Even for student teachers prior experience has been found to inform their beliefs about practice (Calderhead and Robson 1991).

Academic literature also suggests that age is a factor that might moderate teachers' behavioural intentions, including teachers' use of technology. In fact, Goodwyn et al. (1997) found that older teachers perceive Information and Communication Technologies (ICTs) as a threat and cause of anxiety. Hamari and Nousiaien (2015) found that age affected teachers' perceived value of EVGs. Therefore, the following hypotheses are posited:

H5: age will moderate the effect of teachers' perceived usefulness on attitude towards educational video games.

H6: age will moderate the effect of teachers' perceived ease of use on perceived usefulness of educational video games.

H7: age will moderate the effect of teachers' perceived ease of use on attitude towards educational video games.
Figure 1 depicts a graphical representation of the research model.

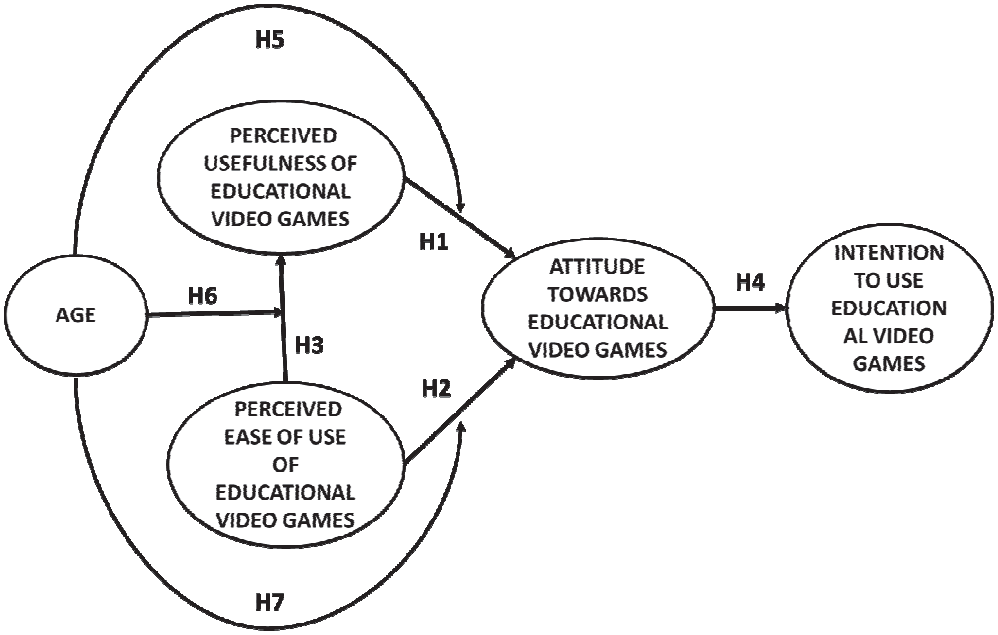

Figure 1: Graphical representation of the reseaarch model

4. Method

An exploratory transversal study involving teachers serving in Higher Education institutions was used in this research. Data was gathered through an online questionnaire. Snowball sampling (Goodman, 1961) was used for selection of respondents in this study. Although snowball sampling is unlikely to obtain a representative sample because there is no real control of the snowball effect (Hall and Hall 1996), this form of sampling is often used in online questionnaires to target hard-to-reach population subgroups (Sadler, Lee, Lim, and Fullerton, 2010).

4.1 Sample

A total of 312 teachers serving in Higher Education institutions completed the online questionnaire. The age of the participants ranges between 26 and 65 years, with an average of 42.8 years and 52.4% are males.

4.2 Survey instrument

All items used to develop the questionnaire were adapted from existing scales previously validated in the academic literature: ten items were adapted from Davis (1985) to measure perceived ease of use (e.g. “It is easy for me to use educational video games in my classes”); ten items were adapted from Davis (1985) to measure perceived usefulness (e.g. “Overall, I find educational video games useful to learn”; three items were adapted from Taylor and Todd (1995) to measure attitude (e.g. “My attitude towards educational video games is positive”); and three items were adapted from Shimp and Kavas (1984) to measure behavioural intention (e.g. “My general intention to use educational video games in my classes in the future is high”). All questionnaire items were measured using a 5-point Likert-type scale where (1) = strongly disagree, and (5) = strongly agree.

4.2.1 Measurement model validation

As shown in tables 1 and 2, the measurement model shows evidence of reliability and convergent validity as composite reliability indicators and Cronbach’s alpha are higher than .90 and AVEs are also higher than .50. All the standardized loadings are significant and higher than the generally accepted minimum cut off score of .70 (Nunnally and Bernstein, 1994; Fornell and Larcker, 1981). Regarding discriminant validity correlations among factors are always lower than their correspondent AVE square root and ratio HTMT is lower than .50

Table 1: Reliability and convergent validity

Factor	Item	Loading	t-value	CA	CR	AVE
Attitude	ATT1	0,94	62,84 **	0,95	0,97	0,92
	ATT2	0,98	201,75 **			
	ATT3	0,95	61,14 **			
Perceived ease of use	EOU1	0,76	23,02 **	0,92	0,93	0,58
	EOU2	0,80	25,90 **			
	EOU3	0,64	11,73 **			
	EOU4	0,82	29,72 **			
	EOU5	0,68	15,69 **			
	EOU6	0,82	26,92 **			
	EOU7	0,76	17,79 **			
	EOU8	0,74	14,35 **			
	EOU9	0,77	17,44 **			
	EOU10	0,81	22,00 **			
Intention to use	INT1	0,91	76,72 **	0,87	0,92	0,79
	INT2	0,92	62,97 **			
	INT3	0,83	17,94 **			
Perceived usefulness	PU1	0,89	52,22 **	0,96	0,96	0,71
	PU2	0,81	26,45 **			
	PU3	0,83	32,58 **			
	PU4	0,81	29,16 **			
	PU5	0,77	16,22 **			
	PU6	0,90	50,46 **			
	PU7	0,79	27,44 **			
	PU8	0,91	64,20 **			
	PU9	0,88	45,73 **			
	PU10	0,85	31,59 **			

** p<0.01

Note: CA=Cronbach's alpha; AVE=Average Variance Extracted; CR=Composite Reliability

Table 2: Discriminant validity

Factor	F1	F2	F3	F4
F1. Attitude	0,96	0,40	0,88	0,75
F2. Perceived ease of use	0,38	0,76	0,34	0,46
F3. Intention to use	0,81	0,31	0,89	0,70
F4. Perceived usefulness	0,72	0,45	0,64	0,84

Note. Diagonal: square root of AVE; Lower triangle: factor correlation; Upper triangle: ratio HTMT

Figure 2 depicts a graphical representation of the measurement model with the factor loadings.

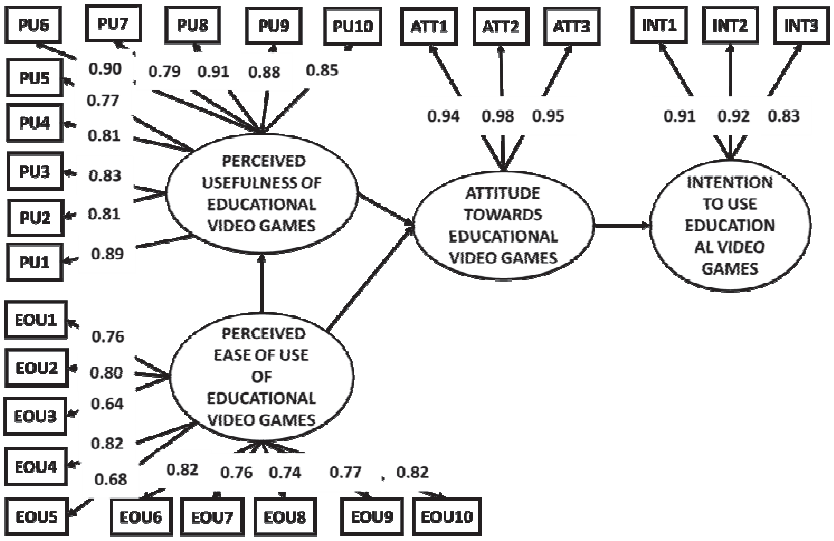

Figure 2: Graphical representation of the measurement model with the factor loadings

5. Results

The structural model was estimated using PLS-SEM. R2 of all the dependent latent variables are higher than 10% and Stone-Geisser Q2 are positive confirming the predictive relevance of the model. The effect of perceived usefulness (H1, beta=0.68; p<0.01) on attitude is significant. Although ease of use improves perceived usefulness (H3, beta=0.43; p<0.01), it has not a significant direct effect on attitude (H2, beta=0.06; p>0.05), showing that ease of use itself cannot foster EVGs use without the mediation of perceived usefulness. A significant attitude significantly causes intention to use EVGs favourably perceived (H4, beta=0.81; p<0.01). Age was found to moderate teachers' perceived ease of use on perceived usefulness of EVGs (H6, beta=0.07; p<0.05). Nevertheless no moderating effect was found neither for perceived usefulness and attitude (H5, beta=0.03; p>0.05) nor for ease of use on attitude (H7, beta=0.00; p>0.05). Table 3 shows the hypotheses testing results.

Table 3: Hypotheses testing

Hypotheses		Std. Beta		t-value
H1	Perceived usefulness -> Attitude	0,68	**	9,28
H2	Perceived ease of use -> Attitude	0,06		0,85
H3	Perceived ease of Use -> Perceived Usefulness	0,43	**	6,30
H4	Attitude -> Intention to use	0,81	**	23,43
H5	Age x (Perceived usefulness-->Attitude)	0,03		0,55
H6	Age x (Perceived ease of Use -> Perceived Usefulness)	0,07	*	2,04
H7	Age x (Perceived ease of Use ->Attitude)	0,00		0,06

**p<0.01 *p<0.05

R2 (Intention to use)=0.653; R2(Attitude)=0.524; R2 (Perceived usefulness)=0.219

Q2 (Intention to use)=0.485; Q2(Attitude)=0.441; Q2 (Perceived usefulness)=0.148

6. Discussion

Results suggest that perceived usefulness is a main antecedent of attitude towards EVGs, that is, the higher the teachers' perception of usefulness of EVGs the better the teachers' attitude towards EVGs. This is consistent with previous findings that have used TAM to test attitude and adoption of technological developments in education such as a Skype-Based E-Learning System (Martí-Parreño et al, 2013). This finding is also consistent with previous TAM studies analysing secondary school teachers' acceptance of EVGs (Bourgonjon et al., 2013). Although a direct effect of ease of use on attitude was not found, ease of use indirectly influences attitude through perceived usefulness. This has an explanation following this rationale:

teachers might not have a positive attitude towards EVGs just because they perceive EVGs as easy to use but teachers must perceive that EVGs are useful to enhance their teaching activity. Attitude towards EVGs directly and positively influences teachers' intention to use EVGs in their courses, that is, teachers having a positive attitude towards EVGs show behavioural intention to use EVGs. This finding is also consistent with extant literature that found the relationship between attitude and behavioural intention (Warshaw and Davis, 1985).

Regarding the moderating effect of age, results suggest that the effect of teachers' perceived ease of use on teachers' perceived usefulness of EVGs is moderated by this factor. Broadly speaking, how useful EVGs are perceived is a direct effect of how ease of use teachers perceived EVGs differs among older and younger teachers. This is an important finding that must be taken into account when developing Teacher Training Programmes as it suggests a generational gap that might affect teachers' adoption of EVGs. Moreover, considering that perceived usefulness has been found as the main factor contributing to teachers' attitudes towards EVGs this moderating effect of age deserves more attention to delve into factors that contribute age differences on the effect of teachers' perceived ease of use of EVGs on teachers' perceived usefulness of EVGs. However, no moderating effect of age was found either for perceived usefulness and teachers' attitude or for perceived ease of use and teachers' attitude. That is, age is independent of how teachers' perceived usefulness and perceived ease of use of EVGs affects their attitude towards EVGs. Teacher Training Programmes should focus then on different approaches to older and younger teachers because perceptions in both groups of teachers vary regarding how their perceived ease of use of EVGs affects their perceived usefulness of EVGs and consequently their attitude and finally their behavioural intention to use EVGs in their courses.

7. Conclusions, limitations and future research

One main conclusion of this study is that teachers' perceived usefulness is a key factor to predict teachers' intention to use EVGs. This finding suggests that managers of Higher Education institutions who want teachers to use EVGs in their courses should encourage them to enrol in specific Teacher Training Programmes that focuses in highlighting how useful EVGs can be in their teaching activity and how EVGs can benefit students' learning. Because ease of use does not affect teachers' attitude towards EVGs (only indirectly through perceived usefulness), Teacher Training Programmes should not encourage teachers to use EVGS just because EVGs are easy to use but to use EVGs because they can be a useful resource to apply in the classroom. For example, EVGs can be used as a means of motivating students to learn in a more entertaining way and also to increase students' engagement with the learning activities. Teacher Training Programmes should also consider the age of teachers and especially how age moderates the effects of perceived ease of use on perceived usefulness. For example, the effect of perceived ease of use on perceived usefulness in younger teachers might rely on their greater familiarity with video games compared to older teachers. Future research should delve into factors that better explain this moderating role of teachers' age. Because both perceived usefulness and perceived ease of use are directly influenced by design features, future research should also explore EVGs design factors (e.g. difficulty level, course and subject suitability, learning goals…) that might affect teachers' perceived usefulness and perceived ease of use of EVGs. For example, teachers' perceptions on how the content of EVGs can fit the subject they teach or how EVGs' features can increase students' learning could provide a better understanding of key drivers of teachers' perceived usefulness of EVGs.

One main limitation of this study is the use of a convenience sample that does not allow the representation of the target population. Future research should use a probabilistic sample that better represents the target population. Because culture affects human behaviour, future research should be developed within a cross-cultural framework in order to gain a better knowledge of cultural differences when adopting EVGs. Gender can also affect attitudes and behavioural intentions to use EVGs. More research is needed in order to better understand the role of gender in teachers' intention to EVGs. The educational level (primary school, secondary school…) can also affect teachers' decisions about whether to implement EVGs in their course or not. Future research should explore differences in teachers' intention to use EVGs across educational levels but also across institution characteristics, such as public or private schools. Finally, as this study adopts a teacher-centric approach future research should use a student-centric approach in order to better understanding students' intention to use EVGs.

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