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Digital Culture and Education II **115**

Interactive learning games: the importance of art-based production methodologies and aesthetics for the development of innovative content **116**

Polyxeni Kaimara, Georgios Miliotis, Marinos Pavlidis, Evangelia Koumantsioti, Stavros Karakoutis, Aris Melachroinos, Evangelos Pandis, Ioannis Deliyiannis

You have the tablet, I have the cards, let's play together! Combining card-based games, puzzles, multimedia applications and learning content that support inclusive education scenarios **126**

Polyxeni Kaimara, Stavros Karakoutis, Aris Melachroinos, Marinos Pavlidis, Evangelia Koumantsioti, Evangelos Pandis, Georgios Miliotis, Ioannis Deliyiannis

Undergraduate students' attitudes towards collaborative digital learning games **136**

Polyxeni Kaimara, Emmanuel Fokides, Andreas Oikonomou, Ioannis Deliyiannis

Escape Room as Learning Environment: Combining Technology, Theater and Creative Writing in Education **148**

Zoi Karageorgiou, Eirini Mavrommati, Eleni Christopoulou, Panagiotis Fotaris

Promoting Cultural Heritage via Gamification and Augmented Reality **158**

Marios Magioladitis, Dimitrios Ringas, Eleni Christopoulou

Cultural Facets - Augmented Reality in Art **169**

Augmented objects interacting with social media activity **170**

Caterina Antonopoulou

Digital Culture and Technologies II **177**

Orders of the heard. The sacramental order **178**

Loukas Messinezis, Apostolos Loufopoulos

Live coding and Poetry: A text driven synthesis technique in musical live coding **184**

Vasilis Agiomyrgianakis

Greek Cinema and Representations of Disabled People – Autism **191**

Maria Papadopoulou

Storytelling Technology: Design, Usability and Performativity **200**

George Metaxiotis

Undergraduate students' attitudes towards collaborative digital learning games

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Abstract

Digital game-based learning is considered a smart learning environment and has been recognized as an effective approach thanks to the ability of games to motivate and engage students, improving students' learning performance. Digital learning games are the new paradigm for education, based on the idea that children learn more effectively by solving problems in playful activities than by traditional materials that focus on reading, writing, spelling, arithmetic and listening. Whatever changes are made in teaching and learning, teachers remain the levers of the educational process, because they are the ones who will be called upon to implement innovations in the classroom. In this work, the authors' team aimed to investigate undergraduate students' attitudes to the utilization of collaborative digital games in the learning process. The results provided a basic understanding of the students' attitudes. In general, students were slightly positive regarding digital games implementation. This finding allows many interpretations, including the view that students seem reluctant to adopt technology in teaching and learning despite their extensive exposure to digital media. Therefore, a more in-depth investigation of pre-service teacher attitudes, as well as the philosophy and curricula of the Greek Higher Education Pedagogical Departments, their readiness to adapt to the demands of the 21st century and their willingness to accommodate the international trend of transforming educational systems is required.

Keywords

Digital games and higher education pedagogical departments, digital learning games, preservice teachers, students' attitudes

1. Introduction

Digital game-based learning has been recognized as an effective approach thanks to the game dynamics to enhance motivation and to stimulate students' curiosity and learning interest through activities that make sense to them [6]. Games are important for the development of children's cognition and social processes, by engaging and allowing them to have control, providing a more interesting and challenging learning environment, thereby effortlessly improving their learning performance [6]. Digital learning games could be considered as the new paradigm for education, based on the idea that children learn by problem-solving in playful activities rather than traditional based material focusing on reading, writing, spelling, arithmetic, and listening [7]. The pedagogical approach that is implemented in many of these games relates to their potential to function as the

hook to connect the learning objectives and activities defined by the curriculum [16]. The less conservative approaches consider digital learning games as powerful learning tools and part of the overall educational technology. However, digital learning games are more an educational approach rather than just educational tools [4]. In the 21st century, digital games, among others, cultivate learners' skills such as critical thinking, collaboration, communication, creativity, and information seeking [26]. Digital games empower teachers and learners to connect scenarios through the real world with school content, thus responding to the old question "Why should I know this?" [3] In a learning society, flooded with data, the discovery of real information that will lead to knowledge requires complex skills and the transformation of the educational system into a system that is characterized by a readiness to integrate new challenges. Traditional teaching methods cannot provide convincing answers to this old question as they simply reproduce knowledge. Skills that are far from the model "read, write, arithmetic" is demanded. In this educational system, undoubtedly, learners are at the heart of the learning that is, the "who" of education, with teachers being at the heart of system change. No changes in the educational system can happen without teachers. They are both the pedagogues in the classroom and pivotal agents of change in [33].

Even if, the majority of the teachers recognize that digital games support students to develop a wide range of strategies that can be very important for learning such as the resolution of problems, the learning of sequences, deductive reasoning, and memorization, and they have positive attitudes towards their use, few teachers have decided to implement videogames in their classes, partially due to the lack of experience [2]. Several studies have been conducted to examine those factors that lead teachers to utilize or not digital games in education. Numerous researches associated teachers' intention to use games with Keller's [27] ARCS-V Motivation Model [8]. ARCS-V model proposed five key principles associated with motivation in the educational technology context: i) attention, ii) relevance, iii) confidence (iv) satisfaction, and v) self-regulation (volition). Although Keller himself [28] indicated that for students to become fully motivated, teachers need to discover the relevance of games to their specific content areas, [36], surprisingly, concluded that perceived relevance was not found to affect teachers' attitudes toward educational video games or their intention to use them. The explanation given by the researchers was that teachers found it easier to value digital games as an attention driver than as a relevant teaching methodology for students learning the process. This finding is consonant with the view that the key part of the problem regarding the integration of digital games into the classroom related to the perception of technology as a tool rather than a system or set of affordances [4].

Digital game-based learning as part of technology-enhanced learning [19] could be studied in the broader context of technology acceptance in education. Although, according to [40], the first large step has been made: "we have largely overcome the stigma that games are play and thus the opposite of work"(p.2), however, putting educational content on games with the expectation of motivating children is not enough to call a digital game as an educational one. If so, it is just the replacement of the medium, instead of paper/book/whiteboard. It is very important to acknowledge the attitudes of teachers, both in-service and pre-service, that are shaped throughout their lives, both within the wider social environment and during their studies into the school and later into the university [32]. In addition to the teachers' own experiences, the characteristics that encourage or discourage them from using digital games are related to the games per se. There are many features of digital games that will challenge teachers to use them in their educational work. Perceived usefulness, perceived ease of use, computer self-efficacy, and attitude toward computer use were found as significant determinants of the intention to use computers by pre-service teachers [11]. Pre-service teachers

concluded that perceived usefulness and perceived ease of use were the most influential factors to their intention to use 3D multi-user virtual environments (MUVEs) when they become teachers [12]. Similarly, in the case of educational video games, perceived usefulness influences directly and positively teachers' behavioral intention while perceived ease of use indirectly influences intention through perceived usefulness [37]. Kenny and McDaniel [28] regarding the undergraduate students' (pre-service teachers) perceptions about games and their usefulness in education, found that a small minority played video games regularly and this lack of experience may explain why most of the pre-service teachers admitted that they consider video games as too complicated. The impact of game design experience had a positive influence on teachers' attitudes, self-efficacy, and perceptions regarding the use of digital games in the classroom [1]. Therefore, it is proposed several changes to pre-service and in-service teacher training curricula and professional development programs that should provide opportunities for teachers to design their own gaming environment, to explore ways to incorporate game design activities into the classroom or informal learning environments, and thus to become more actively involved in game selection and integration that will allow them to reach games' full potential [29]. Hence, technology can shape, and reshape, who is the learner and who is the teacher [16].

In this context, the authors' research team examines the factors associated with the implementation of digital games in education. Previous authors' research studied players/students' views on serious games [13], In the current research, the authors have focused on teachers' views as one of the key factors in the successful implementation of digital games in the classroom. The survey instrument was a combination of the qualitative and quantitative approaches. This paper analyzes preservice teachers' attitudes (as future teachers) about their intention to use collaborative digital games in the learning process, providing information from the quantitative part of the research. Pre-service teachers will soon start working in the real educational context and at the same time have a dual identity as both students and teachers. The authors considered that is necessary to identify students' (pre-service teachers) views, as games are a common form of entertainment for their generation [32].

2. Aim of the Study

The main aim of this study was to examine undergraduate students' perceptions (preparing to become teachers) towards digital educational games and their implementation into the classroom especially digital educational games, which are designed for collaborative learning. The purpose was to record the general prevailing atmosphere in the University Departments that prepare future primary and secondary education teachers. Following, the hypotheses, the participants/sample size, the onlinebased survey questionnaire, and our data collection process are described.

3. Materials and Methods

The general attitude of pre-service teachers was examined in correlation to demographic items that served as independent variables (IVs) of the research, which shaped the hypotheses of this work:

3.1. Hypotheses

H1. Undergraduate students' attitude toward collaborative digital learning games is positive.

- H2. Scientific background significantly and positively influences undergraduate students' views towards collaborative digital learning games.
- H3. Gender significantly and positively influences undergraduate students' views on collaborative digital learning games.
- H4. Age significantly and positively influences undergraduate students' views on collaborative digital learning games.
- H5. Additional ICT training significantly and positively influences undergraduate students' views on collaborative digital learning games.
- H6. Undergraduate students who play games for more years have more positive views on collaborative digital learning games.
- H7. Undergraduate students who play games more frequently have more positive views on collaborative digital learning games.

3.2. Participants, procedure and duration of the survey

The undergraduate students of the target group were 263 students coming from twenty-five University Departments in Greece, which are preparing students to become teachers of Primary and Secondary Education. The research also included students from the Departments of Special Education. An invitation was sent to the Department's secretariats and Facebook student groups to inform students about the research. Students were also informed that the research will be conducted voluntarily, that the consent of his participation is considered to have been given by completing the online questionnaire and that the researchers committed to keeping their anonymity. The questionnaire was available for about one month and a half, from the beginning of February to the mid of March 2019.

3.3. Questionnaire

The survey instrument was an online questionnaire that combined qualitative and quantitative approaches and contained three sections. In the first section, participants were required to answer questions about their demographic data, as the department, gender, age, additional training in ICT, and information about their game-playing experience. About the university department, the students recorded the department in which they were studying so then be coded according to the subject of their studies/scientific background. Age was divided into 4 groups: 18-23, 24-30, 31-40 and over 40 years old. To confirm students' experience of playing games, multiple-choice questions were created considering the years they have played and their frequency, as follows about the number of years: never, less than 2 years, 2-8 years, 9-15 years and over 15 years and about their frequency: never, occasionally i.e. 1-3 days a month, frequently i.e. 1-3 days a week and every day.

The questions in the second section of the questionnaire were about participants' attitudes towards digital games and their opinion regarding the usefulness of the games or not in the context of collaborative learning. The questions were based on the scale employed by Martín-del-Pozo et al., [32]. The quantitative approach was formulated based on 33 multiple-choice questions and participants were simply selecting the answer that fitted them in a five-point Likert-type scale from 1 (strongly disagree) to 5 (strongly agree). At the end of the questionnaire (third section), participants were given the opportunity, if they wanted, to provide additional comments as an open-ended question: "What do you think is the biggest barrier to integrating collaborative digital

learning games into the learning process?”¹ For this paper, only the answers to 33 multiple-choice questions are analyzed, that is the quantitative approach.

3.4. Data screening and transformations

Data from the “Undergraduate students’ attitudes towards collaborative digital learning games” questionnaire were imputed into SPSS 25 and they were checked for missing or unengaged responses (none was found). A new variable was computed which was the average of the questionnaire’s 33 items, which served as an indicator of participants’ beliefs for undergraduate students’ attitudes towards collaborative digital learning games. The preliminary analysis revealed that the data in this variable were not normally distributed. The issue was addressed by computing a new variable using the two-step transformation to normality technique described by [39]. This transformed to normality variable, served as the study’s dependent variable (DV). The questionnaire’s demographic items, namely: scientific background, gender, age, additional training in ICT, and information about their years and frequency of game-playing experience, served as the study’s independent variables (IVs).

As regressions analysis was to follow to find the relationship between the predictors and the outcome variable, an analysis was conducted for examining whether the assumptions for this type of testing were met. The rule of thumb for at least 20 participants per IV [18], was satisfied since there were 263 participants and six IVs. An analysis of standard residuals was carried out, which showed that the data contained no outliers since no values were exceeding the $|3|$ limit [10]. The data also met the assumption of independent errors (Durbin-Watson statistic 2.01). Variance Inflation Factor (VIF) and tolerance were used for checking multicollinearity. It was concluded that multicollinearity was not an issue, as there were no cases in which VIF was above the value of 4. Moreover, tolerance was, in all cases, well above the recommended minimum of .25 [18]. Finally, heteroscedasticity was not an issue as assessed using the Breusch-Pagan test [5].

4. Results

The data were imputed into SPSS 25 for statistical analysis. The questionnaire’s reliability was examined using Cronbach’s alpha [9], and was found to be acceptable ($\alpha = .806$). As the questionnaire examined the overall attitude toward collaborative digital learning games, an average was calculated for each participant’s responses to all items, which served as the study’s dependent variable (DV). The DV’s mean was slightly above the mid-point ($M = 3.44$, $SD = 0.34$). This indicates that participants’ attitude toward collaborative digital learning games was positive (but not remarkably positive). Thus, H1 “Undergraduate students’ attitude toward collaborative digital learning games is positive” is accepted.

In particular, to accept or reject the additional hypotheses, the sample description is given. The total sample of 263 students, 78 males, and 185 females, was divided into 3 categories of scientific background, according to the main body of the courses being taught in their departments. Thus, three categories emerged UNI1 which included 106 students of theoretical scientific background, UNI2 which included 111 students of technological scientific background, and UNI3 with 46 students of special education departments. The third category emerged because, according to the literature, special education teachers seem to be more positive regarding digital games utilization in the classroom and especially in inclusive settings (Istenic Starcic & Bagon, 2014). According to

¹ The results and conclusions of the qualitative research that emerged from the answers to the open-ended question were published after its presentation at the DCAC2019 conference (Kaimara et al., 2021).

age, four groups were created: (1) 18-23 years old, (2) 24-30 years old, (3) 31-40 years old, and (4) over 40 years old. 180 students were found in the age group 18-23, 51 students had an age between 18 and 23 years old, 24 students were found in the age group 31-40, and 8 students were over 40 years old. Considering the additional ICT training, 163 students did not attend additional training, while 100 students attended additional training programs.

The following was recorded about the students' experience in playing games: Table 1 shows the Experience of playing games regarding the years, and Table 2 shows the frequency of playing games.

Level	Years spent playing	N	%
0	never	58	22.1
1	less than 2 years	51	19.4
2	2-8 years	59	22.4
3	9-15 years	54	20.5
4	over 15 years	41	15.6

Table 1: Experience of playing games regarding the years

Level	Frequency of playing	N	%
0	never	58	22.1
1	occasionally: 1-3 days/month	51	19.4
2	frequently: 1-3 days/week	59	22.4
3	every day	54	20.5

Table 2: Experience of playing games regarding the frequency

For examining whether the IVs had an impact on the DV, a series of One-way ANOVA tests were to be conducted. Given that the data in the DV deviated slightly from being normally distributed and given that there was not an equal number of participants in each IV's levels, it was decided to proceed using non-parametric tests, namely the Mann-Whitney and Kruskal-Wallis tests (depending on whether there were the two or more levels in the IV).

It was found that:

- The different groups of scientific background i.e. theoretical, technological and special education did not have an effect on the DV [$H(2, 260) = 1.73, p = .422$]. Thus, H2 is rejected; the scientific background does not significantly influence undergraduate students' views towards collaborative digital learning games.
- Gender did not have an effect on the DV ($U = 6455.00, p = .177$). Consequently, H3 is rejected; gender does not significantly influence undergraduate students' views on collaborative digital learning games.
- Age did not have an effect on the DV [$H(3, 259) = 1.16, p = .762$]. As a result, H4 is also rejected; age does not significantly influence undergraduate students' views on collaborative digital learning games.
- Additional training in ICT did not have an effect on the DV ($U = 7073.00, p = .072$). Thus, H5 is rejected; additional training in ICT does not significantly influence undergraduate students' views on collaborative digital learning games.

- The years spent playing digital games had an effect on the DV [$H(4, 258) = 15.68, p = .003$]. Thus, H6 is accepted, the more years undergraduate students played games the more positive views have towards collaborative digital learning games.
- The frequency of playing digital games had an effect on the DV [$H(3, 259) = 12.46, p = .006$]. Thus, H7 is accepted, undergraduate students who play games more frequently have more positive views towards collaborative digital learning games.

In the last two IVs, in which statistically significant differences were noted, post-hoc pairwise comparisons were conducted to examine the differences between the levels of these IVs (Tables 3 and 4).

Group pairs										
Levels	0-1		0-2		0-3		0-4		1-2	
N	58	51	58	59	58	54	58	41	51	59
Mean rank	52.56	57.77	47.81	70.00	52.61	60.68	44.30	58.06	47.08	62.78
U	1337.50		1062.00		1340.50		858.50		1075.00	
Z	-.860		-3.541		-1.314		-2.350		-2.576	
p	.390		< .001		.189		.019		.010	

Table 3: Pairwise comparisons for years spent playing digital games

Group pairs										
Levels	1-3		1-4		2-3		2-4		3-4	
N	51	54	51	54	59	54	59	41	54	41
Mean rank	51.75	54.19	42.82	51.07	63.75	49.63	53.31	46.46	44.93	52.05
U	1313.00		858.00		1195.00		1044.00		941.00	
Z	-.411		-1.474		-2.290		-1.161		-1.248	
p	.681		.140		.022		.246		.212	

Table 3: Pairwise comparisons for years spent playing digital games (continued)

Group pairs												
Levels	0-1		0-2		0-3		1-2		1-3		2-3	
N	70	101	70	63	70	29	101	63	101	29	63	29
Mean rank	71.63	95.96	60.04	74.73	45.19	61.62	84.97	78.54	64.69	68.31	44.45	50.95
U	2529.00		1718.00		678.00		2932.00		1383.00		784.50	
Z	-3.163		-2.196		-2.593		-.844		-.456		1.085	
p	.002		.028		.010		.399		.648		.278	

Table 4: Pairwise comparisons for the frequency of playing digital games

From the above tables, it can be inferred that:

- Participants with the lowest frequency, i.e. never played digital games gave a lower rating to the DV compared with the other groups. Simply put, students who never played games or who played at a lower frequency gave the lowest average to the overall attitude toward collaborative digital learning games.

- The results that correlate the years that students have played with their attitude towards digital games in the learning process are not so clear. There seems to be a statistically significant difference between those who have never played games compared to those who have played more than 2 years and especially over 15 years, but this gaming experience is not able to explain a possible positive or negative attitude for learning games.

Generally, pre-service students' attitudes are slightly positive, a mean of 3.44 (out of 5), nearly to the option "Agree". Similar was Martín-del-Pozo et al., [32] finding with an averaging of 3.65. The additional analyzes showed that no independent variable, such as scientific background, gender or age, even the years spent playing, has an impact on the attitudes towards collaborative digital learning games. From the above, it can be concluded that the only factor that could influence a positive attitude is the frequency with which someone is playing games. These findings are consistent with findings of other contemporary surveys in which the correlation of the demographic variables and their attitudes or intention to use educational video games has not shown statistically significant differences among groups of teachers formed by the gender, age, teaching experience, type of school (primary or secondary school) where the teachers were employed [30]. These results are particularly promising, as previous research has shown that age and gender are predictive variables of attitude formation [32]. Sánchez-Mena, Martí-Parreño & Aldás-Manzano [35] found that age moderated teachers' perceived ease of use on perceived usefulness, i.e. the effect of teachers' perceived ease of use on teachers' perceived usefulness of educational video games is moderated by this factor (age). In other words, older teachers found difficulties in the implementation of educational video games due to the lack of experience and familiarity with video games compared to younger teachers. Alongside, in the case of pre-service teachers the most powerful factor that affects their attitudes towards ICT, generally, was the viewpoint of their university professors who teach ICT-related courses [42]. The impact of game design experience had a positive influence on teachers' attitudes, self-efficacy, and perceptions regarding the use of digital games in the classroom [1]. Therefore, pre-service and in-service teacher training curricula and professional development programs should provide opportunities for teachers to design their own gaming environment, focusing on teachers' age as older and younger teachers' perceptions, familiarity and competence. Training programs should showcase the perceived usefulness of educational games to encourage teachers to adopt this educational innovation in their courses.

5. Conclusion – future work

The notion that prevails is that the young generation has positive attitudes towards digital educational games. However, our research pointed out that although there are no strong resistance and negative beliefs by the students, they seem a little bit reluctant to adopt the technology in teaching and learning despite their extensive exposure to digital media². The results provide a basic understanding of the undergraduate students' attitudes and views on collaborative digital learning games. Our research suggested that the concern of the attitudes of future teachers of all educational levels, Primary, Secondary and Higher Education is fundamental as in some years almost the majority of the teachers will be called upon using digital learning materials. This evidence is very important especially for the educational system of higher education level which prepares the future teachers and should be under consideration for educational policy-making. Therefore, a more in-depth investigation of pre-service teacher attitudes, as well as the philosophy and curricula of

² A different statistical approach highlighted the factors that shape student attitudes, which was published shortly after the first results of the present study (Kaimara et al., 2022).

the Greek Higher Education Pedagogical Departments, their readiness to adapt to the demands of the 21st century and their willingness to accommodate the international trend of transforming educational systems is required. If the learners are at the heart of the learning and the teachers of any educational level are at the heart of system change, the cornerstone of any change is teacher education. Following, the researchers' further work has relied on the qualitative approach of the questionnaire that was employed in the current work, analyzing the barriers regarding digital learning integration in the classroom as they were referred by the pre-service teachers.

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