MOBILE SERIOUS GAMES: EFFECTS ON STUDENTS' UNDERSTANDING OF PROGRAMMING CONCEPTS AND ATTITUDES TOWARDS INFORMATION TECHNOLOGY

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DECLARATION OF ORIGINALITY

I, Mirac Yallıhep, certify that

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- this thesis contains no material that has been submitted or accepted for a degree or diploma in any other educational institution;
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ABSTRACT

Mobile Serious Games: Effects on Students' Understanding of Programming Concepts and Attitudes Towards Information Technology

The purpose of this study is to measure the impacts of mobile serious games on fifth grade students' attitudes towards their course and achievements in programming concepts. For this purpose, a five weeks long study was conducted in a primary school in Turkey with 36 fifth grade students. Twenty-one students which are in the experiment group played the mobile serious game Lightbot which teaches some basic programming concepts on iPad for three weeks in one hour of the information technology and software course. On the other hand, the control group, which consisted of 15 students, had their lectures in information technology and software course according to the curriculum which is determined by the Ministry of Education of Turkey. In order to collect the data from the participants pretest-posttest design was used and the results were analyzed to test the hypotheses of the study. Data analysis results showed a significant increase in the achievements of the students in programming concepts after playing the Lightbot game while control group's test results showed no increase. However, the treatment with the game did not create any positive impact on the attitudes of the students towards the information technology and software course as expected and further research in this field is necessary to verify this result.

ÖZET

Mobil Ciddi Oyunlar: Öğrencilerin Programlama Kavramlarını Anlayışı ve Bilgi Teknolojilerine Yönelik Tutumları Üzerindeki Etkileri

Bu çalışmanın amacı mobil ciddi oyunların beşinci sınıf öğrencilerinin programlama kavramlarına yönelik başarı ve tutumları üzerindeki etkilerini ölçmektir. Bu amaçla, Türkiye'de bir ilköğretim okulunda toplam 36 beşinci sınıf öğrencisiyle beş haftalık bir çalışma gerçekleştirilmiştir. Deney grubunda yer alan 21 öğrenci üç hafta boyunca bilgi teknolojileri ve yazılım dersinin bir saatinde bazı temel programlama kavramlarını öğretmeyi amaçlayan bir mobil ciddi oyun olan Lightbot'u iPad üzerinde oynamışlardır. On beş öğrenciden oluşan kontrol grubu ise derslerine Milli Eğitim Bakanlığı'nın belirlediği müfredata göre devam etmişlerdir. Katılımcılardan bilgi toplamak için öntest-sontest deseni kullanılmış ve sonuçlar araştırmanın hipotezlerini test etmek için analiz edilmiştir. Bu analiz sonucunda Lightbot oyununu oynayan öğrencilerin programlama kavramlarına yönelik başarılarında anlamlı bir yükseliş bulunurken, kontrol grubunun test sonuçları bir yükseliş göstermemiştir. Ancak, oyun ile verilen eğitim öğrencilerin bilgi teknolojileri ve yazılım dersine karşı tutumlarında beklendiği gibi bir pozitif etki yapmamıştır. Bu sonucun doğrulanması için bu alanda daha fazla çalışma yapılması gerekmektedir.

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CHAPTER 1

INTRODUCTION

Advancements in technology is changing the world and also changing how we educate the new generations. This is the age of personal and mechanical mobility where mobile gears like phones and tablets are always carried with people to anywhere (Sharples, Arnedillo-Sanchez, Milrad, & Vavoula, 2009). This brand new mobile devices are able to handle most of the daily tasks for us and they are good tools for education as well. Moreover, video game industry, though already huge, is growing each year and it provides an opportunity for the education with the concept of serious games and game based learning. Due to the fact that digital media language is the mother tongue of this new generation, they have a very strong relationship with these new mediums and they even have better learning experiences using these tools (Prensky, 2001).

Mobile learning (m-learning) is a contemporary methodology which is introduced after the rapid improvements in the mobile technologies and based on their ability to provide a more responsive educational system (Sanchez Prieto, Miguelanez & Garcia-Penalvo, 2013). M-learning has many advantages over conventional learning techniques and most important one of them is the ability to carry the learning environment while moving (Barbosa et al., 2006).

M-learning includes all types of mobile devices and iPad is one of them. IPad, with its big screen and easy to use system for the students who are familiar with the smart phones, is more preferred than the other smart mobile devices for the education (Li & Liu, 2017). Since today's PK-12 students are more familiar and more

interested towards mobile devices, it is considered that they are more willing to learn with iPads rather than computers (Ireland & Woollerton, 2010). In order to check this and provide a better learning experience for the young study group, iPad is used in this study as the learning device.

Gaming industry has become pretty huge in recent years and is still growing each year. Since 2012, gaming industry has been bigger than movie and music industries combined, and according to a report from SuperData Research Inc. it generated $108.4 billion revenue worldwide in 2017 (Batchelor, 2018) with an increase more than 18% from $91 billion in 2016 (Takahashi, 2016). In all of the platforms that creates similar amounts of revenue, mobile gaming segment was the biggest one with $59.2 billion revenue with an impressive increase of more than 31% in one year. The report also stated that 2.5 billion people, which is about one out of every three people in the planet, play free-to-play games on PC or mobile devices. Moreover, according to a report from the Entertainment Software Association (2017), 65% of the households in the USA has at least one person who spends more than three hours a week while playing video games. On the other hand, an online survey done by NPD Group (2015) with 5566 individuals showed that average time of playing mobile games a day has increased 57% in two years and has passed two hours per day. These impressive values show how massive the gaming industry is and how fast the mobile gaming is growing.

Serious game term is used for the games that are not created only for entertainment but also has a carefully designed pedagogical purpose to convey information or expertise on some topic (Abt, 1970; Zyda, 2005). Serious game industry has started with the computer video games. One of the pioneers of the computer serious games is America’s Army and it is regarded as the first

successfully carried out serious game that earned entire public recognition (Gudmundsen, 2006). Afterwards, serious games were released for console platforms, and lately, mobile serious games are getting popular with some mobile applications which aim to provide an m-learning experience covering different topics like STEM subjects, environmental awareness, health, business, language learning, etc. During the recent years, these games are started to be used in the educational studies and there are very positive reported results (Giordano & Maiorana, 2014; Kazimoglu, 2013; Tessler, Beth, & Lin, 2013).

Like overall gaming industry, serious game industry is growing really quickly as well. According to a recent report, serious game industry has reached $3.2 billion total revenue in 2017, up from $2.7 billion in 2016, and expected to be $8.1 billion by 2022 (Adkins, 2017). This shows the importance and rise of interest towards the serious games.

Mobile serious game term stands between serious games and m-learning. It is the mix of these two concepts and has the advantage of involving mobile devices and gaming experience together which is an important factor for drawing the attention of digital media generation. Because of this reason, a mobile serious game called Lightbot is used in this study as a pedagogical tool.

Programming, or coding, is one of the most important topics in today's overly digitalized world. Thanks to the massive improvements in information technologies, new high-tech devices are invented every day and as a result of that, programming knowledge is getting more and more critical (Amer & Ibrahim, 2014). In parallel to this, software engineering was found to be the best job in 2011, and 2012 (Amer & Ibrahim, 2014) where data scientists' position became the best in 2017 while data

engineering became the third (Picchi, 2017). Thus, programming is becoming one of the fundamental information that every student should learn (Tundjungsari, 2016). In order to make sure of that, some of the countries, such as Finland, already added learning of programming skills to their curriculum (Hiltunen, 2016). Programming education enables students to figure out what programming is about and learn computational thinking. The value of learning programming will be useful even if the student chooses a very different career than software engineering (Duncan, Bell, & Tanimoto, 2014). There are also some non-profit organizations which promote learning programming like code.org, codeacademy, madewithcode, etc. Considering the importance of programming, there is a need for all kind of research studies about when to start teaching, how to teach, what kind of tools and programs to use and so on. Hence, as the learning target of this study, programming is chosen.

While it is true that educational games are being used more often in different educational settings to boost learning and drawing the attention of the students in mentally challenging topics like programming, there are still very limited number of empirical studies which investigate the effects of serious games on teaching programming, especially to young students (Giannakoulas & Xinogalos, 2018). There are even less empirical studies about serious games for teaching programming in Turkey. Because of this, there is a need for more empirical studies carried out in Turkey to investigate the impacts of mobile serious games for teaching programming. Therefore, the purpose of this study is to contribute to the field by conducting a research about this subject.

In this study, 21 fifth grade students played a mobile serious game Lightbot, which teaches a few programming concepts, on iPad for three weeks in one section of their information technology and software course. At the beginning and after the

end of the treatment, same tests were applied to investigate the impact of the game on students' achievements in programming concepts and attitudes towards the course. Afterwards, statistical analyses were applied to the test results in order to test the hypotheses of the study.

CHAPTER 2

REVIEW OF THE LITERATURE

In this chapter, using mobile devices as a tool in education is discussed. Then, serious game concept, its types and platforms are presented and related research studies are mentioned. Afterwards, serious games that aims teaching programming are analysed. Lastly, some of the recent studies are examined to investigate the effect of serious games on the students' achievement in programming concepts and attitudes towards their course.

2.1 Using mobile devices in education

Mobile devices such as smart phones and tablets have become an important part of everyone's daily life in the past decade. They even turned into a common technology which has begun to "shape our society" like only a few other device could do (Hildmann & Hildmann, 2011, p. 87). Also, their capability to do a lot of different things makes them a useful tool for different subjects. Wong and Looi (2011) claim that these lightweight portable gadgets have the potential to start a new phase in the growth of "technology enhanced learning" with being handy and easily accessible all the time.

One of the early definitions of m-learning was done by Quinn (2000) as: "It's e-learning through mobile computational devices: Palms, Windows CE machines, even your digital cell phone" (para. 1). Using mobile devices for learning has many advantages over conventional learning techniques. Barbosa et al. (2006) explains one of the most important features of m-learning as it allows learners to carry their

individual learning environment beside them while they go anywhere. This leads to "seamless learning" by blending formal and informal education contents and by enabling learners' to have an educational experience more in their taste (Wong & Looi, 2011, p. 4). The difference between m-learning and other types of learning is that in m-learning it is possible that the learners are constantly travelling (Sharples, Taylor, & Vavoula, 2010). According to Chan et al. (2006), these developments, like letting learners to learn whenever they want and seamlessly changing the contents will affect the essence of the learning, the techniques of learning and also the results of the learning.

Among all the m-learning platforms, iPad is one of the most popular one. When it was released in 2010, there was a major amount of excitement around it from the educators since it was a reasonably priced, compact device which could completely increase the efficiency of student learning by empowering them to work collaboratively and reach the data they need at any moment in any place (Falloon, 2017). Some educators even called it as a potential "game changer" for education (Geist, 2011, p. 1).

The iPad is preferred over the other smart devices because it has a very big screen which is convenient when working with PDFs and for doing other visual intellectual assignments (Li & Liu, 2017). Also, iPad is very easy to use. Since applications are produced to be easy to handle by everybody, most of the students who are not familiar with the computers but familiar with the smart phones, will adapt to it with less effort (Ireland & Woollerton, 2010). Shepherd and Reeves (2011) expresses that while iPhone definitely created a good platform for m-learning, it had some restrictions. The iPad, with its wide screen on top of the same capabilities and applications of iPhone, combined the mobility and practicality in one

device for the use of the students. In the light of these advantages and also his field study's results Geist (2011) claimed that "The future of Learning Management Systems (LMS) will be mobile and app based rather than web based" (p. 764).

There are many studies in the literature that use mobile devices, and also the iPad, in education. Manuguerra and Petocz (2011) showed in their study when they use iPad in different teaching activities for 15 months that although the learning outcomes did not significantly rise, students' comfort and adaptability made a big increase. Crompton, Burke, and Gregory (2017) found 113 articles which was published in one of the top 10 education technology journals and feature an original research about m-learning involving PK-12 students between 2010 and 2015. From these 113 articles, 70 of them reported positive results. This means that 62% of the studies found that using m-learning increases the student learning. Moreover, in these research studies, most of them used mobile phones (34%) as the m-learning tool. While 16% used tablets, 11% used only iPad for their research study. Lastly, as the subject of the m-learning study, science was the most common one with 56% ratio, literacy was second (21%) and math was the third (10%) common subject. Among all these 113 studies which they evaluated, there was no study that examined the programming as the subject matter for the m-learning. Hence, it is clear that there is a need for more research focusing on programming as the main subject for m-learning.

2.2 Using serious games in education

Serious games term has its root back in the seventies when Abt (1970) defined it as games which are not intended to be played mainly for entertainment and have a certain and carefully constructed educational intention. Still this does not mean that

serious games are not or should not be supposed to be enjoyable (Abt, 1970). When this definition was given, there was no digital game industry yet. With the rise of the digital games industry, serious games term became more popular and widely used especially after Sawyer and Rejeski published their white paper with the title "Serious Games: Improving Public Policy through Game-based Learning and Simulation" in 2002. In this paper they connected the serious game concept with the digital game industry. Not so long after publishing this paper, they founded the Serious Games Initiative which is an association to help raise the awareness about the use of digital games for serious purposes. The work of Sawyer and Rejeski (2002) influenced many others after them and more definitions were done based on their perspective. Michael and Chen (2005) defined serious games as "Games that do not have entertainment, enjoyment or fun as their primary purpose" (p. 21). Zyda (2005) also added that the difference of serious games from other games is that they include pedagogy in the game in order to convey information or expertise on something. However, this pedagogy element of the game must not be superior to the entertainment element which should come first.

There are some similar terms to serious game in the literature which have small differentiation between them. First of them is edutainment which is the abbreviation of educational entertainment. Edutainment term contains all the entertainment elements that are created for both education and entertainment (Todorova, Tzonkova, & Byanova, 2012). It is a composite genre that is highly based on visual elements, with a story or game setup, and with a more casual approach (Buckingham & Scanlon, 2000). Edutainment does not necessarily need to be a digital game since it is "any kind of education that also entertains" (Susi, Johannesson, & Backlund, 2007, p. 2). Therefore, it can be said that serious games

cover the same aims as edutainment, but it goes further by adding all aspects of education like teaching, training and informing and it addresses all ages (Michael & Chen, 2005) from preschool children to very old people. There is some criticism towards edutainment term as well. Resnick (2004) claimed that people thinks education and entertainment as services that are given to them by someone else. However, people tend to learn and enjoy when they are involved as an active member. Another similar term is game-based learning (GBL) or digital game-based learning (DGBL) which refers to GBL explicitly with the use of digital games (Prensky, 2003). GBL is considered more or less the same as serious games (Corti, 2006). According to Prensky (2003), DGBL is a movement in e-learning and it is based on two important arguments; firstly, current student generation is the natives of the digital media language. Secondly, this generation also exposed to a new type of digital game play and this new type of entertainment has changed their choices and skills which results in a great potential for learning.

The first successful and skilfully carried out serious game that attracted entire public's attention is considered as America's Army (Gudmundsen, 2006). Together with the outstanding achievement of America's Army and Sawyer and Rejeski's attempt to encourage people in such games, makes 2002 to be recognized as the beginning of the current trend in serious games (Djaouti, Alvarez, Jessel, & Rampnoux, 2011). After the success of America's Army, Michael Zyda, who participated in the development of America's Army, stated that mothers came to him and said their children learned everything about the Army by playing the game and asked if playing such games could teach them more beneficial things (Zyda, 2005). After these feedbacks they started to think if it is possible to teach PK-12 science and math subjects via games. After all, there are solid evidences which demonstrate that

playing games affect “digital game natives” – people who have played digital games while growing up – in a positive way (Zyda, 2005, p. 26).

Before 2002, there were also some serious games but the number of games and the variety of the topics as the serious part of the game was limited. Djaouti et al. (2011) found 1265 serious games which were released in eight years between 2002 and 2010, while there were only 926 serious games which were released in 21 years between 1980 and 2001. This shows how much the serious games industry has grown after 2002. Moreover, the games before 2002 was mainly created for the educational market and 65.8% of the serious games were about education. However, after 2002 there were more diverse range of topics and the educational serious games were only 25.7% of them. Depending on this information, it is possible to deduct that the current trend in serious games allows people to create different types of serious games (Djaouti et al., 2011).

It is possible to see the rise in interest towards serious games in recent years from the increasing amount of companies, conferences and academic publications dedicated to the concept (Breuer & Bente, 2010). Boyle et al. (2016) also emphasized the increase of people’s interest towards using digital games for learning and attitude change in recent years since they found much more papers reporting empirical evidence of the positive outcomes of playing games between 2009-2014 (512 papers) than in their previous study (Connolly, Boyle, MacArthur, Hainey, & Boyle, 2012) between 2004-2009 (129 papers). However, out of these 512 papers, only 143 of them passed the inclusion criteria about providing strong empirical evidence about the effect of games. In their study, they found the most popular subject area as Science, Technology, Engineering and Math (STEM) with 24 papers. Then, the games for health followed it closely with 23 papers. Out of the games

about STEM subjects, science was the most popular one (12 papers) and computing was the second (seven papers), forestalling both math (two papers) and engineering (two papers). Hence, it can be said that there is a good amount of interest towards serious games for computing subjects in recent years. However, there is still a need for much more study with the strong evidence to support the use of serious digital games in education (Hainey, Connolly, Stansfield, & Boyle, 2011).

There are a lot of different types of serious games which are used in the literature. Other than above mentioned ones, studies on games for business (Riedel & Hauge, 2011), advertisement (Chen & Ringel, 2001), military training (Beligan, Roceanu, Barbieru, & Radu 2013), language learning (Palomo-Duarte et al. 2017; Johnson, Vilhjalmsson, & Marsella, 2005), biology (Moreno, Mayer, Spires, & Lester, 2001), psychology (Clark, Tanner-Smith, & Killingsworth, 2016), history (Huizenga, Admiraal, Akkerman, & Dam, 2009; Mortara et al., 2014), economics (Todorova et al., 2012), civic learning (Raphael, Bachen, Lynn, Baldwin-Philippi, & McKee, 2010), problem solving and collaborative skills (Sanchez & Olivares, 2011), special education (Brown, Standen, Evett, Battersby, & Shopland, 2010; Durkin, Boyle, Hunter, & Conti-Ramsden, 2015), environmental awareness (Wang & Tseng, 2014) exist in the literature. Especially in environmental awareness, there are many subcategories like energy saving (Knol & De Vries, 2011), pollution and desertification (Zualkernan, Jibreel, Tayem, & Zakaria, 2009; Rossano, Roselli, & Calvano, 2017), sustainability (Torres & Macedo, 2000), agriculture (Yongyuth, Prada, Nakasone, Kawtrakul, & Prendinger, 2010), climate change (Reckien & Eisenack, 2013; Chen, Bodicherla, Scott, & Whittinghill, 2014).

Thanks to the improvements in technology, there are different platforms for education (Imbellone, Botte, & Medaglia, 2015) and also for serious games. Other

than computers which are the oldest serious gaming platform, there are now platforms like consoles, tablets and mobile phones. In their study, Boyle et al. (2016) also investigated the platforms that the serious games are developed for. From the total of 143 studies, 82% of them were games for PC or console. 18 of them were online games and lastly, only the remaining two games were mobile games. Depending on the numbers of research studies found in Boyle et al.'s study (2016), it can be clearly said that more research is needed to investigate the impacts of mobile serious games.

2.3 Serious games for programming concepts

Recent advancements in the technology has made programming a very essential subject. It is also quickly becoming one of the fundamental information that any student should know (Tundjungsari, 2016). Because of this, studies are done to find the best way to teach programming to students. According to Wang and Zhou (2011), programming education for high school students should use enjoyable programming instruments to overcome their nervousness and increase their interest since programming has an abstract characteristic that can cause hardship and exhaustion for the students at the beginning. In order to eliminate these problems and add the enjoyment factor to the education, Wang and Zhou (2011) and also many other researchers (Calder, 2010; Rizvi, Humphries, Major, Jones, & Lauzun, 2011; Saez-Lopez, Roman-Gonzalez, & Vazquez-Cano, 2016; Peppler & Kafai, n.d.) used Scratch game in their study and found positive results like increase in perceived self-efficacy regarding their programming skills.

Scratch was started to be developed in 2002 and released to public in May 2007 (Scratch Timeline, n.d.). It was created by a group of researchers in the MIT Media Lab. with the aim of making programming reachable and engaging to anyone (Resnick et al., 2009) and also supporting people to advance their creative thinking ability (Resnick, 2008). Due to the fact that Scratch uses only graphical blocks for coding, it removes the debugging procedure and the possibility of making syntax errors (Peppler & Kafai, n.d.). Moreover, Scratch's visual setting provides a perceptive drag and drop approach to programming and this makes young players like primary school students create things easily which can increase their comprehension of programming concepts and methods (Saez-Lopez et al., 2016).

After the development of Scratch, many other serious games were developed to help young students learn some of the basic programming concepts and advance their computational thinking. Gibson and Bell (2013) found 41 games that teaches computer science in their study. Their topics were categorized and the most popular topics were binary number conversion and introductory programming concepts teaching with 11 games each. Games like Binary Fun and Crossbin Puzzles are the examples of binary number conversion games and Blockly, Robozzle and Lightbot games are identified as programming concepts teaching games. The other popular topics are networking with seven games and cyber security with four games. Among these 41 games, 21 of them were web-based games and only four of them were mobile games. Garcia-Penalvo et al. (2016) also made a study about resources for introducing programming to young audience like primary school students. They found 12 mobile apps, available in iPad, for teaching programming and one of them is Lightbot.

Lightbot game's aim is to "introduce kids to programming concepts and coding" (Garcia-Penalvo et al., 2016, p. 5) using blocks to program a robot to move around the board and light up the blue tiles. Lightbot also teaches the recursion concept in some levels by giving a puzzle that can be passed only by creating a procedure that calls itself (Gibson & Bell, 2013). Gouws, Bradshaw, and Wentworth (2013) evaluated the Lightbot game in their study with a computational thinking framework. They evaluated the game in different aspects like patterns and algorithms, evaluations and improvements, and tools and resources. At the end, they found the total computational thinking score of Lightbot as 74 out of 100 and it showed that the Lightbot game is a useful serious game for studying computational thinking.

There are some studies in the literature which uses Lightbot as a tool to teach programming. Giordano and Maiorana (2014) made a year-long study with 26 10th grade high school students who are between 14 and 16 years old. They used Lightbot and also other apps and computer programs like CS unplugged, AppInventor and Scratch. Throughout the year, they made some class interventions, gave homework and four written exams. They made the written exams as a pretest-posttest design to test the achievement of the students about nested loops, variables, conditionals and composite Boolean expressions. According to the results of these exams, they reported a rise in the number of correct answers and a minor decline in the number of no answered questions.

Aedo Lopez, Vidal Duarte, Castro Gutierrez, and Paz Valderrama, (2016) also used Lightbot in the laboratory session of the first computer science course in two different universities in Peru. They used the Lightbot as a tool to explain three concepts on programming: abstraction, function and reuse. At the end of the

laboratory session they made a quiz about these three concepts and found that students understood the subjects clearly. Moreover, the average grade of the course, out of 20 total grade, has increased from 11.9 to 14.50 in one university and 10.55 to 13.69 in the other.

Some of the recent studies that uses serious games which are designed to teach programming concepts is presented in the Table 1. In the light of these studies, it can be said that there are studies in the literature about serious games to introduce programming concepts, but there is still a need to implement more studies with empirical evidences especially for the primary and secondary school students.

Table 1. Some of the Recent Studies about Serious Games for Programming and Their Results

Author	Games	Age Group	Size	Objective	Test	Result
Kazimoglu, 2013	Program your robot	Undergrad Students	213	To teach computer programming at the computational thinking level	Pre/Post Test Design	Statistically significant increase in attitude to learn programming through playing games, motivation to learn programming, knowledge about key programming concepts
Adamo-Villani, Cooper, & Whittinghill, 2012	The IA Game	Undergrad Students	63	To teach secure coding and Information Assurance (IA) concepts	Rating Questions and Open-ended questions	Increase in subject content learning 25%, increase in declarative knowledge 23% and procedural knowledge 34%
			54			Increase in subject content learning 22%, increase in declarative knowledge 21% and procedural knowledge 32%
Muratet, Torguet, Viallet, & Jessel, 2011	Prog & Play	First-Year Undergrad Students	+300	To encourage students to persevere in computer science	Evaluation from the game and post questionnaire	Results show that serious game is functional and motivates students to learn computer science
Miljanovic & Bradbury, 2017	RoboBUG	First Year Undergrad Students	14	To teach effective debugging techniques	Pre/Post Test Design	Significant increase in achievement
Pellas, Konstantinou, Georgiou, Malliarakis, & Kazanidis, 2014	Open Sim & Scratch4OS	High School Students	55	To explore the correlation between students' engagement indicators	57 item instrument	Increase in students' engagement
Jemmali & Yang, 2016	May's Journey-3D Puzzle game	Fifth and Eighth Grade Students	10	To teach middle and high school girls basics of programming	Game observation and interview	Increase in motivation to learn programming.
Tessler et al., 2013	Cargo-Bot	High School Students	47	To improve students understanding of recursion	Pre/Post Test Design	Significant improvements in students understanding of recursion

CHAPTER 3

METHODOLOGY

The methodology of the study will be explained in this chapter. Firstly, overall design of the study will be presented. Secondly, research questions and hypotheses will be explained. Then, all of the variables will be defined in detail. Participants and instruments of the study and how they are determined will be explained. Finally, data collection procedure and the experiment will be described.

3.1 Overall design of the study

In this study, students' attitudes towards information technology and software course and achievement in programming concepts will be measured by using experimental research model. Figure 1 shows the process design of the study. According to the design, there are two different groups in this study. The first one is the control group which will study their curriculum that is determined before the academic year by the Ministry of Education (MEB) of Turkey. Their curriculum consists of information technology and software courses in which they use Scratch to create some basic games. The reason to use a control group is to measure the effect of the treatment accurately and interpret the results in a correct way.

The second and research's experiment group is the mobile serious game assisted learning group which will play Lightbot on iPad, a mobile serious game that is developed to teach some programming concepts not only but especially to primary school students. Lightbot game consists of three stages: Basics, Procedures, and Loops.

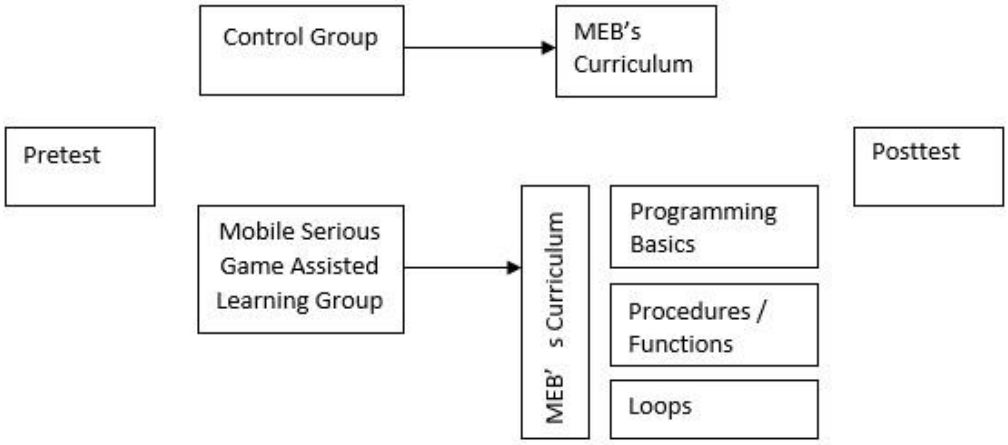


Figure 1. Process design of the study

Pretests will be applied to each group at the beginning of the research study. Then, each group will follow their learning content according to MEB's curriculum and only experiment group will get mobile serious game assisted learning sessions once a week for three weeks. Every week, they will play a stage in class and finish the game in three weeks. After that, posttests are going to be applied. Posttests are the same as pretests and consist of two different tests: Attitude towards information technology and software course which is developed from an existing scale from the literature and achievement in programming concepts which is developed by the instructor of the course and the researcher according to learning targets of the serious game. The development and all of the details about the tests will be explained later in this chapter.

There are two dependent and one independent variables in this study. Dependent variables are achievement in programming concepts and attitude towards information technology and software course. Independent variable is the instructional method of the study which is mobile serious game assisted instruction. Research model is shown in Figure 2.

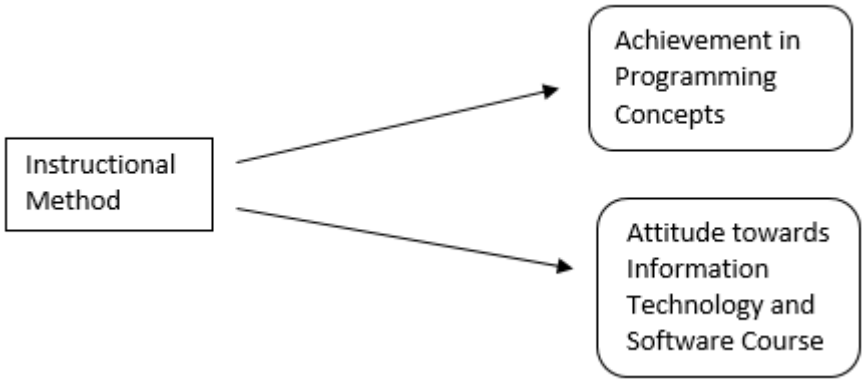


Figure 2. Research model

The study was implemented in Bahcelievler Okyanus Koleji which is a Private Primary School based in Istanbul. One class from fifth grade was selected as Experiment group and another one as the Control Group. Experiment group had 21 students and control group had 15 students that completed the research study. Although there were more students in each of the groups, it was not possible for some of them to attend the study completely. Therefore, they were eliminated from the study. Selection of the school and the details about the participants will also be explained in the next sections of the chapter.

3.2 Research questions

This study aims to find if mobile serious game assisted instruction affects fifth grade students' attitudes towards information technology and software course and achievements in programming concepts. In order to do this, below research questions are proposed and going to be answered within this study:

Question 1a: Does mobile serious game assisted instruction causes a significant increase in fifth grade students' attitudes towards information technology and software course?

Question 1b: Does following MEB's curriculum causes a significant increase in fifth grade students' attitudes towards information technology and software course?

Question 2a: Does mobile serious game assisted instruction causes a significant increase in fifth grade students' achievements in programming concepts?

Question 2b: Does following MEB's curriculum causes a significant increase in fifth grade students' achievements in programming concepts?

3.3 Hypotheses

The hypotheses that are going to be analyzed in line with the research questions are given in this section.

- Hypothesis 1a: There is a significant increase in fifth grade students' attitudes towards information technology and software course when they are exposed to mobile serious game assisted instruction.
- Hypothesis 1b: There is not a significant increase in fifth grade students' attitudes towards information technology and software course when they follow MEB's curriculum.
- Hypothesis 2a: There is a significant increase in fifth grade students' achievements in programming concepts when they are exposed to mobile serious game assisted instruction.

Hypothesis 2b: There is not a significant increase in fifth grade students' achievements in programming concepts when they follow MEB's curriculum.

3.4 Definition of variables

According to the research model, there are two dependent and one independent variables in this study. Independent variable of the study can be defined as follows:

Instructional Method: Instructional method for the experiment group is MEB's curriculum plus Mobile Serious Game Assisted Instruction and Lightbot game will be used as the Mobile Serious Game. Instructional method for the control group is the MEB's curriculum.

Dependent variables of the study can be defined as follows:

Achievement in Programming Concepts: This is the achievement score of the students for the programming concepts that are subjected in the serious game. This achievement score will be calculated by the pretest and posttest results. The final analysis will be made by subtracting the pretest score from the posttest score. This will show us the impact of the instructional method on the achievement of the students.

Attitudes towards Information Technology and Software Course: This implies the attitudes of the students towards the course and will be investigated by a pretest survey and a posttest survey. The final analysis will be made by comparing the results of these two tests to see if there is a significant difference. With this result we can understand the impact of the instructional method on the attitudes of the students towards the information technology and software course.

3.5 Participants

The study was conducted in Okyanus Koleji which is a private primary school in Bahcelievler with the referral of the research advisor. This school is chosen because the serious game's language is English and they have a very good English language education. Therefore, the students have enough English to understand the game. Also, the teacher of the information technology and software course was open to try new instructional methods and happy to help to an academic research study.

Fifth grade students were chosen as the target group since the study's aim is to investigate the success of a mobile serious games' at teaching coding in early age. A pilot study was done with one third grade, one fourth grade, one fifth grade and one seventh grade student to investigate how they were able to understand and play the game successfully. This pilot study showed that after the basic stage, students who are younger than fifth grade had difficulty to pass some levels and got bored from the game easily. As a result of this pilot study, it was clear that fifth grade is the earliest grade that the students are able to understand the concepts and play the game completely.

Among all the fifth grades in the school 5B and 5D were chosen as the research groups based on the suggestion of the course instructor since these classes were very equal in achievement in information technologies and software courses based on their previous year grades. It was not possible to regroup the classes to build exactly the same achievement levels for the experiment and the control group since all of the fifth grade classes had different course hours and there was only one information technologies and software classroom in the school. Moreover, both classes were very heterogeneous according to basic programming skills and interest.

This way it was possible to investigate the impacts of the mobile serious game on both the students who are interested and talented towards information technologies and software course and who are not. Among these two classes 5B was picked as the experiment and 5D as the control group randomly.

Experiment group consisted of 23 students and control group consisted of 24 students. Although there were 23 students in the experiment group, the number of valid participants at the end is 21 since two students from the experiment group were eliminated from the study since one parent didn't sign the consent form to approve their child to attend the study and one student was sick and couldn't attend the second and third weeks of the implementation. Similarly, nine students from the control group were eliminated. There was a national exam for the 8th grade students in the day which the posttests were done. Thus, these students thought that the school was on holiday for the other classes and did not come to school. At the end, the valid participant number from the control group decreased to 15. The number of participants for each group is given in the Table 2.

Table 2. Number of Participants Who Attended and Eliminated From the Research Study

Groups	Beginning	Eliminated	Final
Experiment Group	23	2	21
Control Group	24	9	15
Total	47	11	36

Because the study is conducted with only the fifth grade students, age of the participants was not different. They were all 10 or 11 years old. Since there is not any significant difference in terms of age, the student's age information was not gathered.

Furthermore, gender difference was not the subject of this research study and therefore number of female and male students is not required to be equal. There were 13 female and eight male students in the valid experiment group and nine female and six male students in the valid control group. Gender distribution according to research group can be found in Table 3.

Table 3. Gender Distribution According to Research Group

Groups	Participants	Female	Male	% of Female	% of Male
Experiment Group	21	13	8	61.9	38.1
Control Group	15	9	6	60	40
Total	36	22	14	61.1	38.9

Although the groups are not perfectly homogeneous, there is not a significant difference between their gender distributions. Therefore, the impact of gender difference will not be investigated within this research study.

3.6 Instruments

In this study, two consent forms, attitude towards information technology and software course survey, achievements in programming concepts test, and a mobile serious game are used as research instruments. These data collection instruments and the game will be explained in this section.

3.6.1 Consent forms

In order to get the necessary permissions for the research study, consent forms were prepared. Firstly, the Information Technology and Software course instructor's permission to carry out the study in their classroom and during their course hour was got with the Teacher Consent Form (see Appendix A). In this form the teacher was informed about the content, application and duration details of the study. He was also informed that there is no prize for participating and he can leave the study anytime without stating any reasons.

Secondly, it was necessary to get the permission of the participants. Since the participants are younger than 18 years old, their parent's permission was necessary. Therefore, Student Consent Forms (see Appendix B) were sent to their parents. In this form parents were informed about the application details and objectives of the study. Parents are also informed that students' personal information is secured, students' names are not used anywhere, there is no grade or prize for the study, and test scores will not be shared with anyone. Parents are also notified that they are free to withdraw their child in any part of the study and their results are not going to be used in that case. At the end there is a part asking for their signature if they accept their child to join the study.

The project and the consent forms are approved by the Ethics Commission of Boğaziçi University.

3.6.2 Attitude towards information technology and software course survey

This survey was prepared to evaluate the attitude of students towards the course. It consists of 20 Likert scale questions and is used as both pretest and posttest since the

study aims to investigate the impact of the treatment. In order to prepare this survey, a literature review was done. A scale was found in the literature to evaluate the attitudes of the fourth grade students towards a math course when a computer assisted instruction system was implemented (Pilli, 2008). The same scale was adapted for this research study as it is not towards a math course but towards information technology and software course. This scale was taken from a previous study and the reliability coefficient from that study was 0.96 (as cited in Pilli, 2008). In Pilli's study (2008) reliability coefficient was calculated as 0.86 for pretest and 0.90 for posttest which are in line with the result of the original study. Reliability analysis gave also similar results in this study. Alpha reliability coefficient was calculated as 0.90 and 0.91 for pretest and posttest surveys respectively. Since the coefficient is much bigger than 0.7 and indicates that the results are reliable, no item was removed from the scale. See Appendix C for the reliability analysis SPSS results.

After adapting the scale for this study, survey was inspected by the research advisor and also the instructor of the information technology and software course. Some changes in terms of wording were done according to their feedback and then the survey was given its last form (see Appendix D).

3.6.3 Achievement in programming concepts test

The target of this test is to evaluate the students' achievements in programming concepts which are subjected in the mobile serious game, Lightbot. In order to develop this test, Lightbot game's learning objectives were analyzed and also a literature review was conducted and similar tests were examined. Lightbot game has

three stages: Basic stage, Procedure stage and Loop stage. In order to evaluate the students' knowledge for all of the stages, this test is also designed to have three sections. Every section has questions related to a stage, namely Basic section, Procedures section, and Loops section. Every section consists of three questions (see Appendix E). There are different types of questions in each section like open ended questions, multiple choice questions and true-false questions. The draft test was prepared with the assist of an expert on the education area and after preparing the draft test, it was examined by the research advisor and the instructor of the information technology and software course. Their feedback was acquired and the test was rearranged, and some wording changes were made to make the questions clearer. After that, the final form of the test was prepared and both the instructor of the course and the research advisor approved the test. Parallel to the Attitude test, this test was also applied before the study as a pretest and after the study as a posttest since the aim of the study is to investigate the impact of the treatment on the subjects.

3.6.4 Mobile serious game: Lightbot

In order to implement this study there was a need for a mobile serious game that is focused on teaching coding while having fun. There were three important features that the game should have:

- The game should be easy to play.
- The game's language should be pretty easy to understand.
- The game should be free, since it will be played at school.

First, the author checked the game development platforms like Unity to develop a serious game for this study. However, the time until the experimental study was not

long enough and there would not be an adequate amount of time to develop a new game from the beginning. Also, it was realized that there are similar mobile serious games already and some of them were used in the literature. Therefore, it was decided to find a suitable game for this study and use it as a treatment tool.

In order to find such a game, firstly the literature was searched and some games were experimented, and a pilot study was made with a seventh grade student. In addition to this, the games from serious game platforms like www.gamesforchange.org, www.khanacademy.org, and www.code.org are checked and tried. Some of the games that were considered were Robozzle, Cargo-Bot, and CodeSpark Academy.

Finally, Lightbot: Code Hour game which is developed by the Lightbot Inc. was tested and the pilot study showed that the game has above three necessary features and is also very fun to play for the students above fourth grade. The game is a short version of the original Lightbot: Programming Puzzles that is not free and has 50 levels. On the other hand, the free version Lightbot: Code Hour has 20 levels. Lightbot: Code Hour game was developed with the support of code.org to be used by everyone freely especially by teachers to teach programming in PK-12. The game is used in Hour of Code events which take place in different places all around the world, to introduce computer science to people and to kids. These events are also supported by code.org and more than 15,000 events have been done so far in the world according to www.hourofcode.com and 92 of them were in Turkey.

Lightbot: Code Hour game's aim is to introduce players to programming who have none or very little programming experience. All of the levels in the game require programming logic to solve. However, this programming logic is realized

with the blocks which are basically coding parts. Each block has some purpose, some of them are commands like walking, turning right or left, and jumping; and others serve for programming needs like executing procedures. Since the player is not supposed to write any code, but simply use already designed blocks, it is much easier for them to learn programming logic without even knowing any programming language. Figure 3 shows the main screen of the game where it is possible to continue playing, load the game from a save slot, change the language, change the gender of the bot, and also mute or unmute the sound.

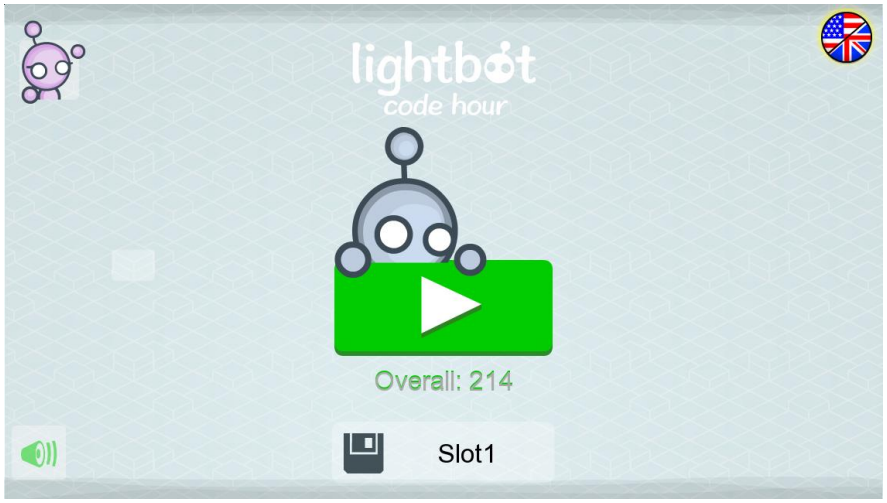


Figure 3. Main screen

As stated above, the game has 20 levels and these levels are part of three stages. First stage is Basics which has eight levels and is aimed to teach the basic concept of the game, usage and functions of different types of blocks (Figure 4). Each level presents a set of tiles and a robot character, which is called Lightbot, placed on one of them. In order to pass the levels, Lightbot must light up all the blue tiles. Player must use code blocks to move the Lightbot and light up these tiles. There is a main section on the right side of the screen to place the blocks that are necessary to pass the level. In any part of the level, player can run the code blocks and see the result. This serves like a debug mode and let the player see the result and the mistakes if there is any.

Figure 5 shows level one of basic stage and also main section can be seen on the right side.

Figure 4. Stage 1 – basics

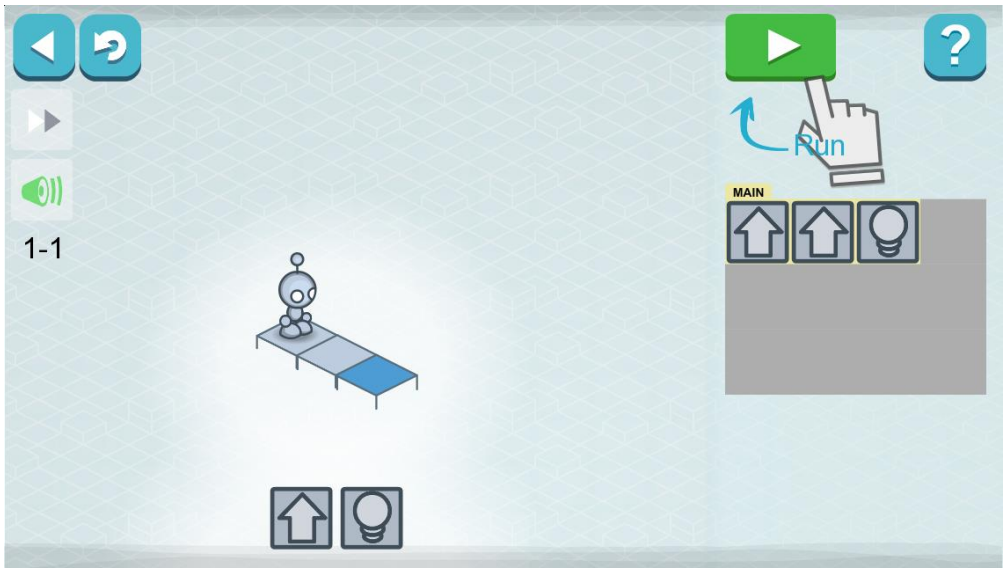


Figure 5. Basic Stage - level one

At the start of the game only the first level of every stage is unlocked. Players must pass the first level to unlock the next level (Figure 6).

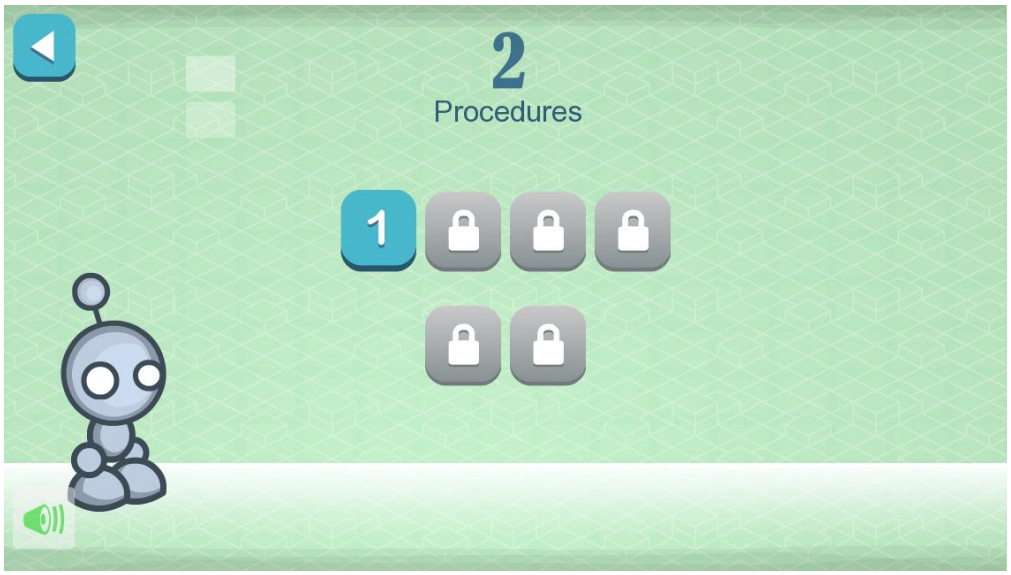


Figure 6. Locked levels

The main section where the blocks are executed sequentially has a limited space. Thus, only a limited number of blocks can be used. This leads the player to find the best and shortest solution for the level, since in some levels the main section is not enough to move Lightbot and light up all the blue tiles. Because of this limitation, players need another section which is called Procedure 1 (or PROC1 in game) to achieve the objective of the level. This procedure can be "called" from the main section by placing the P1 block when necessary. This adds the concept of functions or classes to the game and teaches this modular structure instead of writing the same thing to the main section every time it is needed. Stage 2 of the game is about this concept and named Procedures. This stage consists of six levels and a second procedure space is also added in the advanced levels as the game gets more complex. A sample screen from stage 2 is shown in Figure 7 where the player is supposed to use P1 block to call the PROC1 and P2 block to call the PROC2 section.

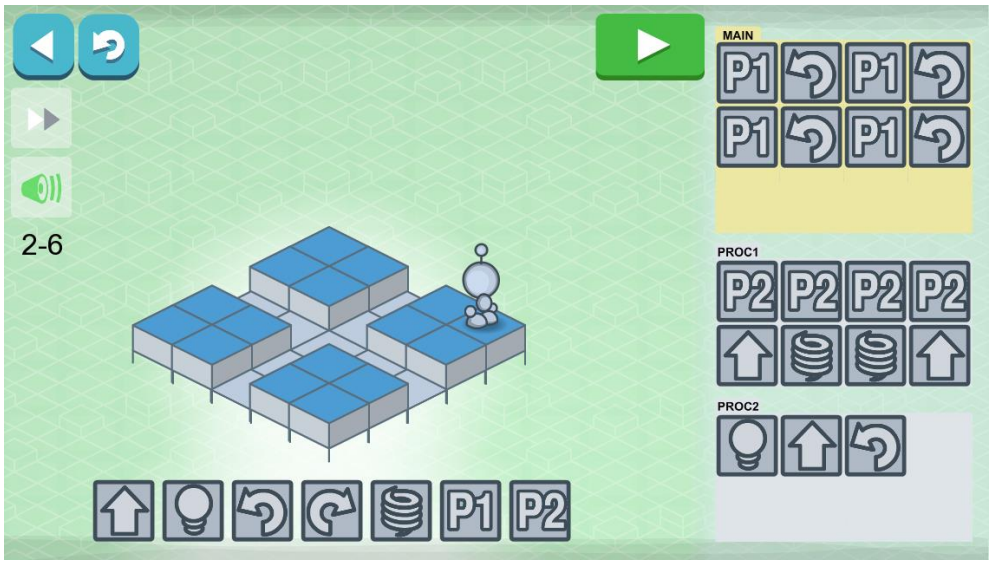


Figure 7. Two procedures in one level

Lightbot gives some tips and explanations at the beginning of some levels when there is something new introduced in the level. Figure 8 shows the tips for level one of Procedures stage.

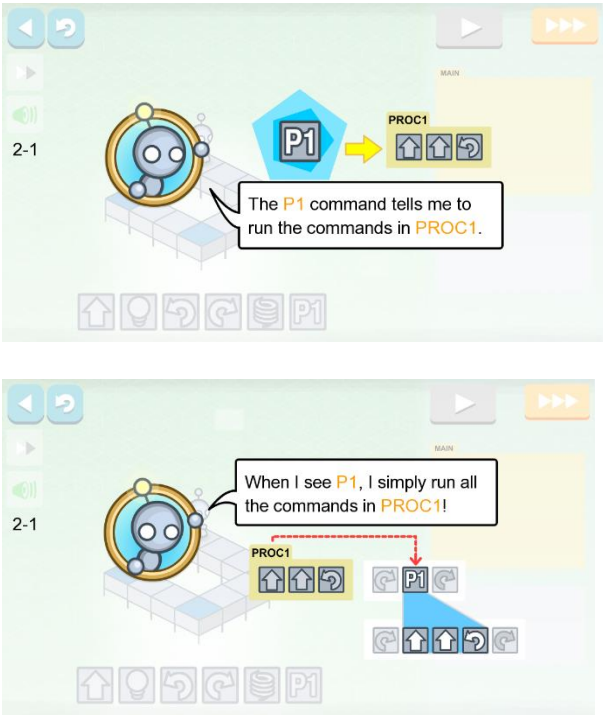


Figure 8. Tips from level one of procedures stage

The last stage of the game is called Loops and focuses on teaching to repeat the code block if the action should be repeated. This is being done by a recursive call in the procedure and therefore it creates an infinite loop. This stage also has six levels and the difficulty of the levels increase progressively. Lightbot's tip for the loops can be seen in Figure 9 and the solution for level one of this stage is in Figure 10.

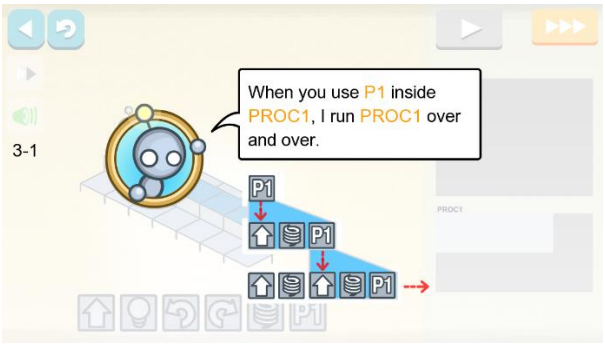


Figure 9. Tips from level one of loops stage

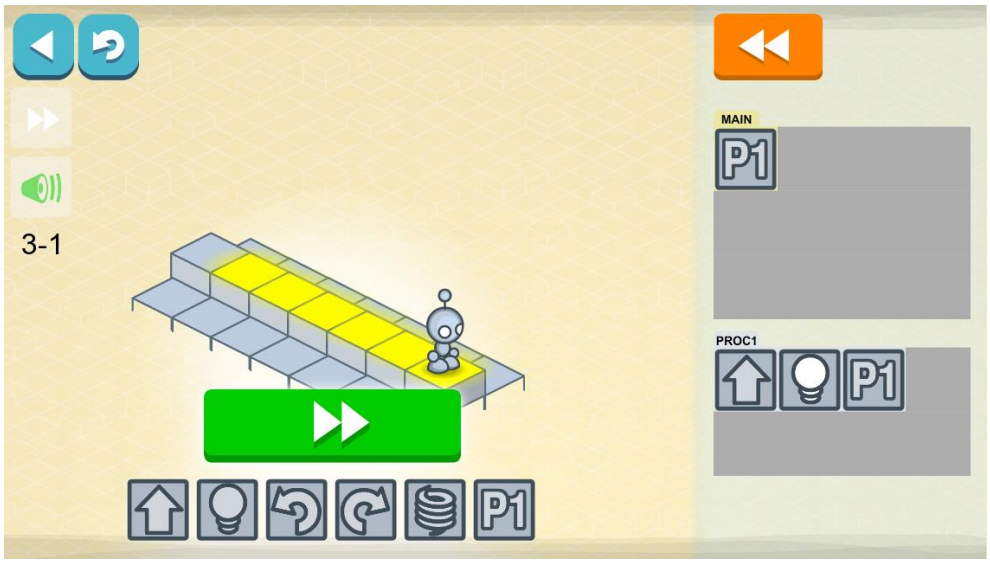


Figure 10. Solution of level one

3.7 Data collection procedure

Implementation of the study has been made in Okyanus Koleji with two fifth grade classes. First of all, student consent forms have been sent to the course instructor. He contacted and gave the forms to the parents of all students in experiment and control groups. Meanwhile a consent form was given to the course instructor for his approval and the research study was explained to him in detail. Afterwards, he signed the form and accepted to join the study. One student's parents did not approve their child to join the study; therefore he was excluded from the study.

The study plan was made according to information technology and software course schedule. Only one session was planned each week since there is only one hour of information technology and software course every week for both experiment and control groups. Duration of the study was set as five weeks. The first and the last weeks were reserved for pre and posttests and remaining three weeks were reserved

for the application of the game since it is planned to play one stage each week with the experiment group. The timeframe can be seen in Table 4.

Table 4. Timeframe of the Study

Dates	Task for Experiment Group	Task for Control Group
29 March 2017	Pretest	Pretest
5 April 2017	Lightbot: Stage 1	No treatment
12 April 2017	Lightbot: Stage 2	No treatment
19 April 2017	Lightbot: Stage 3	No treatment
26 April 2017	Posttest	Posttest

The study began with pretests in Week 1. First, it was applied to the experiment group. Twenty-two students attended to the pretests from experiment group. Before handing out the pretests, students were informed verbally about the tests and their content. Also, it was stated that these tests will not be graded, their information technology and software course grade will not be affected by these tests and also their answers will not be shared with anyone including their teacher. Moreover, it was told that they can leave the study anytime if they want to. At the end the researcher thanked the students for their attendance to this study. After that, attitude pretest surveys were given to the students. Although some students asked questions about the test, researcher did not answer them and asked students to answer the questions as they understand. Only one word in Turkish was explained by saying the synonym since some students were not familiar with the word and didn't understand the question because of this. Researcher asked students to write their school numbers to the papers instead of their names since any personal information will not be

collected for this study. This number was also used in the posttests to compare the results of the tests.

Because there is only one course hour which is 40 minutes for information technology and software course 15 minutes were given to students to answer the 20 questions of the attitude pretest surveys. Most of the class finished the test before the 15 minutes duration. The few remaining students were waited for to finish in order to continue with the achievement test. After everybody is finished and all of the tests were gathered by the researcher, the achievement test was handed out and 20 minutes were given for the achievement test. The students asked more questions about the achievement test since there were so many things in the test they did not know before the treatment started. The researcher told the students that they can leave the questions unanswered if they do not know. Students that finished the test gave their paper and their teacher told them to study their course book until the end of the course. Until the course is over everybody finished doing the test. Researcher gathered all the papers again and thanked the students.

The next session was with the control group and there were 24 students in the classroom for the pretests. The same procedure was followed also with the control group. First some information was given about the tests and about the study. Then pretests were given. Fifteen minutes were given for the attitude test and 20 for the achievement test. The same word explanation in attitude pretest survey was also given to the control group class since the students were asking as well. Furthermore, it was told that they can leave any question in achievement test unanswered if they do not know since most of the students were not familiar with the subjects and asking what to write. After the tests were finished and papers were gathered, researcher thanked the students for their attendance.

The next week was the first week of the treatment. The researcher rented 10 iPads from a renting company in Istanbul to play the Lightbot game in iOS. Although there were 22 students in experiment group, there were only 10 iPads. Because of this limitation, the class was divided randomly into two groups with 11 students. Since there were 10 iPads but 11 students in the groups, one student played the game with an iPhone. It was planned to have 20 minutes with each of the group and finish one stage of the game in this timeframe. While one group was playing the game in their common classroom with the researcher, the other group was studying their lesson in information technology and software classroom with the instructor and when 20 minute is over they were exchanging.

Before the start of the course, researcher prepared the iPads and the iPhone by opening the game in these devices and checking that there is not a problem in any of them in order not to lose any time with this procedure in class. When the course started, 11 students who are in the first group came directly to their common classroom and the others went to information technology and software classroom because their teacher already told them about these two groups. The iPads and the iPhone were given to the students and everybody opened level one of the Basics stage. Then, the researcher explained the game briefly by playing and showing in this level. Afterwards, every student passed to level two and started playing on their own. If they were stuck in a level, researcher helped them to pass and play the next levels. Since the Basics stage is not so hard, most of the students were able to pass all the levels successfully with so little or no help. After 20 minutes was over, students gave the devices to the researcher and changed the classroom with the other group. While they were changing classrooms, the researcher prepared the iPads again to play from the first level. All of the iPads and the iPhone were given to 11 students and

researcher explained the game briefly again by playing the first level. Then they played the eight levels in this stage and if they were stuck in some point researcher tried to help a little to make them continue the game. This group also played for 20 minutes. After this time was done, researcher gathered all of the devices and first week of the treatment was finished. Most of the students from both groups said they liked the game very much and they wanted to play more instead of leaving. Researcher told them that they would continue playing next week. In this week and next two weeks, control group continued studying MEB's curriculum with their teacher. Therefore, the researcher did not have any session with them.

Experiment group played the second stage of the game, which is Procedures, in the third week. Ten iPads and one iPhone were prepared again before the course. The first group started again, but this time they were 10 people since one of the students could not attend because of the sickness. The researcher explained the second stage briefly with Lightbot's tips and they started playing. Since this stage was harder, more students needed help especially in the fifth and sixth levels. However, a couple of students were able to finish all of the stages without the need of any help. Then, they exchanged the classrooms with the other group and the same preparation and explanation was done for them as well. There was not any missing student in this group for that week. This group also needed some help in the last levels and when 20 minutes was over some of them could not finish the sixth level. Researcher showed them the answer of the level quickly and students gave their iPads and went to recess.

The fourth week of the study was the last week of the treatment. Students played the third stage of the Lightbot game in this week which is Loops. The first group was ten people again in this week, since the same student was absent again and

second group was 11 as the previous week. Both groups played the game 20 minutes again. Some of the students had difficulty in some levels, but none of them gave up playing. They asked the researcher's help in order to continue. Most of the students could not succeed to solve the last level on their own in the specified timeframe, but there were three students who could finish all of the levels in the Loops stage without any help and this also meant finishing the Lightbot game.

Posttests were done in the fifth that was the last week of the study. Firstly, tests were applied to the experiment group and then to the control group. There were 18 students in the class that week from the experiment group. The missing three students have done the test the next day with their teacher and researcher took their posttest results afterwards from the teacher. While applying the posttests, the same procedure was followed as the pretests. Attitude posttest survey was applied at the beginning. The students wrote their school numbers on the paper before starting to answer the questions. All of the students finished the test in 15 minutes since they were familiar with it. Then, the researcher gathered all the papers and gave the achievement posttest to the students. They had more knowledge about the concepts that are in the achievement test this time, therefore they asked less questions and answered more problems from the test. Most of the students finished the test in 20 minutes and the researcher waited for the remaining students to finish. After everybody gave their papers researcher thanked the students for completing the study and attending every week.

There were 15 students in the class for the last week from control group. They were given the posttests by starting with attitude survey and then achievement test. They finished the attitude survey in a little more than 15 minutes and started the achievement test. Since the control group did not have any treatment and studied

MEB's curriculum, they were still not familiar with the concepts in the achievement test. They were not sure what to write since they had the same test before, therefore the researcher told them to write everything they know and leave the questions unanswered if they do not know. After everybody finished the test and gave their papers, researcher also thanked the students from control group for their attendance and valuable contribution to this research study. This was the end of the application part of the research study.

CHAPTER 4

RESULTS

As explained in the previous chapter, experiment and control groups were exposed to achievement tests and attitude surveys before and after the treatment. Equality of the research groups before the treatment and results of the statistical analysis of the data collected by these tests and surveys will be discussed in this chapter. In order to do this statistical data analysis, IBM SPSS Statistics 21 program was used. Also, research hypotheses will be tested according to these data analysis results.

4.1 Equality of groups before the treatment

First the aim is to check if there was a statistically significant difference between the groups at the beginning of the study. According to the sources from the literature, sample size should be more than 30 to show normal distribution and to use parametric statistical tests (Greenwood & Sandomire, 1950; Hogg & Tanis, 1997; Pett, 2015; Salkind, 2016; Gosset, 1908). Due to the fact that there are less than 30 students in each of the research study group, these groups should be regarded as nonparametric. Thus, Kruskal Wallis, a nonparametric statistical test was applied to check the equality of the groups instead of one-way ANOVA.

Descriptive statistics of the achievement pretest can be seen from Table 5 According to these descriptive statistics, control group has a mean of 12.80 with 4.395 standard deviation and experiment group has a mean of 13.33 with 4.115 standard deviation.

Table 5. Descriptive Statistics of the Achievement Pretest

Achievement Pretest	N	Minimum	Maximum	Mean	Std. Deviation
Control Group	15	3	18	12.80	4.395
Experiment Group	21	5	22	13.33	4.115

Table 6 shows the ranks and Kruskal Wallis test results of the achievement pretest. According to these results, Chi-Square value is 0.013 and significance level is 0.910. Considering this results, $\chi 2\ (2) = 0.013$, $p = 0.910$, we can say that there is not a statistically significant difference in control and experiment groups' achievement pretest results.

Table 6. Kruskal Wallis Test Results of the Achievement Pretest

	Achievement Pretest
Chi-Square	0.013
df	1
Asymp. Sig.	0.910

Attitude pretest survey results can be seen from Table 7 and Table 8. According to these results we can say that, Kruskal-Wallis test showed that there is not a statistically significant difference in attitude pretest survey results between the control and experiment groups, $\chi 2(2) = 0.434$, $p = 0.510$, with a mean rank of 17.52 for Experiment, and 19.87 for Control Group.

Table 7. Descriptive Statistics of the Attitude Pretest Survey

Attitude Pretest	N	Min	Max	Mean	Std. Deviation
Control Group	15	62	96	82.9333	9.69143
Experiment Group	21	51	100	79.1429	14.99095

Table 8. Kruskal Wallis Test Results of the Attitude Pretest Survey

	Attitude Pretest Survey
Chi-Square	0.434
df	1
Asymp. Sig.	0.510

As a conclusion, from these test results, it can be safely said that the groups were not statistically different before the treatment in terms of achievement in programming concepts and attitude towards the information technology and software course.

4.2 Data analysis results

Detailed data analysis results are presented in this section. Descriptive statistical analysis and Wilcoxon signed-rank nonparametric test is applied to measure the difference between pretest and posttest results and test the hypotheses.

4.2.1 Attitude survey results

Attitude scale is applied to both control and experiment group as pretest and posttest survey. Hence, there are four different results of the attitude scale. There are 20 items in the scale which consists of 10 regular and 10 reverse scored items. Reverse items are translated as regular to calculate the total score. Since this scale is a 5-point Likert scale, total point from 20 questions is 100.

Table 9 shows the descriptive statistic results of the control group's pre and post attitude surveys. It is seen that mean score of the pretest survey is 82.9 with a

standard deviation of 9.69, while mean score of the posttest survey is 67.6 with a standard deviation of 14.9.

Table 9. Descriptive Statistics of the Control Group's Attitude Surveys

	N	Mean	Std. Deviation	Min.	Max.	Percentiles		
						25th	50th (Median)	75th
Total_Score_ Pre	15	82.9333	9.69143	62.00	96.00	81.0000	86.0000	89.0000
Total_Score_ Post	15	67.6000	14.9799	39.00	90.00	58.0000	66.0000	78.0000

Since the sample of the study is nonparametric, a nonparametric test is used to analyse the results. In order to do that, Wilcoxon signed-rank test which is the nonparametric equivalent of the dependent t-test is used. Table 10 shows the results of this test.

Table 10. Results of the Wilcoxon Signed-Rank Test of Control Group's Attitude Survey

	Posttest – Pretest
Z	-2.694
Asymp. Sig. (2-tailed)	0.007

According to the results of Wilcoxon signed-rank test, it can be said that there is a statistically significant difference between the control group's pre and posttest results (Z=-2.694, P=0.007) in a negative way with median score of pretest survey being 86 and posttest survey being 66.

Experiment Group's Attitude Survey results are given in the table 11. Pretest mean score of experiment group is 79.14 with a standard deviation of 14.9 and posttest mean score of the test is 78.09 with a standard deviation of 16.85.

Table 11. Descriptive Statistics of the Experiment Group's Attitude Surveys

	N	Mean	Std. Deviation	Min.	Max.	Percentiles		
						25th	50th (Median)	75th
Pretest Score	21	79.1429	14.99095	51.00	100.00	68.0000	83.0000	91.5000
Posttest Score	21	78.0952	16.85795	43.00	100.00	62.5000	81.0000	92.0000

Wilcoxon signed-rank test is also applied to the attitude survey results of the experiment group. The ranks and statistical results are shown in the table 12.

Table 12. Results of the Wilcoxon Signed-Rank Test of Experiment Group's Attitude Survey

	Posttest – Pretest
Z	-0.299
Asymp. Sig. (2-tailed)	0.765

According to the results of Wilcoxon signed-rank test, there is not a statistically significant difference between experiment group's test results which are before and after the treatment with Z equals to -0.299 and significance level is 0.765.

4.2.2 Achievement test results

Achievement scale consists of three stages which are 10 points each. Therefore, the total score of this scale is 30. Table 13 shows the descriptive statistics result of control group's achievement tests. It is seen that both mean and standard deviation results are pretty similar for these tests. Mean score of the pretest is 12.8 with a standard deviation of 4.395, while mean score of the posttest is 11.2 with a standard deviation of 4.539.

Table 13. Descriptive Statistics of Control Group's Achievement Tests

	N	Mean	Std. Deviation	Min.	Max.	Percentiles		
						25th	50th (Median)	75th
Pretest Score	15	12.80	4.395	3.00	18.00	10.00	14.00	16.00
Posttest Score	15	11.20	4.539	5.00	19.00	8.00	9.00	16.00

In order to analyse the achievement test results of the control group, Wilcoxon signed-rank test is used. Ranks and statistical results of this test can be seen in Table 14.

Wilcoxon signed-rank test shows that, there is not a statistically significant difference between the control group's pre and posttest results (Z=-1.236, P=0.185).

Table 14. Results of the Wilcoxon Signed-Rank Test of Control Group's Achievement Tests

	Posttest – Pretest
Z	-1.326
Asymp. Sig. (2-tailed)	0.185

Experiment Group's Achievement Tests results are given in the table 15. Pretest mean score of experiment group is 13.33 with a standard deviation of 4.115, while mean score of the posttest is higher as 21.43 with a standard deviation of 5.381.

Table 15. Descriptive Statistics of the Experiment Group's Achievement Tests

	N	Mean	Std. Deviation	Min.	Max.	Percentiles		
						25th	50th (Median)	75th
Pretest Score	21	13.33	4.115	5.00	22.00	11.00	13.00	16.00
Posttest Score	21	21.43	5.381	8.00	30.00	17.00	22.00	25.50

Wilcoxon signed-rank test is applied to check if there is a statistically significant difference between these tests. Results of the Wilcoxon signed-rank test are given in Table 16.

Table 16. Results of the Wilcoxon Signed Rank Test of Experiment Group's Achievement Tests

	Posttest – Pretest
Z	-3.922
Asymp. Sig. (2-tailed)	0.000

According to the results of Wilcoxon signed-rank test, there is a statistically significant difference between experiment group's test results after the treatment with Z equals to -3.992 and significance level is 0.000.

4.3 Results of hypotheses testing

In this section, results of the hypotheses testing will be given according to the survey and test results which are analysed in the previous section.

The first hypothesis, Hypothesis 1a, argues that there is a significant increase in fifth grade students' attitudes towards information technology and software course when they are exposed to mobile serious game assisted instruction. In order to test this hypothesis, the results of Wilcoxon signed-rank test will be considered. According to the results of Wilcoxon signed-rank test, there is not a significant difference between the attitude pretest and posttest survey results of the students who are exposed to mobile serious game assisted instruction since the significance value of the test is 0.765. Thus, Hypothesis 1a is not verified.

The second hypothesis, Hypothesis 1b, argues that there is not a significant increase in fifth grade students' attitudes towards information technology and software course when they follow MEB's curriculum and are not exposed to mobile serious game assisted instruction. According to the results of Wilcoxon signed-rank test, there is not a significant increase, but there is a decrease between the attitude pretest and posttest survey results of the students who follow the MEB's curriculum and the significance value of the test is 0.007. Thus, Hypothesis 1b is verified.

The third hypothesis, Hypothesis 2a, argues that there is a significant increase in fifth grade students' achievements in programming concepts when they are exposed to mobile serious game assisted instruction. According to the results of Wilcoxon signed-rank test, there is a significant difference between the achievement pretest and posttest results of the students who are exposed to mobile serious game assisted instruction since the significance value of the test is 0.000. Thus, Hypothesis 2a is verified.

The last hypothesis, Hypothesis 2b, argues that there is not a significant increase in fifth grade students' achievements in programming concepts when they follow MEB's curriculum. According to the results of Wilcoxon signed-rank test, there is not a significant difference between the achievement pretest and posttest results of the students who follow the MEB's curriculum since the significance value of the test is 0.185. Thus, Hypothesis 2b is verified.

CHAPTER 5

CONCLUSION

The purpose of this study was to investigate the impacts of a mobile serious game about programming on fifth grade students' achievements in programming concepts and attitudes towards their course. In order to achieve this purpose, a five weeks long study was held in a primary school with 36 fifth grade students. Students which are in the experiment group was exposed to mobile serious game assisted instruction by playing the Lightbot game for three weeks and students in the control group studied only the MEB's curriculum. Tests were applied to the research groups in the first week and the last week of the study. Then the results of these tests were analyzed with SPSS tool to test the four hypotheses of the study.

Hypothesis 1a claimed that there would be a significant increase in fifth grade students' attitudes towards information technology and software course when they are exposed to mobile serious game assisted instruction and Hypothesis 1b argued that there would not be a significant increase in fifth grade students' attitudes towards information technology and software course when they follow MEB's curriculum.

According to the results of the hypotheses testing, Hypothesis 1a is rejected because there was not a significant increase in the experiment group's attitude towards information technology and software course. This means that the instruction by playing the mobile serious game Lightbot, did not create a significant difference in the students' attitudes towards their course. On the other hand, Hypothesis 1b is verified since attitude survey results of the control group did not show any increase.

However, the results showed a significant decrease while following only MEB's curriculum.

Because many studies in the literature reported an increase in the students' motivation (Jemmali & Yang, 2016), engagement (Pellas et al., 2014) and attitude (Knol & De Vries, 2011) when they were exposed to serious game assisted instruction, it was expected that there would be a significant increase in the experiment group's attitude towards their course. However, this was not proved in this study according to the results. There can be a couple of reasons for this. Firstly, a prior observation can have an effect on the later observation. This is called "main testing effect" and one reason for it could be the urge of the subjects to be consistent in their answers (Marks & Kamins, 1988). Since the same survey was applied to the participants as pretest and posttest in a short time range like after four weeks, they may have wanted to be consistent in their answers. This could be the reason of the very similar mean scores of the pretest (79/100) and posttest (78/100) survey results of the experiment group.

Secondly, the day which the posttest surveys were applied to the study groups was the same day that the national high school entrance exam (TEOG) was held and it was holiday for all of the primary schools in the country except a couple of them which had no 8th grade class in their schools. Due to the fact that there was no 8th grade class in the school which this research study was implemented, Bahcelievler Okyanus Koleji, it was not a school holiday. However, many students did not come to school that day since they thought it is holiday and because of the absent students, teachers were giving free time in their courses. Since the posttest surveys were applied in a special day like this, it was seen that the students were not very willing to do it. This could have affected their attitude and impacted the results in an adverse

way. This could explain the significant decrease in the attitude survey results of the control group although they did not experience any different treatment during this time. Moreover, this could be the reason for the experiment group to give lower scores like the control group and not have a significant increase in their attitude survey results.

Although experiment group students' attitudes towards their course did not increase in this study, most of them showed a great interest towards the Lightbot game and they did not want the study to end. At the last week of the treatment, they were asking if there would be any more game playing sessions. This also shows that above mentioned reasons could be the cause of the low attitude scores.

Hypothesis 2a argued that there would be a significant increase in fifth grade students' achievements in programming concepts when they are exposed to mobile serious game assisted instruction while Hypothesis 2b claimed that there would not be a significant increase in fifth grade students' achievements in programming concepts when they follow MEB's curriculum.

According to the results of the hypotheses testing, Hypothesis 2a was proved to be true since there was a significant increase in the experiment group's achievements in programming concepts test results. Moreover, the same test results of the control group did not show any significant difference and verified the argument of Hypothesis 2b. Because there was no increase in the control group's achievements in programming concepts test results while there was a significant increase in experiment group's achievement, it can be said that the difference is the result of the treatment given to the experiment group.

The findings of this study about the achievements of the students were supported by many other studies in the literature by proving the success of the serious games in general (Adamo-Villani et al., 2012; Huizenga et al., 2009; Kazimoglu, 2013), and the mobile serious game Lightbot in particular (Giordano & Maiorana, 2014; Aedo Lopez et al., 2016) on being an effective tool to help teaching some complex subjects like programming and increasing the student learning.

The results of this study showed the positive outcomes of a mobile serious game on the fifth-grade students' achievements in some programming concepts in Turkey. Although there was no significant increase found in the attitudes of the experiment group students towards their course, there was no significant decrease in their results like the control group and this could be seen as the positive effect of the Lightbot game. Thus, it can be concluded that mobile serious games for programming can be used in the Turkish education system. Moreover, it was shown that some of the complex programming subjects like recursion and procedures can be started to be taught as early as the fifth grade in primary education.

5.1 Limitations of the study

There were some limitations in this study and they will be discussed in this section. First of all, since the iPads which are used in the study were rented from a renting company and the prices were high, only 10 iPads could be rented. This caused the need to divide the students in the classroom in two groups since the number of iPads were not enough. Dividing the students led to a decrease in students' time spent, only around 20 minutes every week, with the Lightbot game because both of the groups should have played the game in one course hour which was 40 minutes. Because of

this time limitation, the researcher had to explain some points about the game at the beginning of the session to reduce the amount of time for students to understand some basics of the game. Thanks to this approach, the time limitation did not create a serious problem.

Another limitation was the small number of students in the study. Due to the fact that the number of the students in the classes were lower than the ideal sample size and some students were eliminated from the study because of the reasons explained in the methodology section, the total size of the study got even lower and presented a limitation for the study.

Lastly, the total duration of the study was limited to five weeks and since two weeks were spent for the pretest and posttest surveys, only three weeks were dedicated to the application of the serious game. Because of this limitation, every week a chapter was needed to be finished. In order to do this, students were required to finish the levels really fast. Since the difficulty of the levels increased in the last chapter, some students were not able to finish a couple of the levels in that chapter. This may have resulted in not completely learning the educational target of the chapter and could have impacted their results in the achievement tests.

5.2 Recommendations for future research

This study only covered the mobile serious game assisted instruction for programming subject. In order to generalize the results for all the education topics, more studies should be done in Turkey about different subjects with mobile serious games. Also, only one game was used in this study. More mobile serious games about programming should be developed and used in research studies to reach a

generic conclusion about their effects on programming education. In this study, recursion and procedures were tried to be taught with the Lightbot game. New serious games should cover different programming concepts such as control structures and loops, and studies should check their effectiveness. Moreover, Lightbot game and also other serious games should be studied with students younger than fifth grade to check when to start teaching specific programming concepts. Furthermore, studies should be done for durations longer than three weeks and with more participants than this study to see the effects of the game on students' attitudes and achievements more clearly.

APPENDIX A

TEACHER CONSENT FORM

Sayın öğretmen,

Boğaziçi Üniversitesi Yönetim Bilişim Sistemleri Bölümü Yüksek Lisans öğrencisi Mirac Yallıhep yüksek lisans tezi kapsamında "Ciddi Mobil Oyunların 5. Sınıf Öğrencilerinin Programlama Kavramlarına Yönelik Tutum ve Başarıları Üzerindeki Etkileri" adı altında bilimsel bir araştırma projesi yürütmektedir. Bu çalışmanın amacı Programlama konulu ciddi oyunların 5. Sınıf öğrencilerinin derse karşı tutumlarına ve programlama konusundaki başarılarına olan etkisini gözlemlemektir. Bu araştırmada bize yardımcı olmanız için sizi ve sınıfınızdaki öğrencileri projemize katılmaya davet ediyoruz. Kararınızdan önce araştırma hakkında sizi bilgilendirmek istiyoruz.

Bu araştırmaya katılmayı kabul ettiğiniz takdirde sınıfınızdaki öğrencilere iki konuda ön test uygulayacağız: Derse karşı tutum ve Programlamaya yönelik başarı. Daha sonra 3 hafta süresince her hafta 1 ders olmak üzere seçtiğimiz bir programlama konulu mobil ciddi oyunu sınıfınızdaki öğrencilere oynatacağız. Bu çalışma bitiminde yine aynı konulardaki testleri öğrencilerinize uygulayıp, oynattığımız ciddi oyunun bu konulardaki etkilerini inceleyeceğiz. Bu çalışma sonucunda ciddi oyunların programlama öğretiminde kullanılması konusunda ve belirli programlama kavramlarının öğrencilere ilkokuldan itibaren öğretilmesi konusunda önemli çıktılara ulaşacağımızı umuyoruz.

Bu araştırmaya katılmak tamamen isteğe bağlıdır. Çalışma için sizden herhangi bir ücret talep etmiyoruz ve sonucunda siz ve öğrencilere herhangi bir ödeme yapmayacağız. Katıldığınız takdirde çalışmanın herhangi bir aşamasında herhangi bir sebep göstermeden onayınızı çekmek hakkına da sahipsiniz. Bu araştırmada farklı okulları, sınıfları ve öğrencileri birbirleriyle karşılaştırmadığımızı belirtmek istiyoruz. Araştırma projesi hakkında ek bilgi almak istediğiniz takdirde lütfen Boğaziçi Üniversitesi Yönetim Bilişim Sistemleri Bölümü Öğretim Üyesi Prof. Dr. Birgül Kutlu Bayraktar ile temasa geçiniz (birgul.kutlu@boun.edu.tr).

Bu koşullarda söz konusu araştırmaya kendi isteğimle, hiçbir baskı ve zorlama olmaksızın katılmayı kabul ediyorum.

Formun bir örneğini aldım / almak istemiyorum (bu durumda araştırmacı bu kopyayı saklar).

Katılımcının Adı-Soyadı: .....

İmzası: .....

E-posta adresi:.....

Tarih (gün/ay/yıl): ...../...../.....

Araştırmacının Adı-Soyadı: Mirac YALLIHEP

İmzası:.....

Tarih (gün/ay/yıl):...../...../.....

APPENDIX B

STUDENT CONSENT FORM

Sayın Veli,

Okulumuz 5B öğrencileri olarak Bilişim Teknolojileri ve Yazılım dersi kapsamında, Boğaziçi Üniversitesi, Yönetim Bilişim Sistemleri yüksek lisans öğrencisi Mirac YALLIHEP tarafından bir araştırmaya davet edildik. Bu araştırma, mobil bir uygulamanın öğrencilerimizin programlama konseptlerini öğrenmelerine katkısı olup olmadığını ve Bilişim Teknolojileri ve Yazılım dersine karşı tutumlarına etkisini ölçmektedir.

Boğaziçi Üniversitesi işbirliği ile gerçekleşecek olan çalışma 3 hafta süresince Bilişim Teknolojileri ve Yazılım dersinin 20 dakikalık bir kısmında yürütülecektir. Öğrencilerimize, gelişimlerini ölçmek için çalışma öncesinde ve sonrasında aynı testler uygulanacak, ön test-son test karşılaştırmasıyla bir sonuç elde edilecektir.

Araştırma kapsamında öğrencilerin edinmesini beklediğimiz kazanımlar şu şekildedir:

- Öğrenciler komut yazma mantığını kavrar, tamamlanması gereken görevi komutlar yardımı ile ifade eder. (Basic/ Temel)
- Öğrenciler tekrar eden komut setleri için ayrı bir blok kullanarak, aynı komut setini tekrar yazmak yerine verilen adla çağırabileceğini kavrar. (Procedure/ Prosedür)
- Öğrenciler sonsuza giden bir döngü oluşturmayı kavrar. (Loop/ Döngü)
- Öğrencilerin, Yazılım ve Kodlamaya karşı tutumları olumlu bir yönde etkilenir.

Bu araştırma bilimsel bir amaçla yürütülmektedir ve katılım gönüllülük esaslıdır. Araştırmaya katılım için ne siz veliler ne de araştırmacı bir bedel ödemeyecektir. Öğrenciler istedikleri zaman araştırmadan çekilme hakkına sahiptir. Öğrenci bilgileri gizliliği esastır, bu sebeple öğrencilerimizin ismi veya skoru yayınlanmayacaktır. Araştırma projesi hakkında ek bilgi almak istediğiniz takdirde araştırma danışmanı, Boğaziçi Üniversitesi Yönetim Bilişim Sistemleri Bölümü Öğretim Üyesi Prof. Dr. Birgül Kutlu Bayraktar ile iletişime geçebilirsiniz (birgul.kutlu@boun.edu.tr).

Bu koşullarda, velisi bulunduğunuz öğrencinin araştırmaya katılımını onaylıyorsanız, lütfen formu imzalayıp bana geri ulaştırınız.

Katılımcı Velisi	Bilişim Dersi Öğretmeni	Araştırmacı
		Mirac YALLIHEP

☐ Araştırmaya katılabilir.

☐ Araştırmaya katılmasına izin vermiyorum.

APPENDIX C

RELIABILITY ANALYSIS RESULTS

Table C1. Reliability Analysis of Attitude Scale Pretest Survey

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
,908	,908	20

Table C2. Reliability Analysis of Attitude Scale Posttest Survey

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
,919	,921	20

APPENDIX D

ATTITUDE SCALE

Bilişim Teknolojileri Dersine Yönelik Tutum Ölçeği
(Attiude Scale Towards Information Technology and Software Class)

Aşağıdaki ankette 20 ifade bulunmaktadır. Her ifadeyi okuduktan sonra, buna ne derecede katıldığınızı işaretleyiniz.
(There are 20 items in this scale. Please read each one of them and select the most suitable option for you.)

Örnek: "Bilişim Teknolojileri sevdiğim bir derstir" ifadesine ne ölçüde katıldığınızı gösteren sütuna "**X**" işareti koyunuz.
(Example: Put an X sign on the column which shows how much you agree with "I like Information Technology class." item.)

1	2	3	4	5
Kesinlikle Katılmıyorum *(Totally Disagree)*	Katılmıyorum *(Disagree)*	Emin değilim / Kararsızım *(Neutral)*	Katılıyorum *(Agree)*	Kesinlikle Katılıyorum *(Totally Agree)*

	1	2	3	4	5
1. Bilişim Teknolojileri sevdiğim bir derstir *(I like Information Technology class)*					
2. Bilişim Teknolojileri dersine girerken büyük bir sıkıntı duyarım *(I feel distress while I am coming Information Technology class)*					
3. Bilişim Teknolojileri dersi olmasa öğrencilik hayatı daha zevkli olur. *(Studentship would be more fun without Information Technology class)*					
4. Arkadaşlarımla Bilişim Teknolojileri dersini tartışmaktan zevk alırım. *(I enjoy to discuss about Information Technology class with my friend)*					
5. Bilişim Teknolojilerine ayrılan ders saatlerinin daha fazla olmasını dilerim. *(I wish Information Technology class had more course hour)*					
6. Bilişim Teknolojileri dersi çalışırken canım sıkılır. *(I get bored while I am studying Information Technology class)*					

7. Bilişim Teknolojileri dersi benim için bir angaryadır. *(Information Technology class is a drudgery for me)*					
8. Bilişim Teknolojileri dersinden hoşlanırım. *(I like Information Technology class)*					
9. Bilişim Teknolojileri dersinde zaman geçmek bilmez. *(Time hangs heavy in Information Technology class)*					
10. Bilişim Teknolojileri dersi sınavından çekinirim. *(I refrain from Information Technology class exams)*					
11. Bilişim Teknolojileri benim için ilgi çekicidir. *(Information Technology class is interesting for me)*					
12. Bilişim Teknolojileri tüm dersler içinde en korktuğum derstir. *(Information Technology class is the most scariest class)*					
13. Yıllarca Bilişim Teknolojileri okusam bıkmam. *(I do not get bored Information Technology class even I have that course for years)*					
14. Diğer derslere göre Bilişim Teknolojilerini daha çok severek çalışırım. *(I willingly study for Information Technology class according to all the other classes)*					
15. Bilişim Teknolojileri dersi beni huzursuz eder. *(Information Technology class makes me uncomfortable)*					
16. Bilişim Teknolojileri dersi beni ürkütür., *(Information Technology class frighten me)*					
17. Bilişim Teknolojileri dersi eğlenceli bir derstir. *(Information Technology class is enjoyable)*					
18. Bilişim Teknolojileri dersinde neşe duyarım. *(I feel joy in Information Technology class)*					
19. Derslerin içinde en sevimsiz olanı Bilişim Teknolojileridir. *(Most unlikeable class is Information Technology class)*					
20. Çalışma zamanımın çoğunu Bilişim Teknolojileri dersine ayırmak isterim. *(I like to spent most of my study time to Information Technology class)*					

Anket bitti. Teşekkür ederiz.
(Survey is over. Thank you.)

APPENDIX E

ACHIEVEMENT SCALE

1. Basic (Temel)

Bu bölümde temel programlama bilgisi ile ilgili 3 soru yanıtlamanız beklenmektedir.

(It is expected you to answer 3 questions about basic programming knowlegde in this section)

1. Aşağıdakilerden hangisi komuta örnektir?

(Which one is an example of a command?)

a. Yürü (Walk) b. Sarı (Yellow) c. Duvar (Wall)

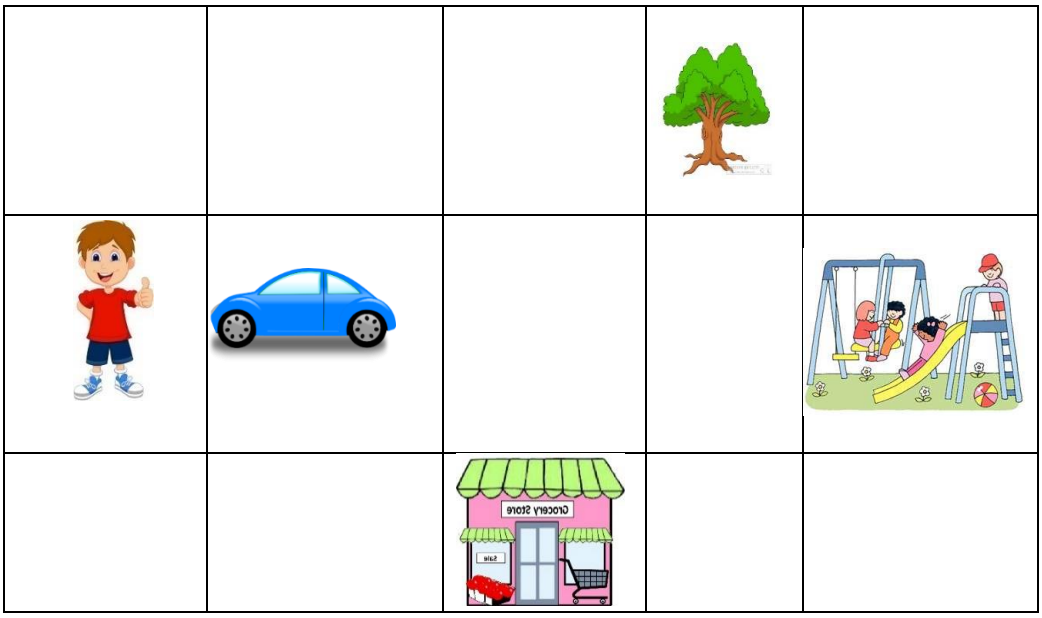
2. Aşağıdakilerden hangisi komuta örnek değildir?
(Which one is not an example of a command?)

a. Oku (Read) b. Merdiven (Stairs) c. Dur (Stop)

3. Ahmet şekildeki harita üzerinde ilerleyerek parka gidecektir. Ahmet'in engelleri aşıp, boş karelerden yürümesini sağlayarak parka ulaştıran komutları yazınız. (İlk komut verilmiştir.)
(Ahmet wants go to the park over the below map. Please write the correct commands to make him reach the park by passing through the obstacles. (First command has been given.))

(yukarı) /(up)

(sol)/ (left)



(sağ)/ (right)

(aşağı)/ (down)

(Kullanılacak komutlar: “ilerle, aşağı dön, yukarı dön, sağa dön, sola dön”)
(Commands shall be used: “forward, turn down, turn up, turn right, turn left”)

YUKARI DÖN *(Turn Up)*-_____

_____

_____

__

2.Prosedür (*Procedure*)

Bu bölümde prosedür ile ilgili 3 soru yanıtlamanız beklenmektedir.
(It is expected you to answer 3 questions about procedures in this section)

1. Prosedürler ile ilgili verilen ifadelerin başına doğru ise “D”, yanlış ise “Y” yazınız.
(Read each sentence about procedures and write “D” if it is correct, write “Y” if it is false)

( ) Birden fazla komut içerebilir. (Procuderes can consist of more than one command.)

( ) Ana blokta sadece bir kez kullanılabilir. (It can be used only one time in main block.)

( ) Aynı komutların tekrar yazılarak, komut setinin fazla uzamasına engel olur. (It is helpful to prevent longer command set by repeating same commands.)

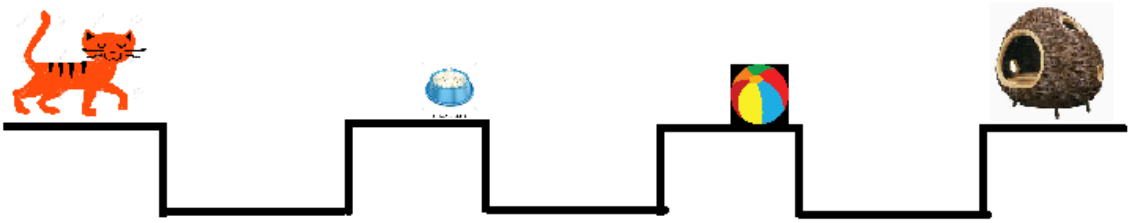
2. Aşağıda matematiksel bir ifade verilmiştir. Bu ifadeyi programlama dili ile daha kısa şekilde ifade etmek isteyen Deniz’in oluşturacağı prosedür hangisidir?
(A mathematical statement is given below. Which one is the proper procedure that Deniz should create to state it in a shorter way?)

“1+3-2+5+1+3-2-7+1+3-2+4”

a. **P1:** 3-2 b. **P1:** 5+1+3 c. **P1:** 1+3-2

3. Bir kedi aşağıdaki yolda ilerleyerek yuvasına ulaşmak istiyor. Kedinin yuvasına ulaşması için gerekli komutları prosedür kullanarak yazınız.
(There is a cat that wants to reach its home. Please write down the needed commands to by using procedure.)

(Kullanacağınız komutlar; ‘in, çık, süt iç, top oyna, yuvaya gir’ olmalıdır.)
(Commands shall be used: “down, up, drink milk, play ball, enter home”)



Prosedür / *(Procedure)*	**Ana Blok (Main) /** *(Main Block)*
P1:	

3.Loop (Döngü)

Bu bölümde Loop (döngü) ile ilgili 3 soru yanıtlamanız beklenmektedir.

(It is expected you to answer 3 questions about loops in this section)

1. Döngü (loop) ne amaçla kullanılır?
(What is loop used for?)

_____

_____

_____.

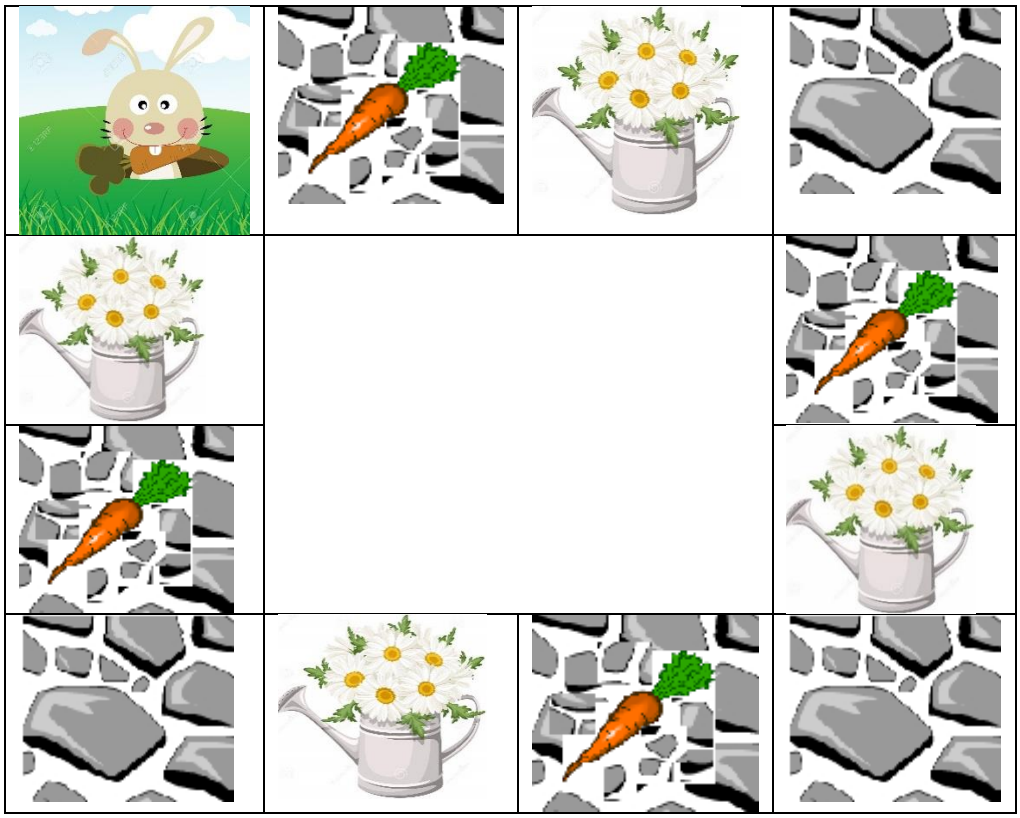
2. Aşağıdakilerden hangisi bir döngüye örnek olamaz?
(Which one is not an example of a loop?)

a. Güneşin her gün doğup batması
(The Sun sets and rise every day)

b. Mevsimlerin birbirini takip etmesi
(Seasons follow each other in the same order)

c. Haftalık hava sıcaklığı
(Weekly air temperature)

3. Tavşan havuçları toplayıp, papatyaların üzerinden atlayarak yuvasına dönmek istiyor. Bunun için gereken komutları <u>döngü (loop)</u> kullanarak yazınız. (Kullanılacak komutlar: "ilerle, havuç topla, zıpla, sağa dön")
(Rabbit in the picture wants go back his home by collecting carrots, jumping over the daisies. Please write down the necessary commands by using loop. (Commands shall be used: "forward, collect carrot, jump, turn right"))



P1 (Prosedür) / *(Procedure)*	Ana Blok (Main) / *(Main Block)*

REFERENCES

Abt, Clark C. (1970). *Serious games.* New York: The Viking Press.

Adamo-Villani, N., Cooper, S., & Whittinghill, D. (2012, May). *Building a serious game for teaching secure coding in introductory programming courses.* Poster session presented at the 33rd Annual Conference of the European Association for Computer Graphics, Cagliari, Italy.

Adkins, S. S. (2017, July). The 2017-2022 Global game-based learning market. Retrieved from http://seriousplayconf.com/wp-content/uploads/2017/07/Metaari_2017-2022_Global_Game-based_Learning_Market_Executive_Overview.pdf

Aedo Lopez, M., Vidal Duarte, E., Castro Gutierrez, E., & Paz Valderrama, A. (2016, July). *Teaching abstraction, function and reuse in the first class of CS1: A lightbot experience*. Paper presented at the 2016 ACM Conference on Innovation and Technology in Computer Science Education. https://doi.org/10.1145/2899415.2925505

Amer, H., & Ibrahim, W. (2014, April). *Using the iPad as a pedagogical tool to enhance the learning experience for novice programing students*. Paper presented at the Global Engineering Education Conference (EDUCON). https://doi.org/10.1109/EDUCON.2014.6826087

Barbosa, D. N. F., Augustin, I., Barbosa, J. L., Yamim, A. C., Da Silva, L. C., Fernando, C., & Geyer, R. (2006, March). *Learning in a large-scale pervasive environment*. Paper presented at the Fourth Annual IEEE International Conference on Pervasive Computing and Communications Workshops. https://doi.org/10.1109/PERCOMW.2006.74

Batchelor, J. (2018, January 31). Games industry generated $108.4bn in revenues in 2017. Retrieved from https://www.gamesindustry.biz/articles/2018-01-31-games-industry-generated-usd108-4bn-in-revenues-in-2017

Beligan, D., Roceanu, I., Barbieru, D., & Radu, C. (2013, May). *Features of using serious games in military education and training.* Paper presented at the International Scientific Conference eLearning and Software for Education. https://doi.org/10.12753/2066-026X-13-117

Boyle, E. A., Hainey, T., Connolly, T. M., Gray, G., Earp, J., Ott, M., & Pereira, J. (2016). An update to the systematic literature review of empirical evidence of the impacts and outcomes of computer games and serious games. *Computers & Education*, 94, 178-192.

Breuer, J. S., & Bente, G. (2010). Why so serious? On the relation of serious games and learning. *Eludamos. Journal for Computer Game Culture*, 4(1), 7-24.

Brown, D. J., Standen, P., Evett, L., Battersby, S., & Shopland, N. (2010). Designing serious games for people with dual diagnosis: Learning disabilities and sensory impairments. In P. Zemliansky, & D. Wilcox (Eds.), *Design and Implementation of Educational Games: Theoretical and Practical Perspectives* (pp. 424-439). Hershey, PA: IGI Global.

Buckingham, D., & Scanlon, M. (2000, November). *That is edutainment: Media, pedagogy and the market place*. Paper presented at the International Forum of Researchers on Young People and the Media, Sydney, Australia.

Calder, N. (2010). Using scratch: An integrated problem-solving approach to mathematical thinking. *Australian Primary Mathematics Classroom*, 15(4), 9-14.

Chan, T. W., Roschelle, J., Hsi, S., Kinshuk, Sharples, M., Brown, T., & Soloway, E. (2006). One-to-one technology-enhanced learning: An opportunity for global research collaboration. *Research and Practice in Technology Enhanced Learning*, 1(01), 3-29.

Chen, Y., Bodicherla, D., Scott, B. & Whittinghill, D. (2014). Meltdown: A serious game for environmental awareness on climate change. In T. Bastiaens (Ed.), P*roceedings of 2014 world conference on e-learning in corporate, government, healthcare, and higher education* (pp. 388-394). New Orleans, LA: Association for the Advancement of Computing in Education (AACE).

Clark, D. B., Tanner-Smith, E. E., & Killingsworth, S. S. (2016). Digital games, design, and learning: A systematic review and meta-analysis. *Review of Educational Research*, 86(1), 79-122.

Connolly, T. M., Boyle, E. A., MacArthur, E., Hainey, T., & Boyle, J. M. (2012). A systematic literature review of empirical evidence on computer games and serious games. *Computers & Education*, 59(2), 661-686.

Corti, K. (2009). *Games-based learning; a serious business application.* PIXELearning White Paper, The Serious games Institute.

Crompton, H., Burke, D., & Gregory, K. H. (2017). The use of mobile learning in PK-12 education: A systematic review. *Computers & Education*, 110, 51-63.

Djaouti D., Alvarez J., Jessel JP., & Rampnoux O. (2011) Origins of serious games. In L. C. Jain, M. Ma, A. Oikonomou (Eds.), S*erious games and edutainment applications* (pp. 25-43). London: Springer.

Duncan, C., Bell, T., & Tanimoto, S. (2014, November). *Should your 8-year-old learn coding?* Paper presented at the 9th Workshop in Primary and Secondary Computing Education. https://doi.org/10.1145/2670757.2670774

Durkin, K., Boyle, J., Hunter, S., & Conti-Ramsden, G. (2015). Video games for children and adolescents with special educational needs. *Zeitschrift fur Psychologie* 221(2), 79-89.

Entertainment Software Association. (2017, April). Essential facts about the computer and video game industry. Retrieved from http://www.theesa.com/wp-content/uploads/2017/06/!EF2017_Design_FinalDigital.pdf

Falloon, G. (2017, April). *Exploring student thinking, problem solving, and collaboration in iPad-supported learning environments*. Retrieved from http://www.tlri.org.nz/sites/default/files/projects/TLRI%20Summary%20report%20for%20website%20_Falloon.pdf

Garcia-Penalvo, F. J., Rees, A. M., Hughes, J., Jormanainen, I., Toivonen, T., & Vermeersch, J. (2016, November). *A survey of resources for introducing coding into schools.* Paper presented at the Fourth International Conference on Technological Ecosystems for Enhancing Multiculturality. https://doi.org/10.1145/3012430.3012491

Geist, E. (2011). The game changer: Using iPads in college teacher education classes. *College Student Journal*, 45(4), 758-769.

Giannakoulas, A., & Xinogalos, S. (2018). A pilot study on the effectiveness and acceptance of an educational game for teaching programming concepts to primary school students. *Education and Information Technologies*, 1-24. https://doi.org/10.1007/s10639-018-9702-x

Gibson, B., & Bell, T. (2013, November). *Evaluation of games for teaching computer science.* Paper presented at the 8th Workshop in Primary and Secondary Computing Education. https://doi.org/10.1145/2532748.2532751

Giordano, D., & Maiorana, F. (2014, April). *Use of cutting edge educational tools for an initial programming course*. Paper presented at the Global Engineering Education Conference (EDUCON). https://doi.org/10.1109/EDUCON.2014.6826147

Gosset, W.S. (1908). Probable error of a correlation coefficient. *Biometrika*, 6(2-3), 302-310.

Gouws, L. A., Bradshaw, K., & Wentworth, P. (2013, July). *Computational thinking in educational activities: An evaluation of the educational game light-bot.* Paper presented at the 18th ACM Conference on Innovation and Technology in Computer Science Education. https://doi.org/10.1145/2462476.2466518

Greenwood, J. A., & Sandomire, M. M. (1950). Sample size required for estimating the standard deviation as a per cent of its true value. *Journal of the American Statistical Association*, 45(250), 257-260.

Gudmundsen, J. (2006, May 19). Movement aims to get serious about games. Retrieved from https://usatoday30.usatoday.com/tech/gaming/2006-05-19-serious-games_x.htm

Hainey, T., Connolly, T. M., Stansfield, M., & Boyle, E. A. (2011). Evaluation of a game to teach requirements collection and analysis in software engineering at tertiary education level. *Computers & Education*, *56*(1), 21-35.

Hildmann, H., & Hildmann, J. (2011). A formalism to define, assess and evaluate player behaviour in mobile device based serious games. In L. C. Jain, M. Ma, A. Oikonomou (Eds.), *Serious Games and Edutainment Applications* (pp. 85-106). London: Springer.

Hiltunen, T. (2016). *Learning and teaching programming skills in Finnish primary schools–the potential of games* (Master's thesis, University of Oulu, Linnanmaa, Finland). Retrieved from http://jultika.oulu.fi/files/nbnfioulu-201605221873.pdf

Hogg, R. V., & Tanis, E. A. (1997). *Probability and statistical inference*. Upper Saddle River, New Jersey: Prentice-Hall International Inc.

Huizenga, J., Admiraal, W., Akkerman, S., & Dam, G. T. (2009). Mobile game-based learning in secondary education: Engagement, motivation and learning in a mobile city game. *Journal of Computer Assisted Learning*, *25*(4), 332-344.

Imbellone, A., Botte, B., & Medaglia, C. M. (2015). Serious games for mobile devices: The intouch project case study. *International Journal of Serious Games*, 2(1), 17-27.

Ireland, G. V., & Woollerton, M. (2010). The impact of the iPad and iPhone on education. *Journal of Bunkyo Gakuin University Department of Foreign Languages and Bunkyo Gakuin College*, 10, 31-48.

Jemmali, C., Yang, Z. (2016). *May's journey: A serious game to teach middle and high school girls programming* (Master's thesis, Worcester Polytechnic Institute, Worcester, MA). Retrieved from https://web.wpi.edu/Pubs/ETD/Available/etd-042816-153121/unrestricted/zyang.pdf

Johnson, W. L., Vilhjalmsson, H. H., & Marsella, S. (2005). Serious games for language learning: How much game, how much AI?. In B. Bredeweg, J. Breuker, C. K. Looi, G. McCalla (Eds.), *Artificial intelligence in education* (pp. 306-313). Amsterdam: IOS Press.

Kazimoglu, C. (2013). *Empirical evidence that proves a serious game is an educationally effective tool for learning computer programming constructs at the computational thinking level* (Doctoral dissertation, University of Greenwich, London). Retrieved from http://gala.gre.ac.uk/11953/1/Cagin_Kazimoglu_2013.pdf

Knol, E., & De Vries, P. W. (2011). EnerCities-A serious game to stimulate sustainability and energy conservation: Preliminary results. *eLearning Papers*, 25. Retrieved from http://www.qeam.com/docs/EnerCities_QEAM_BV_Knol-De-Vries-EnerCities-article-eLearning-Papers.pdf

Li, Y., & Liu, X. (2017). Integration of iPad-based m-learning into a creative engineering module in a secondary school in England. *Turkish Online Journal of Educational Technology-TOJET*, 16(2). Retrieved from https://files.eric.ed.gov/fulltext/EJ1137789.pdf

Manuguerra, M., & Petocz, P. (2011). Promoting student engagement by integrating new technology into tertiary education: The role of the iPad. *Asian Social Science*, 7(11), 61-65.

Marks, L. J., & Kamins, M. A. (1988). The use of product sampling and advertising: Effects of sequence of exposure and degree of advertising claim exaggeration on consumers' belief strength, belief confidence, and attitudes. *Journal of Marketing Research*, 25(3), 266-281.

Michael, D. R., & Chen, S. L. (2005). *Serious games: Games that educate, train, and inform*. New York: Muska & Lipman/Premier-Trade.

Miljanovic, M. A., & Bradbury, J. S. (2017, August). *RoboBUG: A serious game for learning debugging techniques.* Paper presented at the 2017 ACM Conference on International Computing Education Research. https://doi.org/10.1145/3105726.3106173

Moreno, R., Mayer, R. E., Spires, H. A., & Lester, J. C. (2001). The case for social agency in computer-based teaching: Do students learn more deeply when they interact with animated pedagogical agents? *Cognition and Instruction*, 19(2), 177-213.

Mortara, M., Catalano, C. E., Bellotti, F., Fiucci, G., Houry-Panchetti, M., & Petridis, P. (2014). Learning cultural heritage by serious games. *Journal of Cultural Heritage*, 15(3), 318-325.

Muratet, M., Torguet, P., Viallet, F., & Jessel, J. P. (2011). Experimental feedback on Prog&Play: A serious game for programming practice. *Computer Graphics Forum*, 30(1), 61-73.

NPD Group. (2015, January 27). Average time spent playing games on mobile devices has increased 57 percent since 2012. Retrieved from https://www.npd.com/wps/portal/npd/us/news/press-releases/2015/average-time-spent-playing-games-on-mobile-devices-has-increased-57-percent-since-2012/

Palomo-Duarte, M., Berns, A., Cejas, A., Dodero, J. M., Caballero, J. A., & Ruiz-Rube, I. (2016). Assessing foreign language learning through mobile game-based learning environments. *International Journal of Human Capital and Information Technology Professionals (IJHCITP)*, 7(2), 53-67.

Pellas, N., Konstantinou, N., Georgiou, G., Malliarakis, C., & Kazanidis, I. (2014, July). *Utilizing a serious game via Open Sim standalone server and Scratch4OS for introductory programming courses in Secondary education: Their effect on student engagement*. Paper presented at the 14th International Conference on Advanced Learning Technologies (ICALT). https://doi.org/10.1109/ICALT.2014.203

Peppler, K., & Kafai, Y. (n.d.). Creative coding: Programming for personal expression. Retrieved from http://download.scratch.mit.edu/CreativeCoding.pdf.

Pett, M. A. (2015). *Nonparametric statistics for health care research: Statistics for small samples and unusual distributions*. Singapore: Sage Publications.

Picchi, A. (2017, January 24). The best 11 jobs in America for 2017. Retrieved from *https://www.cbsnews.com/media/the-best-11-jobs-in-america-for-2017/10/*

Pilli, O. (2008). *The effects of computer-assisted instruction on the achievement, attitudes and retention of fourth grade mathematics course* (Doctoral dissertation, Middle East Technical University, Turkey). Retrieved from https://etd.lib.metu.edu.tr/upload/3/12609336/index.pdf

Prensky, M. (2001). Digital natives, digital immigrants part 1. *On the Horizon*, *9*(5), 1-6.

Prensky, M. (2003). Digital game-based learning. *Computers in Entertainment (CIE)*, 1(1), 21-21.

Quinn, C. (2000). mLearning: Mobile, wireless, in your pocket learning. Retrieved from: *http://www.linezine.com/2.1/features/cqmmwiyp.htm.*

Raphael, C., Bachen, C., Lynn, K. M., Baldwin-Philippi, J., & McKee, K. A. (2010). Games for civic learning: A conceptual framework and agenda for research and design. *Games and Culture*, 5(2), 199-235.

Reckien, D., & Eisenack, K. (2013). Climate change gaming on board and screen: A review. *Simulation & Gaming*, *44*(2-3), 253-271.

Resnick, M. (2004). Edutainment? No thanks. I prefer playful learning. *Associazione Civita Report on Edutainment*, 14, 1-4.

Resnick, M. (2008). Sowing the seeds for a more creative society. *Learning & Leading with Technology*, 35(4), 18-22.

Resnick, M., Maloney, J., Monroy-Hernandez, A., Rusk, N., Eastmond, E., Brennan, K., ... & Kafai, Y. (2009). Scratch: Programming for all. *Communications of the ACM*, *52*(11), 60-67.

Riedel, J. C., & Hauge, J. B. (2011, June). *State of the art of serious games for business and industry*. Paper presented at the 17th International Conference on Concurrent Enterprising (ICE), Aachen, Germany.

Rizvi, M., Humphries, T., Major, D., Jones, M., & Lauzun, H. (2011). A CS0 course using Scratch. *Journal of Computing Sciences in Colleges*, 26(3), 19-27.

Rossano, V., Roselli, T., & Calvano, G. (2017). A serious game to promote environmental attitude. In R. J. Howlett, L. C. Jain, V. L. Uskov (Eds.), S*mart education and e-learning* (pp. 48-55). Cham, Switzerland: Springer.

Saez-Lopez, J. M., Roman-Gonzalez, M., & Vazquez-Cano, E. (2016). Visual programming languages integrated across the curriculum in elementary school: A two year case study using "Scratch" in five schools. *Computers & Education*, 97, 129-141.

Salkind, N. J. (2016). *Statistics for people who (think they) hate statistics*. Thousand Oaks, CA: Sage Publications.

Sanchez Prieto, J. C., Miguelanez, S. O., & Garcia-Penalvo, F. J. (2013, November). *Mobile learning: tendencies and lines of research*. Paper presented at the First International Conference on Technological Ecosystem for Enhancing Multiculturality. https://doi.org/10.1145/2536536.2536609

Sanchez, J., & Olivares, R. (2011). Problem solving and collaboration using mobile serious games. *Computers & Education*, 57(3), 1943-1952.

Sawyer, B., & Rejeski, D. (2002). *Serious games: Improving public policy through game-based learning and simulation*. Foresight and Governance Project White paper, Woodrow Wilson International Center for Scholars.

Scratch Timeline. (n.d.) *Scratch Timeline.* Retrieved from: *https://wiki.scratch.mit.edu/wiki/Scratch_Timeline#May*

Sharples, M., Arnedillo-Sanchez, I., Milrad, M., & Vavoula, G. (2009). Mobile learning. In N. Balacheff, S. Barnes, T. D. Jong, A. Lazonder, S. Ludvigsen (Eds.), *Technology-enhanced learning* (pp. 233-249). Dordrecht: Springer.

Sharples, M., Taylor, J., & Vavoula, G. (2010). A theory of learning for the mobile age. In B. Bachmair (Ed.), *Medienbildung in neuen Kulturräumen* (pp. 87-99). Wiesbaden: VS Verlag für Sozialwissenschaften.

Shepherd, I. J., & Reeves, B. (2011). *iPad or iFad–The reality of a paperless classroom.* (Doctoral dissertation, Abilene Christian University, Abilene, TX). Retrieved from https://www.usma.edu/cfe/Shared%20Documents/ipad-or-ifad.pdf

Susi, T., Johannesson, M., & Backlund, P. (2007). *Serious games: An overview*. School of Humanities and Informatics, University of Skövde, Sweden. Retrieved from: *http://www.diva-portal.org/smash/get/diva2:2416/FULLTEXT01.pdf*

Takahashi, D. (2016, December 21). Worldwide game industry hits $91 billion in revenues in 2016, with mobile the clear leader. Retrieved from *https://venturebeat.com/2016/12/21/worldwide-game-industry-hits-91-billion-in-revenues-in-2016-with-mobile-the-clear-leader/*

Tessler, J., Beth, B., & Lin, C. (2013, August). *Using cargo-bot to provide contextualized learning of recursion.* Paper presented at the Ninth Annual International ACM Conference on International Computing Education Research. https://doi.org/10.1145/2493394.2493411

Todorova, M., Tzonkova, V., & Byanova, N. (2012). Serious games in economics. *Digital Presentation and Preservation of Cultural and Scientific Heritage,* 2, 187-192.

Torres, M., & Macedo, J. (2000). Learning sustainable development with a new simulation game. *Simulation & Gaming*, 31(1), 119-126.

Tundjungsari, V. (2016, February). *E-learning model for teaching programming language for secondary school students in Indonesia*. Paper presented at the 13th International Conference on Remote Engineering and Virtual Instrumentation (REV). https://doi.org/10.1109/REV.2016.7444477

Wang, T. L., & Tseng, Y. F. (2014, August). *An empirical study: Develop and evaluation a mobile serious game on environmental education*. Paper presented at the 9th International Conference on Computer Science & Education (ICCSE). https://doi.org/10.1109/ICCSE.2014.6926476

Wang, X., & Zhou, Z. (2011, August). *The research of situational teaching mode of programming in high school with Scratch.* Paper presented at the 6th IEEE Joint International Information Technology and Artificial Intelligence Conference (ITAIC). https://doi.org/10.1109/ITAIC.2011.6030380

Wong, L. H., & Looi, C. K. (2011). What seams do we remove in mobile-assisted seamless learning? A critical review of the literature. *Computers & Education*, 57(4), 2364-2381.

Yongyuth, P., Prada, R., Nakasone, A., Kawtrakul, A., & Prendinger, H. (2010, October). *AgriVillage: 3D multi-language internet game for fostering agriculture environmental awareness*. Paper presented at the International Conference on Management of Emergent Digital EcoSystems. https://doi.org/10.1145/1936254.1936280

Zualkernan, I. A., Jibreel, M., Tayem, R., & Zakaria, R. (2009, July). *A role-playing game-based learning platform for environmental awareness.* Paper presented at the Ninth IEEE International Conference on Advanced Learning Technologies. https://doi.org/10.1109/ICALT.2009.186

Zyda, M. (2005). From visual simulation to virtual reality to games. *Computer*, 38(9), 25-32.