Exploring the Impact of Digital Games on Elementary School Students' Cognitive and Social Skill Development: A Perception-based Study

Eleni Kougioumtzidou, *University of Thessaly, Adjunct Professor, ekougioum@uth.gr*

Kafenia Botsoglou, *University of Thessaly, Professor, kmpotso@uth.gr*

Eleftheria Beazidou, *University of Thessaly, Assistant Professor, liliabe@uth.gr*

Nikolaos Zygouris, *University of Thessaly, Assistant Professor, nzygouris@uth.gr*

Abstract: Widespread use of digital games among elementary school children has attracted significant research attention. This study aimed to investigate the perceived social and cognitive skills developed through digital games, according to children's beliefs. Data were collected using a questionnaire based on previous research and enriched with additional questions. The questionnaire consisted of 19 Likert scale questions, measuring various aspects of cognitive and social skills and 537 students participated.

The research employed inductive analyses to examine differences among sub-groups of students based on demographic characteristics. T-Test and ANOVA tests were utilized to compare groups. Factor analysis was performed to determine variable correlations. Findings indicated that students believed that digital games enhanced their cognitive skills, among others problem-solving, decision making. Additionally, students reported that games facilitated the development of social skills such as collaboration, competitiveness and empathy.

This research contributes to the existing literature by focusing specifically on elementary school children's perspectives, a relatively understudied area in digital game research. Given the popularity of digital games, further research, focusing on a diversity sample, is needed, in order to comprehend the influence of digital games in children's development.

1. Introduction

A great number of studies have been conducted to determine whether digital games contribute to the development or enhancement of children's cognitive skills. Although this field is relatively new, research is growing rapidly. Since the importance of play in children's cognitive development has been sufficiently documented (Avgitidou, & Botsoglou, 2003; Plass, Homer & Kinzer, 2015) and because play is considered to be a learning mechanism in all cultures (Anastasiadis, Lampropoulos & Siakas, 2018; Van Eck, 2006), recent research addresses digital games' cognitive dimension, which concerns the ability to facilitate learning and improve student performance (Riemer & Schrader, 2015).

Cognitive skills are all kinds of mental processes that help children to acquire knowledge, enable them to collect and process contextual information and ultimately learn to calculate, remember, measure, make comparisons and understand causes and results. According to Bloom (1956 in Anderson & Krathwohl, 2001), cognitive skills fall into six categories: knowledge, understanding, application, analysis, synthesis, and evaluation. They are related to perception, learning, memory, comprehension, awareness, logic, judgment, intuition and language (American Psychological Association, n.d.). As highlighted in the literature, digital games with high cognitive requirements can enhance players' perceptual and cognitive skills (Blumberg et al., 2019), which is beneficial for learning, as cognitive skills, combined with intrinsic motivation, increased attention and concentration, lead to academic achievement (Rosas et al., 2003).

Digital games promote students' emotional and mental development and have the potential to support cognitive processes and strategies of thinking, enabling students to make decisions and solve problems (Anastasiadis, Lampropoulos & Siakas, 2018; Camilleri & Camilleri, 2017; De Aguilera & Mendiz, 2003; Erhel & Jamet, 2013; Gee, 2005b; Granic, Lobel & Engels, 2014; Mitchell & Savill-Smith, 2000; Papastergiou, 2009; Tatli, 2018). Students also develop digital skills, that prepare them for science and technology (Subrahmanyam et al., 2001; Tang, Hanneghan & El Rhalibi, 2009), problem-solving skills, visual-spatial skills, and other high-level cognitive skills (Anastasiadis, Lampropoulos & Siakas, 2018), some of which are not taught in formal education (Tang, Hanneghan & El Rhalibi, 2009).

In contrast to cognitive skills changes, which can be measured with appropriate tools, changes in social skills are more complex and difficult to identify (Granic, Lobel & Engels, 2014). Although there is no universally accepted definition of social skills, it is clear that they relate to communication and interaction with others. The term relates to specific behaviors that presuppose interaction with others and implies that they are skills related to the social context and allow individuals to function effectively in a particular context (Beazidou & Botsoglou, 2016; Blau, Shamir-Inbal, & Avdiel, 2020; Czauderna & Budke, 2020; Little, Swangler & Akin-Little, 2017).

However, since play is a means of socialization in all cultures (Van Eck, 2006) and social games develop social skills (Campit, 2015), literature has shown that digital games can have a positive effect on children and adolescents' social development and well-being (Anastasiadis, Lampropoulos & Siakas, 2018; Campit, 2015). Thus, it is argued that digital games can promote communication and collaboration, regardless of individual differences (Annetta et al., 2009; Anastasiadis, Lampropoulos & Siakas, 2018), and facilitate social interaction between players (Annetta et al., 2009).

In general, the literature highlights digital games' benefits to children's and adolescents social development and social relationships (Fromme, 2003; Gentile et al., 2009; Granic, Lobel & Engels, 2014; Riivari, Kivijärvi & Lämsä, 2021; Subrahmanyam et al., 2001), as in the prosocial behaviour of children and young people (Gentile et al., 2009; Harrington & O'Connell, 2016;

Suziedelyte, 2012), which refers to voluntary behaviour aimed at the benefit of another person (Harrington & O'Connell, 2016).

The primary aim of the present study was to investigate elementary school children's perceptions, as revealed by their answers in a questionnaire. In line with other research studies, the aim was to indicate social and cognitive skills that children believe are developed through playing digital games.

2. Methodology

2.1. Research design

This research project is quantitative and constitutes a cross-sectional survey. Surveys study a large representative sample of the population, making measurements of various variables and indicators (Robson, 2010). Their purpose is to collect information from the sample, describe its characteristics and investigate any correlations between them, in order to highlight common, or not, points of differentiation between the variables under study. A survey is considered to be a structured approach to data collection and analysis, based on specific analysis logic (De Vaus, 1993). Variables, which result from the responses of the studied population, refer to behaviors, attitudes and views, and contribute to social and demographic statistics. The present study is also characterized as cross-sectional, because the data collection took place at a point in time (Iosifidis, 2008).

2.2. Participants

A total of 537 elementary school students, 297 boys (55.3%) & 240 girls (44.7%) participated in the study. Questionnaires were distributed to 9 elementary schools of the Municipality of Volos, so that students in the 4^{th}, 5^{th} and 6^{th} grades would complete them. The duration of the questionnaires' completion was one teaching hour, while the researcher was actively present, providing clarifications and explanations, in order to achieve the best possible result and avoid misinterpretations. The processes of questionnaire distribution and collection lasted 7 months.

Regarding the sampling strategy, convenient sampling was performed. All students that participated in the present study (N=537) presented typical academic performance, according to their teachers' ratings. Additionally, none of the participants had a history of major medical illnesses, psychiatric disorders, developmental disorders, or significant visual or auditory impairments, according to their schools' health records.

2.3. Data collection and analysis

The research tool was a questionnaire, which was based on Hatzis (2006) questionnaire and enriched with additional questions that would meet the research objectives, and variables that

emerged from the literature review. In the first phase, a pilot study was conducted, in order to confirm the tool's reliability. Additionally, Cronbach's Alpha index, which was found to be equal to .91, was used to test the reliability of the questions. The questionnaire used, was based on multivariate Likert scales, consisting of 15 Likert scale questions (5 possible answers 1 = strongly agree, up to 5 = strongly disagree).

Data statistical analysis was performed by applying the statistical package SPSS, version 25. Descriptive data analysis was performed, and averages and standard deviations for all variables were calculated.

3. Results

Descriptive analysis portrayed students' perceptions, and, more specifically, as illustrated in the descriptive tables, the perceptions of all three groups of students (4^{th}, 5^{th} and 6^{th} grades) were compared. Inductive analyses were performed, in order to investigate differences among student subgroups, based on their demographic characteristics. Specifically, the T-Test was used for independent samples for comparisons between two groups and the ANOVA test was used for comparisons of more than two groups. Demographic variables, used in the analysis of the students' questionnaire, were as follows: gender, class, existence of siblings, mother's educational level, and father's educational level.

Subsequently, a factor analysis of the participants' responses to the 6, scale A, variables was performed, in order to determine the correlation between these 6 variables. Specifically, a Principal Component Analysis was performed, with orthogonal rotation of the factors and applying a criterion for selecting a number of factors the eigenvalue greater than 1.5, having first ensured that the conditions for exploratory analyses are met. Kaiser–Meyer–Olkin Measure of Sampling Adequacy was .75 and the Bartlett's test of Sphericity, which evaluates whether the correlations between the variables allow the application of factor analysis, was significant($p<.001$) (Table 1).

Table 1. Appropriateness check of factor analysis

KMO and Bartlett's Test		
Kaiser Meyer Olkin Measure of Sampling Adequacy		,747
Bartlett's Test of Sphericity	Approx. Chi-Square	338,706
	Df	15
	Sig.	,000

The analysis of the responses yielded one factor with an eigenvalue greater than 1.5, which in total explains the 36.17% variance. This factor was named Social Skills (6 questions). The internal reliability index was satisfactory ($\alpha = 0.86$).

The same procedure was performed for the 13 scale B questions (Table 2).

Table 2 Appropriateness check of factor analysis

KMO and Bartlett's Test		
Kaiser Meyer Olkin Measure of Sampling Adequacy		,897
Bartlett's Test of Sphericity	Approx. Chi-Square	1844,693
	Df	78
	Sig.	,000

The analysis showed a factor with an eigenvalue greater than 1.5 which explains a total of 45,190 of the variances. This factor was named Cognitive Skills (13 questions). The internal reliability index was satisfactory (α = 0.82).

3.1. Children's beliefs, about social skills development through playing digital games

According to the results, students' averages in all three classes (4th, 5th and 6th grades) show that playing digital games help them a lot to:

- collaborate with others
- become competitive
- feel how the hero or teammate thinks
- manage their anger better
- understand better how someone else feels, eg the hero of the game

It is worth noting, that each class average considers that help provided by a digital game in dealing with school bullying situations is not enough (Table 3).

Table 3: Average Students' Views on Social Skills Developed by Playing Digital Games

Questions	Class D		Class E		Class F	
When you play a digital game, you think it helps you to						
	Mean	SD	Mean	SD	Mean	SD
Collaborate with others	2,89	1,60	2,99	1,50	2,74	1,41
To become more competitive	3,09	1,64	3,13	1,45	3,17	1,41

Think about how your hero or teammate feels	3,07	1,51	2,92	1,46	3,14	1,47
Handle your anger	3,15	1,59	3,32	1,55	3,17	1,55
Learn how to deal with situations of school bullying	3,57	1,66	3,51	1,45	3,50	1,55
Understand better, how someone else feels, eg the game hero	3,24	1,47	3,23	1,41	3,05	1,45

Likert scale ranged from 1 -5 (1 = Extremely helpful, 2 = Very helpful, 3 = Somewhat helpful, 4 = Slightly helpful, 5 = Not helpful at all)

The t-test conducted to compare attitudes towards social skills development through playing digital games revealed statistically significant difference between the two genders, in the factor Social Skills, with male students reporting more positive attitudes than female students (M=17.92, SD=5.30, for males and M=20.23, SD= 5.28, for females) (Table 4).

Table 4: Average and standard deviation of boy & girl responses to the social skills factor

	Social Skills			
Group	N	M	SD	t-test
Boys	297	17,92	5,30	-5.025
Girls	239	20,23	5,28	

Students' views, on social skills development, through digital game playing, do not differ statistically significantly, between students who have siblings and those who do not (p-value = 0.397).

The one-way Anovas, concerning factors "Social skills" components, failed to detect statistically significant differences, regarding school class effect ($F_{2.534}$=.17, p = 0 .83), father's educational level ($F_{5,529}$=1.90, p = 0 .09) and mother's educational level ($F_{5,531}$=1.82, p = 0.11).

3.2. Children's beliefs about cognitive skills development through playing digital games

The research results show that students of all three classes (4th, 5th and 6th grades), in average, believe that playing a digital game helps them a lot to:

- solve problems more easily

- make decisions more easily
- obey to rules
- make their imagination more intense
- be more curious
- learn more
- learn how to tell a story
- be able to understand if an action is right or wrong
- understand difficult concepts
- learn the way to think and understand the information provided
- think about what is right and what is wrong
- concentrate better on what they are doing

Table 5: Averages of D, E and F students' views on cognitive skills

Questions	Class D		Class E		Class F	
Playing a digital game helps you to:						
	Mean	SD	Mean	SD	Mean	SD
Solve problems more easily	3,25	1,53	3,20	1,39	3,09	1,42
Make decision easier	3,36	1,59	3,21	1,41	3,04	1,45
Obey to rules	2,49	1,43	2,71	1,44	2,90	1,37
Makes your imagination more intense	2,43	1,45	2,51	1,37	2,56	1,39
Makes your curiosity vivid	2,81	1,45	2,93	1,36	2,78	1,35
Feel that you have to complete your goal	2,58	1,52	2,37	1,39	2,36	1,36
Learn more	2,94	1,50	2,74	1,42	2,60	1,34
Learn how to tell a story	3,44	1,45	3,32	1,36	3,52	1,39
Understand if an action is right or wrong	2,79	1,51	2,83	1,46	2,93	1,41

Helps you understand difficult concepts	3,17	1,45	2,99	1,36	3,03	1,32
Learn to think and understand the information given	2,63	1,41	2,60	1,25	2,54	1,33
Think what is right and what is wrong	2,50	1,50	2,74	1,34	2,52	1,38
Helps you to concentrate better on what you are doing	2,85	1,54	2,75	1,45	2,83	1,54

Likert scale ranged from 1 -5 (1 = Extremely helpful, 2 = Very helpful, 3 = Somewhat helpful, 4 = Slightly helpful, 5 = Not helpful at all)

The difference observed in the sample responses is that 5th-grade children average thinks that digital games help them a lot to feel that they ought to complete their goal, in contrast to the average responses of 4th and 6th-grade children, who state that digital games give them a kind of help in completing goals (Table 5).

The t-test conducted to compare attitudes towards cognitive skills development through playing digital games revealed statistically significant difference between the two genders, in the factor cognitive skills, with male student's reporting more positive attitudes than female students (M=35.06, SD=11.09, for males and M=39.31, SD= 10.99, for females) (Table 6).

Table 6: Average and standard deviation of boys & girls responses to cognitive skills factor

Social Skills				
Group	N	M	SD	t-test
Boys	296	35,06	11,09	-4,419
Girls	239	39,31	10,99	

The results show that, at the level of statistical significance α = 0.05, students' views regarding the development of cognitive skills through playing digital games do not differ statistically significantly, between students who have siblings and those who do not (p-value = 0.47).

The one-way Anovas concerning factors "Cognitive skills" components failed to detect statistically significant differences regarding school class effect ($F_{2.533=.11}$, p = 0.90) and mother's educational level ($F_{5,530=6.10}$, p = 0.69). However, father's educational level seems to influence children's answers, regarding the cognitive skills they develop by playing digital games, as its influence was found to be statistically significant ($F_{5,528=2.49}$, p = 0 .03).

4. Discussion

The present study explored elementary school children's opinions about the social and cognitive skills, which they consider to be developed by playing digital games. According to students' average responses in all three classes (4th, 5th and 6th) of elementary school, digital games help them considerably to develop or enhance social skills (cooperate with others, become competitive, feel how the hero or a teammate thinks, manage their anger better, and understand better how someone else feels) and cognitive skills (solve problems and make decisions more easily, obey to rules, make their imagination more intense, be more curious, learn more, learn how to tell a story, be able to understand if an action is right or wrong, understand difficult concepts, learn the way to think and understand the information provided, think about what is right and what is wrong, concentrate better on what they are doing).

These findings provide answers to the research questions regarding children's views on the development of social and cognitive skills through playing digital games. Similar results, such as problem-solving skills enhancement, effective communication and collaboration, higher sense of ownership over learning outcomes, development of branching, social-emotional, and real-time thinking skills, were found in previous studies (Blau et al., 2020; Blumberg, Blumberg, Deater - Deckard, Calvert, Flynn, Green, Arnold & Brooks, 2019; Freeman & Wohn, 2017; Khalid, Batool, Khalid, Saeed & Zaidi, 2019; Ruipérez-Valiente & Kim, 2020).

It is worth noticing that the research sample average from each class believes that digital games do not help them deal with school bullying situations. In contrast, competition, collaboration, recognition, but also enhancing motivation, commitment and efficiency, are the most important elements that students gain from digital games, according to several studies (Bekebrede, Warmelink & Mayer, 2011; Latif, 2007; Subhash, & Cudney, 2018; Vlachou, Botsoglou, Andreou, 2013).

The fact that digital games, besides the pleasure they offer to gamers, enable children to develop their cognitive skills is reported in several studies, as players' practice of decision-making, development of new strategies in order to overcome obstacles, understanding complex systems through experimentation, and lucid feedback that helps children to modify the choices they can make within the game are some of the reported effects of digital games reported in the literature (Blumberg et al. 2019; Armstrong & Georgas, 2006; Kougioumtzidou, Botsoglou, Xenakis, Kalovrektis, 2021; Kovess-Masfety, Keyes, Hamilton, Hanson, Bitfoi, Golitz, Koç, Kuijpers, Lesinskiene, Mihova, Otten, Fermanian & Pez, 2016; Lieberman, 2001; Manero, Torrente, Serrano, Martínez-Ortiz & Fernández-Manjón, 2015; Sugimoto, 2007).

Furthermore, the results showed that children believe that digital games help them a lot to solve problems and make decisions more easily, and learn to obey rules, results, findings which are in agreement with those of other studies (Czauderna, & Budke, 2020; Prensky, 2003). Students also stated that digital games intensify their imagination, stimulate their curiosity to a large extent, help them learn more things, help them learn how to tell stories, help them a lot to understand if the actions they will perform are right or wrong, help them a lot in understanding

difficult concepts, as well as in learning to think and understand the information given to them, and concentrate better on what they are doing. Dedication to a goal, with the aim of completing it, in this case winning the game, leads to their full concentration, in order to achieve the desired result. In literature, we find several research studies with similar results, regarding players' need to achieve a goal (Gumulak & Webber, 2011; Smale, 2012; Khalid, Batool, Khalid, Saeed, Zaidi, 2019).

It was also found that children's responses regarding the cognitive and social skills they think they develop by playing digital games differ in terms of gender. This finding is in line with the existing literature, according to which, gender is an important factor that influences children's perceptions (Beavis, Muspratt & Thompson, 2014; Hainey et al. 2016). Similarly, father's educational level seems to influence children's answers regarding the cognitive skills they develop by playing digital games, as its influence was found to be statistically significant. Investigation of differences in the sample views based on age, whether children have siblings or not, or mother's educational level, did not show any differences.

5. Conclusion

Digital games' continuous development, as well as children's increasing engagement in them, creates the need to discover what the benefits gained from playing digital games are and how to integrate them into the educational process. The benefits of such a coupling, as well as the characteristics that should distinguish it, can be highlighted by those directly involved in this process, which are the students themselves. By eliciting children's views about the benefits digital games offer, we can understand the effects of digital games on the development of social and cognitive skills and use students' perceptions in ways that combine learning and pleasure, leading to the desired result, which is children's improved learning outcomes. In addition, because research on children's views regarding digital games is limited, greater emphasis should be placed on their point of view, as they themselves are directly involved in the processes of playing and learning.

This study contributes to the existing literature by addressing the perspectives of elementary school children, an area that has received less attention in digital game research. By highlighting the positive perceptions of students, it emphasizes the potential educational value of digital games in promoting various skills.

However, several limitations should be acknowledged. First of all, we should point out that, despite the fact that the sample was quite large (537 children), convenient sampling does not allow the generalization of the results. Additionally, the fact that there was no control group does not allow drawing conclusions about all children's development or improvement of cognitive and social skills, while playing digital games. Moreover, the children recruited were children who played digital games in general. This is another limitation of the study, as the sample was not divided according to the kind of digital games the children were familiar with. However, this limitation was to some extent addressed, as all children played games belonging

to the categories of adventure, action, fighting, simulation, sports games and strategy games. All these games have similar features, such as intense action, solving problems and puzzles, a lot of interaction among the players, exploration of virtual worlds, and the requirement of using strategies to achieve the final goals.

Therefore, similar studies should be conducted in the future, which will use a wider range of samples with differentiated experiences, so that the findings of the present study are confirmed and extended. Furthermore, the continuous evolution of digital games, as well as changes in children's social and cognitive levels, requires the continuous investigation of this field. Considering that both social and cognitive skills are an important part of children's developmental process, there is a need for continuous, further relevant research, as it is not possible for one research study to cover the whole spectrum. At the same time, it is necessary to design appropriate software, based on children's needs and modern learning theories, so that digital games can become a part of school curricula.

Overall, this study provides valuable insights into the beliefs of elementary school children regarding the benefits of digital games for their social and cognitive development. Nonetheless, additional research is necessary to validate and extend these findings, ensuring a more nuanced understanding of the potential benefits and limitations of incorporating digital games in educational settings.

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