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# Students' attitude towards the use of educational video games to develop competencies

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ABSTRACT

The use of educational video games (EVGs) is gaining momentum as a means to motivate and to engage students in their learning process. Nevertheless, previous research is taking for granted that students have a positive attitude towards EVGs and did not ensure a proper understanding of students' characteristics that might influence their attitude towards them. Therefore, this study's main goal is to explore four students' characteristics (perceived relevance, perceived confidence, media affinity, and perceived self-efficacy) that influence students' attitude towards the use of EVGs to develop competencies. Using the fsQCA method to analyze data gathered on a sample of 128 undergraduate students we delve into different configurations underlying students' positive and negative attitude towards the use of EVGs. Main results suggest three configurations leading to a positive attitude with perceived relevance being a necessary and sufficient condition for students' positive attitude towards the use of EVGs to develop their competencies. Four configurations were found to condition a negative attitude suggesting that equifinality can be considered when explaining students' attitude towards the use of EVGs to develop competencies. Implications for teachers, limitations of the study, and future research lines are addressed at the end of the paper.



## 1. Introduction

Educational video games (EVGs) represent a promising tool to motivate and to engage Higher Education students who have disengaged from traditional learning methodologies. In fact, literature review suggests that traditional learning methodologies are not appealing students to study anymore while EVGs can be used to encourage students to learn in new ways or enjoy otherwise tedious tasks (Hanus & Fox, 2015). Moreover, EVGs can support active learning (Oblinger, 2004) and provide immediate and frequent feedback of the learning progress using visual displays like badges and points (Kapp, 2012). It is also assumed that the elements that make games fun along with the nature of games themselves are intrinsically motivating (Adams, Mayer, MacNamara, Koenig, & Wainess, 2012).

The use of video games in education has been summarized in three main strategies (Van Eck, 2006): 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 video games include the use of *World of Warcraft* to increase social competence (Visser, Antheunis, & Schouten, 2013). Serious games have been defined as video games intended to serve a useful purpose (Girard, Ecalle, & Magnant, 2013) where the useful purpose is learning. Examples of the use of serious games include *Blokify* which was created to develop students' competencies related to three-dimensional figures and their bidimensional representation by the standard views and perspective (Saorin, De la Torre Cantero, Díaz, Meier, & Trujillo, 2015). One example of making students to build their own video games as part of their learning process is the case provided by Yang and Chang (2013) where students designed

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digital games based on biology course content to increase retention of course content and critical thinking skills.

Extant academic literature also supports the use of EVGs to develop students' competencies. For instance, Sánchez and Olivares (2011) found that mobile video games improved students' problem solving and collaboration skills. Sung, Hwang, and Yen (2015) found that their custom-designed serious digital game not only improved students' problem-solving competencies but also learning motivation and learning achievement. Reinders and Wattana (2014) also found that an online role-playing video game improved students' communication skills. Finally, Romero, Usart, and Ott (2015) suggest that serious games can contribute to develop the so-called 21st Century skills such as teamwork and social/cultural skills.

Nevertheless, literature review also suggests that students show different attitude towards active learning methodologies (Livingstone & Lynch, 2000). Therefore, because EVGs are an active learning methodology they might arise both positive and negative attitude among students. Hence, students' positive attitude towards EVGs as a learning methodology cannot be taken for granted. In fact, as gamification is maturing as a field of study it has been pointed out that gamification research is moving from "what?" and "why"? to "how?", "when?" and "how and when not?" (Nacke & Deterding, 2017). That is, there is a need to better know how and when EVGs are working and how and when they are not. A better understanding of students' attitude towards EVGs is important because students play a key role in the choice of learning activities and the amount of effort they put in them (Mikropolous & Natsis, 2011). Moreover, attitude is a strong predictor of behavior (Davis, 1985) so a better knowledge of variables influencing students' attitude towards the use of EVGs to develop their competencies can contribute to a deeper understanding of students' acceptance of EVGs. We also take into account that the assumption that the mirror opposite of a complex statement indicates the opposite outcome is often inaccurate, as causal asymmetry occurs frequently in real-life contexts (Woodside, 2016). Therefore, the purpose of this research, and one main contribution of this study using fsQCA, is not only to analyze which students' characteristics (causal conditions) lead to a positive attitude towards the use of EVGs but also to a negative attitude. FsQCA (Fuzzy-set Qualitative Comparative Analysis) allows the possibility of considering equifinality (Fiss, 2011) rather than a single net effect and has been used to research a wide variety of topics in education that range from Higher Education Institution reputation (Plewa, Ho, Conduit, & Karpen, 2016) to quality of MBA faculty members (Tho, 2017). For example, Plewa et al. (2016) used fsQCA to identify nine configurations leading to Higher Education Institution reputation for domestic students and six configurations for international students. Tho (2017) found that teaching investment combines with signal clarity, signal consistency, and signal credibility to form sufficient conditions for the occurrence of teaching quality. Pappas, Giannakos, Jaccheri, and Sampson (2017) used fsQCA to identify configurations for high intention to continue studies in computer science. Cooper (2005) used both crisp and fuzzy set versions of QCA to study the relations between social class origin, sex, ability and educational achievement. The study pointed out both the strengths and the difficulties of employing QCA with a large dataset, especially the problem of calibrating membership in fuzzy sets in a context where detailed case knowledge is not available. Finally, Tho and Trang (2015) used fsQCA to analyze in-service training students' sufficient conditions for knowledge transfer from business schools to business organizations. Main results of their research suggest a configuration of three factors (knowledge acquired from business schools by students, students' intrinsic motivation, and innovative culture of business organizations) for this knowledge transfer to occur.

Despite all these contributions to educational research applying fsQCA, to the best of our knowledge no prior research has applied fsQCA to identify variables influencing students' attitude (positive/negative) towards EVGs. Therefore, a main contribution of this research lies in the application of fsQCA as an alternative technique to explain students' attitude towards the use of EVGs to develop competencies. Accordingly, the use of this methodology in the study shows how complexity theory can be a useful tool for testing theory that goes beyond the more traditional or usual approaches of considering multiple regression analysis techniques of net effects of main and interaction terms (Woodside, 2014).

With this goal in mind, this paper is structured as follows: first, academic literature is reviewed in order to set the propositions. Second, the method is explained. Third, results are presented, the propositions are tested, and results are discussed. Finally, conclusions, limitations of the study, and future research lines are addressed.

## 2. Literature review

We use a motivation theory approach in this research. While TAM-related factors such as perceived usefulness and social norms have been widely used in educational research to study factors contributing attitude towards the use of EVGs (e.g., Bourgonjon et al., 2013) prior research using motivational variables influencing students' attitude towards EVGs is scarcer. Also, while Sumak, Hericko, and Pusnik (2011) found that TAM factors (perceived usefulness and perceived ease of use) influenced attitudes of users towards using an e-learning technology their meta-analysis also found a moderating effect for user-related factors. In fact, TAM has been criticized for not fully taking into account individual, organizational, and contextual characteristics (Mathieson, 1991; McFarland & Hamilton, 2006). By analyzing four individual characteristics (perceived relevance, perceived confidence, media affinity, and perceived self-efficacy) we aim to expand prior research delving into students' attitude towards EVGs. To achieve this purpose, we test two Keller's (1987) ARCS model variables (relevance and confidence) as variables influencing students' attitude towards the use of EVGs to develop their competencies. Keller's (1987) ARCS model is one of the most widely mentioned theories of motivation in education and it has been suggested that should become the standard by which a game increases learning motivation (Karoulis & Demetriadis, 2005). In fact, Keller's (1987) ARCS model has been broadly used to evaluate and design instructional programs' motivational stimuli (Chang & Lehman, 2002; House, 2003; Song & Keller, 2001; Wongwiwatthananukit & Popovick, 2000). Keller's (1987) ARCS model has also been tested in computer-based learning (Huang, Huang, Diefes-Dux, & Imbrie, 2006) and gamification contexts (Dempsey & Johnson, 1998; Klein, 1992; Su & Cheng, 2015).

As all motivation theories, Keller's (1987) ARCS model assumes that individuals are motivated to the extent that their behavior is expected to lead to desired outcomes (Robbins, 2005). The expected outcome is derived from the expectancy-value theory (Lewin, 1935; Tolman, 1932) which assumes that people are motivated to engage in an activity "if it is perceived to be linked to the satisfaction of personal needs (the value aspect), and if there is a positive expectancy for success (the expectancy aspect)" (Keller,

1987, p. 3). Human behavior is then "a compound function of perceived probability for success (expectancy) and perceived impact of the success (value)" (Huang, Huang, & Tschopp, 2010, p. 790).

### 2.1. Relevance

Relevance indicates both the process and the value of the learning content to the learner (Keller, 1987). Relevance is not related only to the content being learned but also to the way the content is taught (Keller, 1987). We conceptualize relevance as students' beliefs that EVGs will provide learning value to them and that value comes from materials used (EVGs) but also from the way the learning content is taught (a game-based learning approach). As video games are intrinsically motivating (Adams et al., 2012) we assume that students might evaluate the use of EVGs as relevant to develop their competencies because the motivating nature of EVGs will help them to achieve their learning goals. Therefore, we assume that students' perceived relevance will lead a positive attitude towards the use of EVGs to develop their competencies.

### 2.2. Confidence

Confidence —or expectancy for success— is an important motivational driver which can influence learners' persistence and accomplishment (Keller, 1987). Because fear of failure is important for students (Keller, 1987), students can be worried about their inability to properly use EVGs to develop their competencies. Extant literature of game-based learning suggests that students better control their learning process by means of immediate and frequent feedback used in games (Kapp, 2012). Game-based learning also allows scaffolded instruction based on each individual student's needs (Hanus & Fox, 2015), that is, using EVGs students can learn at their own pace. The visual display of progress (e.g., badges) used in game-based learning (Kapp, 2012) can also facilitate students' control of their learning process through EVGs. Therefore, we assume that students' perceived confidence to use EVGs will lead a positive attitude towards the use of EVGs to develop their competencies.

Due to the specific nature of video games (a mediated interactive medium) we include in our research model two additional variables along with confidence and relevance that might influence students' attitude towards the use of EVGs to develop their competencies: media affinity and self-efficacy.

### 2.3. Media affinity

Media affinity refers to the importance that a medium has in the lives of individuals (Perse, 1986; Rubin, 1981). This construct has been used to assess the attitudes of individuals towards the medium and the contents delivered by the medium (Aldás, Ruiz, & Sanz, 2009; Ruiz, Sanz, & Tavera, 2010). For example, studies focused on interactive media suggest that media affinity is an important factor that influences future behavioral intentions (Bigné, Miquel, Ruiz, & Sanz, 2007). In this sense, previous research found that the affinity towards the mobile phone had a direct and positive influence on the intention to engage in mobile shopping (Aldás et al., 2009). Ruiz et al. (2010) also suggest that affinity towards television programs determine SMS acceptance to participate in TV programs. Following this rationale, and because behavioral intentions in technology-driven contexts are mediated by individuals' attitudes (Davis, 1985), we assume that individuals' media affinity (in this case, how important video games are for students) will affect students' attitude towards the use of EVGs to develop their competencies.

### 2.4. Self-efficacy

Self-efficacy refers to an individual's belief on his/her ability to achieve a desired outcome and is an important antecedent of motivation and behavior (Bandura, 1982). Educational research suggests the importance of self-efficacy as a predictor of students' performance (Pintrich & De Groot, 1990) and future learning outcomes (Pajares, 1996). Moreover, academic literature suggests that individuals' positive judgements about their ability to achieve a desired outcome influence the acceptance of technological tools in education (Teo, 2011). Previous research also found that when players' self-efficacy for challenges they must face in a game is higher the players are more likely to engage in the game (Eseryel, Law, Ifenthaler, Ge, & Miller, 2014). Moreover academic self-efficacy has been found to be an important mediator of students' learning behaviors (Meluso, Zheng, Spires, & Lester, 2012) and affects students' choice of learning activities and the amount of effort they attribute to learning while playing EVGs (Mikropolous & Natsis, 2011). Therefore, we assume that perceived self-efficacy using EVGs will affect students' attitude towards the use of EVGs to develop their competencies.

### 2.5. Research propositions and research question

As Wu, Yeh, Huan, and Woodside (2014) point out, the word hypothesis is usually associated with statistical hypothesis testing in behavioral social science. However, in fsQCA no statistical hypothesis testing is developed, so it is more common to use other words such as tenet or proposition to express testable precepts of complexity. *Proposition* is the term in-use here to posit the precepts to be tested in the context of this research.

Configurational analysis stresses several tenets in the study of antecedent conditions. In this research, the analyzed students' characteristics are *perceived relevance*, *perceived confidence*, *media affinity*, and *self-efficacy* affecting an outcome: *students' attitude towards the use of EVGs to develop their competencies*. As Isaksson and Woodside (2017) posit, "building from complexity theory, a configurational analysis includes the propositions that a complex multiple recipe lead to the same outcome (equifinality tenet) whereby variables (ingredients) found to associate causally in one configuration may be absent in another recipe or even inversely

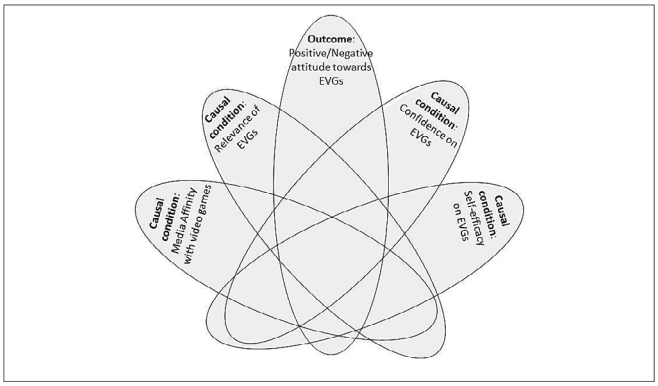


**Fig. 1.** Illustration of the conceptual model.

related in a third recipe associated with this same outcome" (p. 185). The configurational approach permits complexity to be captured, as it identifies sets of different configurations which consist of "patterns of attributes" (Fiss, 2007, p. 1181). In this research, configurations are different possible combinations of students' characteristics that collectively exhaust a large fraction of the phenomenon under consideration (attitude) (Miller & Friesen, 1984).

Extant literature suggested us to support a main effect between each of the aforementioned specific students' characteristic and students' attitude towards the use of EVGs to develop their competencies. However, the reviewed literature has not considered all the characteristics altogether. Consequently, equifinality tenet could be considered and, as a consequence, for having a positive (or negative) attitude towards EVGs students would not need showing the characteristics altogether.

Fig. 1 shows a Venn diagram that helps to visually conceptualize the relationships suggested. The overlapped areas represent the possible combinations among the variables under analysis, in other words, those are areas on which distinct students' characteristics (including students' attitude towards EVGs) may co-exist with the rest.

Based on this rationale, the first two propositions of this research are set:

**Proposition 1**. No single configuration of students' perceived relevance, perceived confidence, media affinity, and perceived self-efficacy, leads to a positive (1a) or a negative (1b) attitude towards the use of EVGs to develop students' competencies. Rather, there exist multiple, equally effective configurations of causal factors.

**Proposition 2**. Single causal conditions (students' perceived relevance, perceived confidence, media affinity, and perceived self-efficacy) may be present or absent within configurations for students' positive (2a) or negative (2b) attitude towards the use of EVGs, depending on how they combine with other causal conditions.

As suggested previously, configural theory also stresses the tenet of causal asymmetry, which implies that the causes leading to the presence of an outcome may be quite different from those leading to the absence of the outcome (Ragin, 2008a). Within the context of our research, we then suggest the third proposition:

**Proposition 3**. Configurations of students' perceived relevance, perceived confidence, media affinity, and perceived self-efficacy, leading to a positive attitude towards the use of EVGs are not the same of those configurations of students' perceived relevance, perceived confidence, media affinity, and perceived self-efficacy leading to a negative attitude.

Finally, we are also interested in analyzing the role of those single students' characteristics (causal conditions) favoring a positive – or negative – attitude towards the use of EVGs to develop students' competencies. In fact, our goal is also to analyze to what extent students' characteristics are necessary conditions (causal conditions that produce the outcome but by themselves are not enough) and/or sufficient conditions (causal conditions that always lead to the outcome) for showing a positive or negative attitude. As no information regarding that role of each specific causal condition is available from prior research, we posit the following research question (RQ):

RQ1. Which is the role of necessity and/or sufficiency for students having a positive (RQ1a) or a negative (RQ1b) attitude towards the use of EVGs to develop their competencies?

## 3. Methodology

### 3.1. Sample and questionnaire

A total of 128 students enrolled in a private Spanish University were contacted on campus and gave their permission to participate in this study filling a written informed consent. Data was gathered through a self-administrated questionnaire using a convenience sample of students enrolled in different degrees.

The measurement instrument for the study was organized into two parts: the first one consisted of measures of the constructs relevant for our research: the outcome (attitude towards the use of EVGs to develop students' competencies) and the four causal conditions (perceived relevance, perceived confidence, media affinity, and perceived self-efficacy). All measures were multi-item scales, adapted from existing scales previously tested in literature and translated into Spanish. Two English teachers, living and teaching for more than 20 years in Spain, supervised the translation of the questionnaire. In order to ensure that the translated items/scales were clear and properly understood by potential respondents, a pretest on the questionnaire was conducted with a sample of 20 students who did not take part in the main study. The result of the pretest showed that the students had no problem in understanding the items, therefore this pretest ensured the adequacy of the translated scales. Specifically, attitude towards the use of EVGs to develop students' competencies (AT) was measured with a scale adapted from Chattopadhyay and Basu (1990). The scale to measure perceived relevance (RE), and perceived confidence (CO), on EVGs was adapted from Su and Cheng (2015). Media affinity (MA) considered the proposal of Perse (1986), and perceived self-efficacy (SE) was adapted from Pintrich and De Groot (1990). Items for all the scales were rated on 5-point Likert scales where (1) = strongly disagree, and (5) = strongly agree.

The second part of the questionnaire measured socio-demographic data of the sample including age, gender, and the degree in which the respondents were enrolled in. The average age of the participants in the study is 21.6 years old (35.54% between 17 and 19, 43.8% between 20 and 22, 10.47% between 23 and 25 and 9.92% between 26 and 41), being 52% females. Students of eight different degrees participated in the study (Architecture; Criminology and Psychology; Law; Physiotherapy; Marketing; Odontology; International Relations; Languages and Intercultural Communication) what we consider gave us a good view of a general degree student.

### 3.2. Psychometric properties of the scales used

Before testing the propositions, we assessed the psychometric properties of the scales used in order to be sure that all the scales were measuring the constructs under analysis in a proper way. With that purpose, a confirmatory factor analysis via EQS 6.1 was carried out using the robust estimation method. For achieving the convergent validity it was necessary to remove one item from the attitude scale, two items from the scale measuring perceived confidence, and three items from the perceived self-efficacy scale. After removing those items, all remaining items for each factor had significant factorial loads higher than .60 which is the recommended threshold (Bagozzi & Baumgartner, 1994; Bagozzi & Yi, 1988). Appendix A shows the final items used to measure each construct, along with descriptive statistics and loadings. Regarding reliability, Table 1 shows that all the Cronbach alphas (Cronbach, 1951) were greater than the recommended .70 (Churchill, 1979; Nunnally, 1978). Moreover, two other indicators were calculated for

**Table 1**
Descriptive statistics, Reliability and Discriminant validity.

| | Mean (S.D.) | Cronb. α | CR | Constructs | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | AT | RE | CO | MA | SE |
| **AT** | 3.66 (.95) | .84 | .85 | **.74** | .79 | .72 | .01 | .65 |
| **RE** | 3.72 (.75) | .92 | .91 | [.96; .82] | **.66** | .84 | .01 | .73 |
| **CO** | 3.63 (.83) | .87 | 0.87 | [.93; .76] | [.97; .86] | **.70** | .03 | .73 |
| **MA** | 2.49 (1.25) | .90 | .91 | [.28; −.10] | [.29; −.08] | [.36; −.01] | **.71** | .02 |
| **SE** | 3.36 (1.05) | .90 | .90 | [.89; .74] | [.92; .80] | [.93; .78] | [.34; −.03] | **.60** |

*Note:* CR=Composite Reliability.
Under the diagonal: confidence interval for the correlation between each pair of factors.
Diagonal: average extracted variance.
Over the diagonal: squared correlation between each pair of factors.

overcoming the limitations of the Cronbach alpha, which are also shown in Table 1: the composite reliability index, showing values higher than the recommended value of .70 (Fornell & Larcker, 1981) and the average variance extracted or AVE with a recommended value higher to 0.50 (Fornell & Larcker, 1981). For both indicators, each factor exceeds the recommended values. Consequently, data suggested an acceptable level of reliability for all the scales.

To analyze the discriminant validity, (a) we tested that the confidence interval for the estimation of the correlation between each pair of factors did not include the unit (Anderson & Gerbing, 1988) and (b) we tested that the average variance extracted, for each factor, was greater than the squared correlation between each pair of factors (Fornell & Larcker, 1981). This information is also reported in Table 1. Data suggested reliability problems between (a) relevance and (a1) attitude towards the use of EVGs, (a2) confidence and (a3) self-efficacy, between (b) attitude towards the use of EVGs and (b1) confidence and (b2) self-efficacy and between (c) confidence and self-efficacy, as the average variance extracted between those factors resulted lower to the squared correlation between them.

In other to overcome this problem, a third criterion was used: the Chi-square difference test. Considering that the critical value for $p < ,001$ is 10.82, we checked that the Chi-square difference was higher than the critical value, in every case (see Appendix B for Chi-square difference test). So, according to the whole criteria we could assume that the measurement instrument had discriminant validity.

Next, we assessed the research model's goodness of fit using multiple indices. As mentioned, a robust estimation was developed in order to address possible problems regarding normality. Considering the values of the different indices as a whole the research model's goodness of fit was assessed [S-B $\chi 2$ (179 d.f.) = 152.12 ($p > .05$); BBNFI = .910; BBNNFI = .989; CFI = .991; IFI = .991; MFI = .929 RMSEA = .06]. Satorra-Bentler Scaled Chi-Square (S-B $\chi 2$) was used, where usual normal-theory chi-square statistic is divided by a scaling correction to better approximate chi-square under non-normality.

Finally, Harman's single-factor test was considered to analyze the potential common method bias (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). We checked that no single factor occurred from the exploratory factor analysis and that the first factor did not account for the majority of the variance. Accordingly, there was an absence of common method bias.

### 3.3. Internal and external validity

Internal validity refers to "the validity of inferences about whether observed covariation between A (the presumed treatment) and B (the presumed outcome) reflects a causal relationship from A to B, as those variables were manipulated or measured" (Shadish, 2010, p. 4). In our study, the interviewees were all active students of different university degrees, so they shared their goal of developing the necessary competencies to get the degree they were enrolled in. A possible threat regarding factors outside of the study would be the same for all participants.

Sackett and Larson (1990, p. 430) refers to the external validity as "the type of validity closest to our definition of generalizability", as it is related to generalizing across different times, settings, treatment variables, measurement variables, and individuals (Cook & Campbell, 1976; Shadish, 2010). In the present research, students enrolled in different courses of different degrees participated in the study, so we could generalize results to the average degree student. However, those students belonged to only one private Spanish university and data was gathered in a specific period of time (the moment of developing the present research), so generalization should be taken with caution.

## 4. Data analysis

### 4.1. Contrarian case analysis

Woodside (2016) highlights that a usual bad practice of researchers using variable-level analysis is ignoring cases with associations contrary to significant main effects. As the author suggests, "good practice includes recognizing that cases contrary to statistically significant main effects almost always occur in reasonably large data sets" (p. 370) and researchers using asymmetric case-level analysis embrace them.

With the purpose of identifying the occurrence of contrarian cases (Pappas, Giannakos, & Sampson, 2016) that run counter to a large main effect, a quintile analysis was performed. A quintile analysis includes dividing the respondent cases from the lowest to highest quintile for each measured construct and examining the relationships among two or more constructs (McClelland, 1998). The idea is to show that two variables may have positive, negative, and no effect in the same dataset, regardless of the main effect of one on the other. We performed cross-tabulations across the quintiles via SPSS (Version 22) Crosstabs function between every independent variable and the dependent variable (see Appendix C). On a variable by variable basis, the $phi^2$ measure indicates a significant and positive large main relationship (Cohen, 1977) between attitude towards the use of EVGs and relevance, confidence and self-efficacy, although not for media affinity. However, negative and positive contrarian cases between the variables, separate from the main effect, still occur. Accordingly, the results support the importance of configurational analysis for also explaining these relationships (Woodside, 2014, 2016).

### 4.2. Fuzzy-set Qualitative Comparative Analysis (fsQCA)

Fuzzy-set Qualitative Comparative analysis (fsQCA) (Ragin, 2000) describes a case as a combination of "causal conditions"

and the "outcome". The outcome is the result to be identified (in this research: students' attitude towards the use of EVGs to develop students' competencies), and the causal conditions are the variables identified as leading to the outcome (in this research: perceived relevance, perceived confidence, media affinity, and perceived self-efficacy). Considering our goals, the characteristics of this technique allow for consideration of equifinality (there can be multiple paths or solutions to the same outcome, and not just one), causal complexity (not all the variables considered in the analysis have to be relevant altogether, in other words, different combinations of causal measures can lead to the same outcome) and the possibility of testing not only variables leading to the outcome but also testing which variables lead to the absence of the outcome (in this research: students showing a negative attitude towards the use of EVGs) (Woodside, 2016). Although fsQCA as a case-oriented research approach was originally designed for small and medium samples, prior research indicates that set-theoretic approaches are well suited to analyze larger empirical data (Rihoux, 2006; Woodside, Ko, & Huan, 2012).

A premise of this methodology is that relationships among different variables are best understood in terms of set membership (Fiss, 2007). Ragin (2008a) defines a fuzzy set as "a continuous variable that has been purposefully calibrated to indicate degree of membership in a well-defined and specified set" (p. 30). First, the outcome and the causal conditions must be specified. Because we used multi-item scales it was necessary to sum up into one single item or value each construct, calculating for that the arithmetic mean of each construct. A key stage of fsQCA is the generation of well-constructed fuzzy sets. In fsQCA, calibration is the procedure to translate construct measures into fuzzy set membership scores. All fuzzy set values for all simple causal conditions range from 0.00 (denoting no set membership) to 1.00 (denoting full set membership) and these values indicate the degree of membership of the case in each causal condition. In the present study, a direct method for calibration was considered (see Ragin, 2008a), identifying three substantively meaningful thresholds: full membership, full non-membership, and a cross-over point (the point of maximum ambiguity) (Ragin, 2008b). The transformation of variables into calibrated set is done by the fsQCA program. Specifying the original values for these three breakpoints permits the software to calibrate all remaining scores. According to Schneider and Wagemann (2009) the coding rules for assessing set memberships to cases must also consider empirical information, and not just be based on mathematical operations. Considering that this is an explorative study, and we lacked the theoretical or in-depth knowledge to consider a more objective criterion to calibrate, we analyzed the sample data distribution for each causal condition. Then, we decided to consider the median value of each construct as the cross-over point for all the possible causal conditions as the mean is not recommend for that purpose (Wagemann, Buche, & Siewert, 2016). Moreover, we considered the 5% percentile for the full non-membership, and the 95% percentile for the full-membership (Table 2), as we assumed that just the .05% of the individuals in both extremes, low and high, of each causal condition could be considered fully-out and fully-in the set respectively. The same percentile-based approach is used in previous research with fsQCA methodology (e.g. Andrews, Beynon, & McDermott, 2016; Barton & Beynon, 2015; Lewellyn & Muller-Kahle, 2016).

Once the calibration is completed, fsQCA is used to analyze how membership of cases in causal conditions is linked to membership in the outcome (Ragin, 2008a) identifying necessary and/or sufficient causal conditions for the outcome. A causal condition is necessary for the outcome if it must be present for an outcome to occur, whereas it is sufficient when it produces the outcome by itself (Ragin, 2000, 2008a). In the process of identifying sufficient causal conditions a *truth table* is calculated. This truth table contains all possible combinations of causal conditions with the number of empirical cases that fulfil each possible causal combination (Fiss, 2011). The truth table is then redefined based on frequency and consistency criteria (Ragin, 2008a). Frequency indicates the extent to which each combination of causal conditions is empirically represented. Setting a frequency cut-off ensures that the assessment of the fuzzy subset relations occurs only for those configurations exceeding a specific minimum number of cases (Leischnig, Henneberg, & Thornton, 2014). In this research, as it is the case for small and medium-sized samples, a cut-off point of 1 was considered appropriate (Ragin, 2008a). Consistency assesses the degree to which the cases sharing a given causal condition, or combinations of causal conditions, agree in exhibiting the outcome in question (Fiss, 2011; Ragin, 2006). In the present research, the consistency level for both analyses (positive/negative attitude towards the use of EVGs as outcomes) was above the threshold of 0.8 recommended by Ragin (2008a) with a value of .86 in both cases.

**Table 2**
Thresholds used for calibration.

| Construct | Full non-membership | Cross-over point | Full membership |
|---|---|---|---|
| Attitude | 2 | 4 | 5 |
| Relevance | 2.4 | 3.66 | 5 |
| Confidence | 2.33 | 3.66 | 5 |
| Media Affinity | 1 | 1.62 | 4.5 |
| Self-efficacy | 2.33 | 3.58 | 5 |

## 5. Findings

### 5.1. Results from fsQCA

The first step in the analysis consisted in analyzing the sufficient conditions for having a positive/negative attitude towards the use of EVGs to develop competencies. Consistent with Ragin's (2000), Table 3 shows the intermediate solution, reaching in both cases the minimum criteria for consistency and coverage considered adequate for sufficiency (.75 and .60 respectively). Additionally, core and peripheral conditions were identified by comparing both parsimonious and intermediate solutions, as suggested by Fiss (2011). Core conditions are part of both solutions, whereas peripheral ones only appear in the intermediate solution. This

**Table 3**
Sufficient combinations of conditions.

| | For a positive attitude towards EVGs | | | For a negative attitude towards EVGs | | | |
|---|---|---|---|---|---|---|---|
| Configuration | Solutions [a] | | | Solutions [a] | | | |
| | 1a | 2a | 3a | 1b | 2b | 3b | 4b |
| Relevance | | ● | | | ⌀ | • | ⌀ |
| Confidence | | | ● | ⌀ | | | |
| Media Affinity | | | • | | | | • |
| Self-efficacy | ● | | | | • | ⌀ | |
| Raw coverage | .86 | .91 | .53 | .83 | .47 | .49 | .52 |
| Unique coverage | .03 | .06 | .01 | .18 | .01 | .03 | .01 |
| Consistency | .81 | .81 | .85 | .85 | .91 | .86 | .92 |
| Overall solution coverage: | .96 | | | .91 | | | |
| Overall solution consistency: | .75 | | | .82 | | | |

[a] Black circles • indicate the presence of a condition. Circles with "/" (⌀) indicate its absence. Large circles indicate core conditions, and small ones represent peripheral conditions. Blank spaces indicate "don't care".

approach defines causal coreness "in terms of the strength of the evidence relative to the outcome, not connectedness to other configurational element" (Fiss, 2011, p. 403).

Regarding the positive attitude towards the use of EVGs, the solution table shows that the fuzzy set analysis results in three solutions that, as a whole, account for 96 percent of membership in the outcome (overall solution coverage), and exhibits acceptable overall solution consistency (.75). For the students to show a positive attitude towards the use of EVGs to develop their competencies, it is sufficient that (a) students perceive EVGs relevant for developing their competences (solution 2a, being the biggest group of people identified among those showing a positive attitude towards the use of EVGs), or (b) students perceive self-efficacy in using EVGs (solution 1a), or (c) students show a media affinity with video games along with a perception of confidence in being able to use EVGs to develop their competencies (solution 3a, being the smallest group of the three). These three solutions lead to the same outcome: having a positive attitude towards the use of EVGs to develop students' competencies. However, inspection of coverage values of each specific solution allowed to assess the relative importance of configurations of causal conditions for the outcome. Raw coverage represents the size of the overlap between the size of the causal combination set and the outcome set relative to the size of the outcome set, whereas unique coverage controls for overlapping explanations by partitioning the raw coverage (Ragin, 2008a). Accordingly, solution 2a (in first place) and 1a are the ones that "explain more" a positive attitude towards the use of EVGs to develop competencies. Moreover, in solutions 1a and 2a each causal condition plays a core role, whereas in causal configuration of solution 3a, perceived confidence plays a core role but media affinity appears as a peripheral factor. Broadly speaking, in solution 3a perceived confidence in EVGs to develop one's competencies is more relevant for the outcome (having positive attitude towards the use of EVGs) than individuals' media affinity with video games.

For showing a negative attitude towards the use of EVGs (Table 3), data suggest four possible solutions for sufficiency: it is sufficient that (a) students don't feel confident with the use of EVGs (solution 1b, being the biggest group identified among those students showing a negative attitude), or (b) students perceive themselves as self-efficient in using EVGs but they don't perceive EVGs as relevant for developing their competencies (solution 2b), or (c) although students perceive EVGs as relevant for competencies development, they don't perceive self-efficacy in using EVGs (solution 3b), or (d) although students have media affinity with video games they don't perceive EVGs as relevant for developing their competencies (solution 4b). The four solutions lead to the same outcome (having a negative attitude towards the use of EVGs), and explain altogether 91% of the analyzed sample, showing an overall solution consistency of .82. Based on coverage indexes of each solution, we can conclude that solution 1b, students' lack of confidence in using EVGs, explains more than the other solutions the negative attitude towards the use of EVGs to develop students' competencies. Moreover, lack of perceived confidence acts as a core factor. Additionally, in solutions 2b and 4b, students' lack of perceived relevance of using EVGs to develop competencies is a core construct that combines with the peripheral role of perceived self-efficacy and media affinity respectively, for explaining a negative attitude towards EVGs. In solution 3b, lack of perceived self-efficacy is the core causal condition that combines with perceived relevance as a peripheral factor for explaining a low attitude towards the use of EVGs. From these core and peripheral roles, results suggest that students can show a negative attitude towards the use of EVGs even when they perceive EVGs as relevant, or they perceive self-efficacy in its use, or they have media affinity with video games, as data suggest that each of this causal conditions, when they are present (they are positive) play a peripheral role in explaining students' negative attitude.

**Table 4**
Analysis of necessary conditions.

| | For a positive attitude towards EVGs[a] | | For a negative attitude towards EVGs[b] | |
|---|---|---|---|---|
| Causal conditions | Consistency | Coverage | Consistency | Coverage |
| Relevance | **.91** | **.81** | .80 | .90 |
| Confidence | .84 | .82 | .82 | .84 |
| Media Affinity | .59 | .61 | .64 | .63 |
| Self-efficacy | .85 | .81 | .81 | .86 |

[a] In the analysis of necessary conditions for a positive attitude towards EVGs, the causal conditions have been considered positively.
[b] In the analysis of necessary conditions for a negative attitude towards EVGs, the causal conditions have been considered negatively, as the lack of the characteristic.

The second step in our analysis considered the necessity of the causal conditions for the presence (positive attitude towards EVGs) and the absence (negative attitude towards EVGs) of the outcome to occur in order to answer our research question (RQ). Results suggest (Table 4) that only perceived relevance of EVGs is a necessary condition for students to show a positive attitude towards the use of EVGs to develop competencies (RQ1a), as the values of consistency and coverage for that causal condition reach the minimum values set by Ragin (2006) regarding necessity (.90 and .75 respectively). It means that, apart from other possible considerations, students have to believe that EVGs will provide learning value to them (EVGs are perceived relevant by students in developing their competencies) in order to show a positive attitude towards the use of this educational tool. However, (RQ1b) no causal condition is a necessary condition for having a negative attitude towards EVGs (Table 4). In other words, none of the causal conditions analyzed must be present for the student having a negative attitude towards the use of EVGs.

### 5.2. Testing predictive validity

Following the procedure of previous studies using the same methodology (Pappas, Kourouthanassis, Giannakos, & Chrissikopoulos, 2016; Pappas et al., 2017; Woodside, 2014; Wu et al., 2014), and in order to test predictive validity, the sample was randomly split into a modelling subsample and a holdout sample, and then the analysis was run again for each sample. As Pappas et al. (2017) highlight, in predictive validity testing the overall solution consistency and coverage for the subsample should be similar with the ones for the whole sample, whereas the configurations for the subsample are not expected to be the same. In our analysis (Table 5) just one configuration for each outcome (positive attitude towards EVGs and negative attitude towards EVGs) happens to be the same as for the whole sample. However, the overall solution consistency and coverage are similar of those for the whole sample.

The results presented in Table 5 were then tested against the second sample (the holdout sample) for both outcomes (positive and negative attitude towards the use of EVGs). Fig. 2 shows only the results for model 1 for each outcome although all the models (two for the positive attitude outcome and four for the negative outcome) were tested (results of predictive tests for the rest of the models are available upon request).

For model 1, the casual condition for having a positive attitude towards EVGs was relevance of EVGs, so it was not necessary to create a new variable (causal condition) as this variable was already used and calibrated in our previous analysis. However, the rest of

**Table 5**
Configurations for subsample.

| For a POSITIVE attitude towards EVGs | | | | For a NEGATIVE attitude towards EVGs | | | |
|---|---|---|---|---|---|---|---|
| Models | Row coverage | Unique coverage | Consistency | Models | Row coverage | Unique coverage | Consistency |
| RE | .91 | .45 | .82 | ~SE*~CO | .79 | .30 | .91 |
| CO*MA | .48 | .03 | .89 | RE*~CO | .48 | .01 | .86 |
| Solution coverage: .93 | | | | RE*~SE | .49 | .02 | .88 |
| Solution consistency: .80 | | | | ~RE*MA*CO | .32 | .01 | .89 |
| | | | | Solution coverage: .83 | | | |
| | | | | Solution consistency: .84 | | | |

RE = Relevance; Co= Confidence; MA = Media Affinity; SE= Self-Efficacy.
* = and; ~ = absence (negative).

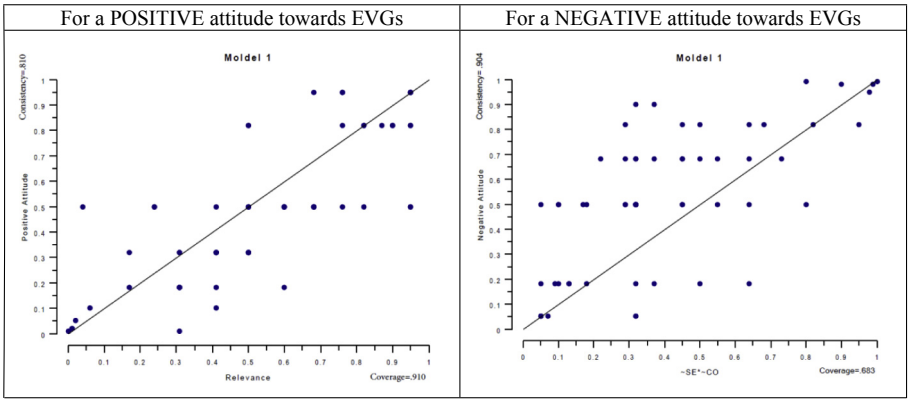


**Fig. 2.** Test of model 1 from subsample using data from holdout sample.
Note: Each dot in the XY plot represents one or more cases (i.e., students) in the study—some students have the same scores in the plot.

the models for both outcomes (positive attitude and negative attitude) involved different causal configurations, that is, the combination of two or three causal conditions of our study, so it was necessary to model each configuration as a new variable, using the appropriate fsQCA software function.

For the outcome positive attitude towards the use of EVGs and regarding the results presented here (Model 1), Fig. 2 shows that, for model 1 from subsample 1, the value of (raw) coverage (.91) and consistency (.82) are similar with the value (see data from Table 5) when testing the same model using data from the holdout sample (coverage = .910 and consistency = 0.810 – Fig. 2). Similarly, for the outcome negative attitudes towards EVGs, Fig. 2 also shows that for model 1 from subsample 1 (~SE*~CO), the value of (raw) coverage (.79) and consistency (.91) are similar with the value (see data from Table 5) when testing the same model using data from the holdout sample (coverage = .683 and consistency = 0.904).

Predictive tests for all models for each outcome suggest that the highly consistent models for the subsample have high predictive abilities for the holdout sample, and vice versa.

## 6. Discussion

Our results support all of three tested propositions. There exist multiple, equally effective configurations of causal factors explaining students' attitude towards the use of EVGs to develop their competencies (Proposition 1). Three paths lead to explain a positive attitude while four paths lead to explain a negative attitude. Regarding variables leading to a positive attitude towards the use of EVGs to develop students' competencies, results suggest that perceived relevance of EVGs plays a key role in students' beliefs as accounts for the biggest group and also was identified as playing a core role as a causal condition. One main implication of this result is that teachers should pay attention when choosing the features of the EVGs to be used to developing students' competencies so the EVG will be perceived as relevant by students and not just as “a nice variation and break in the lecture” (Wang, 2015). Results also suggest that perceived self-efficacy influences attitude in a positive way, so teachers should analyze students' characteristics related to video games (e.g., video gaming experience and video gaming skills) when selecting the EVG to be used for instruction as results suggest it is important for students to perceive they can succeed when using EVGs. In fact, media affinity influences students' positive attitude when they feel confident in using EVGs to develop their competencies. That is, students to whom video games are important in their lives (they usually play video games) might feel they can successfully use EVGs to develop their competencies. However, students showing a high media affinity with video games, show a negative attitude towards the use of EVGs to develop their competencies if they do not perceive EVGs as relevant. Once again, this result suggests that perceive relevance of EVGs appears to be key for students, and independently if students regularly play video games for entertainment they must perceive a learning objective in EVGs for not showing a negative attitude. Regarding other variables leading to a negative attitude towards the use of EVGs to develop students' competencies, results suggest as a sufficient condition students' lack of confidence in using EVGs (the biggest group). Video games can vary in difficulty and not all students may have the skills to play all type of video games. Also, there are different styles of play (Aarseth, 2003) so instructors should pay attention to students' skills regarding playing video games to avoid this lack of confidence becoming a factor leading to a negative attitude towards the EVG.

Results also support Proposition 2 as single causal conditions may be present or absent depending on how they combine with other causal conditions. For students having a positive attitude towards the use of EVGs all the causal conditions identified in the solutions have to be present (to be positive) whereas for explaining the negative attitude, the causal conditions can be present or absent (can be positive or negative). Finally, configurations of analyzed causal conditions leading to a positive attitude towards the use of EVGs are not the same of those configurations leading to a negative attitude (Proposition 3). The three configurations explaining a positive attitude towards the use of EVGs are not the mirror of those configurations explaining a negative attitude towards the use of EVGs.

Considering the results altogether regarding the role of necessity and/or sufficiency for students having a positive attitude (RQ1a) or a negative attitude (RQ1b) towards EVGs for developing their competencies we can conclude that all students' characteristics analyzed do not play the same role influencing attitude towards EVGs: perceived relevance of EVGs is a necessary and also a sufficient condition for having a positive attitude towards EVGs, whereas perceived self-efficacy, and perceived confidence along with media affinity, are sufficient conditions for that positive attitude, being media affinity a peripheral factor. Regarding negative attitude towards EVGs, none of the individually analyzed characteristics are necessary conditions except lack of perceived confidence that acts individually. One possible explanation for this results is that students can be worried about their inability to properly use EVGs to develop their competencies because they are used to play games for fun but not for learning. Prejudices towards the capability of EVGs could also fuel students' lack of perceived confidence. Therefore, teachers using EVGs must educate student about the teaching capabilities of EVGs to overcome students' lack of confidence. The other causal conditions have to appear combined in order to be sufficient conditions for having a negative attitude towards EVGs. The four solutions for a negative attitude, when those causal conditions are absent, act as core factors, but when they are present, they play a peripheral role, which means that they are less relevant than the core ones for causing the outcome.

Regarding the theoretical implications of this research, complexity theory suggests that a simple causal condition may be necessary but a simple causal condition is rarely sufficient for predicting a high or low score in an outcome condition (Woodside, 2014). However, our data identify one of those rarely cases: for predicting students' positive attitude towards the use of EVGs to develop their competencies, perceived relevance of EVGs is both a necessary and a sufficient condition.

Regarding methodology, this paper uses fsQCA as a different data analysis approach to examine complex causality delving into factors leading to a positive or a negative students' attitude towards the use of EVGs to develop their competencies. However, we agree with Leischnig et al. (2014) by considering that, rather than being a competing research approach, fsQCA should be understood as a complementary method of analysis that supplements findings from general correlation-based approaches. This study confirms the importance of examining complex causal patterns of single causal conditions, as well as contrarian cases and asymmetric relationships to analyze students' characteristics influencing their attitude towards EVGS.

FsQCA focuses on whether or not a case shows these specific characteristics or combinations of these characteristics and the outcome (in this research: having a positive or a negative attitude towards EVGs). Then fsQCA can be used to identify relevant combinations of causal conditions, which reach different parameters, which are able to explain the specific outcome. However, as Krogslund, Choi, and Poertner (2015) state, a limitation related to the use of fsQCA relies on the fact that, the causal conditions identified by as being sufficient for an outcome to occur are highly contingent upon the values of several key parameters selected by the researcher. Different criteria regarding, for example, calibration thresholds or frequency cut-off could lead to different solutions. Moreover, the authors highlight that fsQCA results are subject to marked confirmation bias, as it is highly likely to identify as sufficient for an outcome, causal combinations containing even randomly generated variables. On this regard, for a general confirmation of results it should be advisable to go beyond one empirical study in one university and even in one country, and to replicate this study considering students from other universities and different countries. Moreover, it has to be taken into account, that fsQCA examines combinatorial effects, and hence, the influence of each single specific students' characteristics on the outcome is not quantified (Pappas et al., 2017; Woodside, 2013). Accordingly, as a future research, it would be relevant to analyze the relationships between students' characteristics and their attitude towards the use of EVGs by means of other methodology, such as structural equation modelling (SEM) or logistic regressions, in order to identify the specific influence on each characteristic on the outcome, and to compare those results with the ones shown by fsQCA.

## 7. Conclusions, limitations of the study, and future research

The use of EVGs is gaining momentum as a promising tool to motivate and to engage students in their learning process. Nevertheless, as this study suggests, students' positive attitude towards the use of EVGs cannot be taken for granted. On the contrary, four students' characteristics (perceived relevance, perceived confidence, media affinity, and perceived self-efficacy) combine to influence both in a positive and a negative way students' attitude towards the use of EVGs to develop their competencies. Because students' perceived relevance of EVGs as a tool to develop their competencies was found an important variable influencing students' positive attitude, results suggest that teachers using EVGs to develop students' competencies should educate their students about the potential and relevance of using EVGs in order to inspire students' perceived relevance of EVGs. Based on these results we also suggest that teachers must be careful when choosing the features of the EVG to be used to develop students' competencies, so these features meet students' criteria for being perceived as relevant (e.g., the content and gameplay of the EVG is linked to competencies development). However, this study did not delve into students' criteria for EVGs to be perceived as relevant, so future research should explore EVGs features influencing students to consider an EVG as relevant to develop their competencies.

Although extant academic literature clearly supports the use of EVGs to develop students' competencies, to the best of our knowledge this is the first study exploring students' attitude towards using EVGs to develop their competencies. One main contribution of this study to extant literature of EVGs is to highlight the complexity of students' attitude towards the use of EVGs based on different configurations of variables that can influence both in a positive and a negative way students' attitude. Because attitude is a strong predictor of behavior (Davis, 1985) the results of this study can contribute to a better knowledge of variables influencing the acceptance of EVGs as a technological educational innovation by Higher Education students.

One main limitation of this study is the convenience sample used that prevent to generalize our findings. Future research should use probabilistic samples in order to confirm these results. Also, the

limitations of the fsQCA methodology in terms of providing positive evidence for causality must be taken into account. Future research should use other methodology (e.g., SEM) to analyze causality of the variables under research. Although this paper contributes to a better understanding of the benefits of using fsQCA in educational research, future research will contribute the methodological development if symmetrical analyses (e.g., logistic regression) are used to compare fsQCA results. Future research could also benefit of using structural equation modelling (SEM) to confirm the net effects of tested conditions via fsQCA (as in Tho, 2017).

Other factors than those analyzed in this study might influence students' attitude towards the use of EVGs to develop their competencies (e.g., gender, cultural context, perceived value of EVGs). Therefore, future research should explore other factors influencing students' attitude towards the use of EVGs to develop their competencies.

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## Appendix A

Final considered items used to measure each construct, along with descriptive statistics and loadings.

| Factors and items | Mean | S.D. | Stand. loads ($t$) |
|---|---|---|---|
| **Attitude (AT)** | | | |
| AT1.- I like the idea to use educational video games to develop my competencies | 3.73 | 1.00 | .90 (11.83*) |
| AT2.- My attitude towards the use of educational video games to develop my competencies is positive | 3.80 | .86 | .82 (9.18*) |
| **Relevance (RE)** | | | |
| RE1.- I can link the content of an educational video game designed to develop my competencies to knowledge with which I am already familiar about competencies | 3.54 | .86 | .81 (10.32*) |
| RE2.- The content of an educational video game designed to develop my competencies can be linked to my daily experiences | 3.82 | .85 | .80 (12.23*) |
| RE3.- The content of an educational video game designed to develop my competencies is valuable and worth learning | 3.66 | .89 | .83 (10.55*) |
| RE4.- An educational video game designed to develop my competencies can be very helpful to me | 3.79 | .89 | .81 (9.80*) |
| RE5.- Playing an educational video game designed to develop my competencies will help me to develop my competencies | 3.80 | .86 | .77 (9.72*) |
| RE6.- I can be motivated to develop my competencies using an educational video game | 3.92 | .94 | .82 (9.83*) |
| **Confidence (CO)** | | | |
| CO3.- I am confident that I can develop my competencies using educational video games | 3.63 | .86 | .84 (11.66*) |
| CO4.- I am confident that I can apply what I learn about competencies using educational video games to my daily life | 3.66 | .91 | .85 (12.19*) |
| CO5.- I believe I will learn enough about competencies using educational video games so that I will enhance my competencies | 3.59 | .93 | .81 (10.42*) |
| **Media affinity (MA)** | | | |
| MA1.- Playing video games is one of the things I do every day | 2.62 | 1.40 | .72 (11.37*) |
| MA2.- Whenever I'm unable to play video games, I really miss it | 2.02 | 1.30 | .91 (14.21*) |
| MA3.- Playing video games is important in my life | 1.95 | 1.25 | .97 (18.09*) |
| MA4.- I can't go for several days without playing video games | 1.91 | 1.32 | .75 (9.21*) |
| **Self-efficacy (SE)** | | | |
| SE1.- Compared with other students in this class I expect to use educational video games to develop my competencies well. | 3.64 | .97 | .74 (9.27*) |
| SE2.- I'm certain I can use educational video games to develop my competencies. | 3.58 | .93 | .82 (11.31*) |
| SE3.- I expect to do very well using educational video games to develop my competencies. | 3.59 | .93 | .86 (11.20*) |
| SE5.- I am sure I can do an excellent job using educational video games to develop my competencies. | 3.53 | .92 | .78 (9.83*) |
| SE6.- I think I will receive a good grade using educational video games to develop my competencies. | 3.66 | .96 | .81 (9.46*) |
| SE9.- I know that I will be able to use educational video games to develop my competencies. | 3.72 | .96 | .63 (8.68*) |

* = $p < .01$.

## Appendix B

Chi-square difference tests (S-B $\chi 2$ measurement model = 152.12; d.f. = 179).

| | |
|---|---|
| S-B $\chi 2$ covariance model AT-CO equal to 1 = 169.34; d.f. = 180 | $\chi 2$ difference = 17.22; d.f. differ. = 1 |
| S-B $\chi 2$ covariance model AT-SE equal to 1 = 178.90; d.f. = 180 | $\chi 2$ difference = 26.78; d.f. differ. = 1 |
| S-B $\chi 2$ covariance model RE-AT equal to 1 = 163.87; d.f. = 180 | $\chi 2$ difference = 11.75; d.f. differ. = 1 |
| S-B $\chi 2$ covariance model RE-CO equal to 1 = 167.49; d.f. = 180 | $\chi 2$ difference = 15.37; d.f. differ. = 1 |
| S-B $\chi 2$ covariance model RE-SE equal to 1 = 204.29; d.f. = 180 | $\chi 2$ difference = 52.17; d.f. differ. = 1 |
| S-B $\chi 2$ covariance model CO-SE equal to 1 = 183.58; d.f. = 180 | $\chi 2$ difference = 31.46; d.f. differ. = 1 |

Note: Satorra-Bentler Scaled Chi-Square (S-B $\chi 2$) is used: usual normal-theory chi-square statistic is divided by a scaling correction to better approximate chi-square under non-normality

## Appendix C

Quintile analysis and contrarian case analysis.

| | | Attitude towards EVGs | | | | | | | Attitude towards EVGs | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | | | 1 | 2 | 3 | 4 | 5 |
| Relevance ($phi^2$=.81, p<.001) | 1 | *10* *(7.8%)* | *7* *(5.5%)* | 2 (1.6%) | **3** **(2.3%)** | **0** **(.0%)** | Confiden. ($phi^2$=.44, p<.001) | 1 | *8* *(6.3%)* | *6* *(4.7%)* | 1 (.8%) | **1** **(.8%)** | **0** **(.0%)** |
| | 2 | *3* *(2.3%)* | *8* *(6.3%)* | 4 (3.1%) | **1** **(0.8%)** | **2** **(1.6%)** | | 2 | *4* *(3.1%)* | *10* *(7.8%)* | 8 (6.3%) | **7** **(5.5%)** | **2** **(1.6%)** |
| | 3 | 2 (1.6%) | 2 (1.6%) | 10 (7.8%) | 7 (5.5%) | 4 (3.1%) | | 3 | 1 (.8%) | 6 (4.7%) | 6 (4.7%) | 10 (7.8%) | 4 (3.1%) |
| | 4 | **2** **(1.6%)** | **5** **(3.9%)** | 1 (.8%) | *19* *(14.8%)* | *10* *(7.8%)* | | 4 | **2** **(1.6%)** | **1** **(.8%)** | 3 (2.3%) | *14* *(10.9%)* | *5* *(3.9%)* |
| | 5 | **1** **(0.8%)** | **0** **(0.0%)** | 3 (2.3%) | *5* *(3.9%)* | *17* *(13.3%)* | | 5 | **4** **(3.1%)** | **0** **(.0%)** | 1 (.8%) | *5* *(3.9%)* | *19* *(14.8%)* |
| Media affin. ($phi^2$=.03, p N.S.) | 1 | *8* *(6.3%)* | *2* *(1.6%)* | 1 (.8%) | **9** **(7.0%)** | **4** **(3.1%)** | Self-effica. ($phi^2$=.29, p<.001) | 1 | *8* *(6.3%)* | *7* *(5.5%)* | 1 (.8%) | **8** **(6.3%)** | **0** **(.0%)** |
| | 2 | *0* *(.0%)* | *1* *(.8%)* | 4 (3.1%) | **9** **(7.0%)** | **11** **(8.6%)** | | 2 | *5* *(3.9%)* | *8* *(5.5%)* | 6 (4.7%) | **4** **(3.1%)** | **2** **(1.6%)** |
| | 3 | 2 (1.6%) | 7 (5.5%) | 4 (3.1%) | 6 (4.7%) | 4 (3.1%) | | 3 | 2 (1.6%) | 6 (4.7%) | 6 (4.7%) | 15 (11.7%) | 3 (2.3%) |
| | 4 | **3** **(2.3%)** | **10** **(7.8%)** | 7 (5.5%) | *7* *(5.5%)* | *4* *(3.1%)* | | 4 | **2** **(1.6%)** | **3** **(2.3%)** | 4 (3.1%) | *11* *(8.6%)* | *5* *(3.9%)* |
| | 5 | **4** **(3.1%)** | **2** **(1.6%)** | 2 (1.6%) | *11* *(8.6%)* | *6* *(4.7%)* | | 5 | **1** **(.8%)** | **0** **(.0%)** | 1 (.8%) | *3* *(2.3%)* | *18* *(14.1%)* |

Note: In shaded cells, cases in **bold** represent contrarian cases, and cases in *italics* represent main effect.
N.S.= not significant.
The sets of contrarian cases are counter to the main effect size ($phi^2$ range from .29 to .81).

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