THE REPUBLIC OF TURKEY
BAHÇEŞEHİR UNIVERSITY

THE EFFECTS OF DIGITAL GAME BASED LEARNING ON PERFORMANCE AND MOTIVATION FOR HIGH SCHOOL STUDENTS IN COMPUTER SCIENCE EDUCATION

M.S. Thesis

Burcu YURDAARMAĞAN

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ABSTRACT

THE EFFECTS OF DIGITAL GAME BASED LEARNING ON PERFORMANCE AND MOTIVATION FOR HIGH SCHOOL STUDENTS IN COMPUTER SCIENCE EDUCATION

Yurdaarmağan, Burcu

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It is observed that teenagers' interests towards digital games have been considerably increased in recent years with combining fantasy and reality of digital games. This concerning conditition has been directed researchers to combine fun and education. It is started to discuss the effects of enjoyable and educative games on students. This study has been applied to measure the effects of students' motivation and academic performance of digital game based learning. Matching game, based ARCS motivational model has been designed. The experiment has been carried out with 152, tenth grade students (15-17 aged) in programming fundamentals course. These students attend computer science based high school. Students have been chosen randomly and divided into two groups. Group A consist of 75 students with applying digital game based learning. Group B consist of 77 students with applying traditional learning. Learning Achievement Test (LAT) which measures the learning achievement and pre- and post-test (MSLQ) which measure students' motivation are applied to the two groups. The study has run the pre-test, post-test and flow diagram test data for the quantitative research questions with Independent-Samples T-Test, ANCOVA and One-way ANOVA.

Keywords: Digital Game Based Learning, Student Motivation, MSLQ, Computer Science Education, Learning Performance

ÖZET

BİLGİSAYAR DERSLERİNDE DİJİTAL EĞİTİMSEL OYUNLARIN
ORTAÖĞRETİM
ÖĞRENCİLERİNİN BAŞARISINA VE ÖĞRENCİ MOTİVASYONUNA ETKİSİ

Yurdaarmağan, Burcu

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Dijital oyunların hayal ile gerçekliği birleştirmesiyle birlikte gençlerin oyunlara yönelik ilgisinin son zamanlarda oldukça arttığı görülmektedir. Bu kaygı verici durum, araştırmacıları eğlence ile eğitimi birleştirmeye yöneltmiştir. Hem eğlenceli hem de eğitim verici oyunların öğrenciler üzerinde etkisi tartışılmaya başlanmıştır. Bu çalışma dijital eğitimsel oyunların öğrenci motivasyonuna ve öğrenci başarısına etkisini ölçmek için yapılmıştır. ARCS motivasyon modeli merkeze alınarak eşleştirme oyunu tasarlanmıştır. Deney, bilgisayar bölümü olan bir lisede 10. sınıf (15-17 yaş) 152 öğrenci ile programlama temelleri dersini dikkate alarak gerçekleştirilmiştir. Öğrenciler rastgele seçilerek iki gruba ayrılmıştır. Grup A, dijital eğitimsel oyuna dahil olan 75 öğrenciden oluşmuştur, Grup B ise geleneksel eğitime dahil olan 75 öğrenciden oluşmuştur. İki gruba da akademik başarıyı ölçen Learning Achievement Test (LAT) ve öğrenci motivasyonunu ölçen (MSLQ) ilktest ve sontest uygulanmıştır. Bu çalışmada araştırma soruları için toplanan ilk-test, son-test ve akademik başarı test verileri Independent-Samples T-Test, ANCOVA and ONE-WAY ANOVA kullanılarak hesaplanmıştır.

Anahtar Kelimeler: Eğitimsel Oyunlar, Bilgisayar Dersi, MSLQ, Akademik Başarı, Öğrenci Motivasyonu

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LIST OF ABBREVIATIONS

ARCS	: Attention, Relevance, Confidence, Satisfaction
CS	: Computer Science
DGBL	: Digital Game Based Learning
ICT	: Information and Communication Technology
ITS	: Intelligent Tutoring System
LAT	: Learning Achievement Test
MSLQ	: Motivated Strategies for Learning Questionnaire
PISA	: Programme for International Student Assessment
SOBAG	: Social Sciences and Humanities Research Group

1. INTRODUCTION

Students have grown up with technological improvements in recent years so that this situation needs to change traditional lecture based passive learning methodology to an active multisensory experiential learning methodology. Therefore, technology is important for education in Information and Communication Technology (ICT) in daily life. For Interactive learning possibilities, ICT is a great view (Tam, 2000). Students' search for information on the internet and watching movies can supply a reality in class. There are a lot of new technologies about computer so they provide facilities to fulfill the curriculum in an original, complex and significant context. One of these facilities is game play. Computerization has had a great importance on education with the development of computer technology. Surely, active multisensory experiential learning has drawn teenagers' attention and may achieve demands of information society. Modern computer and video games get facilities very frequently (Prensky, 2003).

No matter children or adults, games are common experience. McGonigal (2010) states that in the world people play video games 3 billion hours a week and it is an important activity in the daily life. Oblinger (2004) points the effective learning of the games as follows: (i) game can provide multi-sensory, active, experiential, problem-based learning (ii) games favour activation has to include the previous information that has been given to players for improvement, (iii) players can get feedback immediately by playing games because they can test hypotheses and learn from their actions during the game (iv) games provide self assessment for the players by getting score and extending different levels, and (v) players can involve larger communities in game environment.

Children and adults willingly spend a lot of time, energy and have engagement, and also they get great pleasure from this experience. That shows playing game is an intense learning experience (Rieber, Smith & Noah, 1998). Another important point 'Digital Game-Based Learning' (DGBL) called by Prensky (2003) includes that the motivation of games could be combined with curricular contents.

To learn methodology DGBL has a lot of advantages. DGBL includes so many different studies in terms of different approaches, definitions and applications (Torrente, Lavín-Mera, Moreno-Ger, & Fernández-Manjón, 2009). Besides, learners are allowed trial and error exploratory learning in games and, game controls learners so that the learners assess themselves in each level (Kirriemuir & McFarlane, 2004).

The study of Sandford et al (2006), 36 percent of primary school teachers and 27 percent of secondary school teachers claimed that games had been applied to teach, but 14 percent of the teachers said games didn't have clear evidence whether thay had educational value or not (6 percent of the teachers believed that curriculum and subject weren't relevant to the games). As stated in this study, games designed upon curriculum and subject have great importance.

Learners ought to be able to use factual knowledge, be eager to learn, and get experience in real world via behavioral patterns and the games exactly effect learners' reflection (Pivec, 2007). In sum, games definitely fit for the social constructivist theory of learning.

1.1 BACKGROUND

1.1.1 Digital Games for Learning

It is well known that people have grown up with digital technology. They have been shifting the ways of social thoughts about learning process. Digital games let the educational paradigm change over from teaching-centered to learner-centered classrooms. It is clear that learner-centered education strengths students' learning outcomes.

Prensky (2007) states two main important reasons about why people need to use computer games for learning. First one is that learners have begun to change getting information style and options unlike their parents. The second one is that learners need motivation in new ways in order to learn. For teenagers grown up with digital technology, learners can get important motivation and engaging factor when they use

computer games. If learners are taken part in learning process they can learn and improve themselves more. Besides, taking part in learning process can let learners be more emotional, relax especially through fun (Mitchell & Savill-Smith, 2004). Researchers point out that digital games are changable and complex enough to provide for different learning styles and support cooperation (Sedighian, 1994; Kirriemuir, 2002).

As a result, game suggests fun, interactive mode, related result and feedback, so game elements can attract learners. Game should have an obvious and significant goal that can be potentially matched with learning goal. It should have winning award (eg. bonus) to motivate the learner. It should take learners' attention in terms of conflict, challenge and opposition factors. In this study, the game has designed by thinking the way of being fun, giving feedback and goal to learner and being attractive.

1.1.2 Designing of The Game

Digital games consist well-established principles and models of learning. There are different opinions about game characteristics. It is known that digital games have benefits on education in recent times. However, designing an educative game suitable for its goal requires more effort and time. It is necessary to be able to combine pedagogical approach and designing process in games in order to reach efficiency of educative games (Zin, Yue, 2009). If game designers are master in designing process but lack of performing pedagogical principles, learners may have fun but they won't be able to gain the important knowledge or skills. There is a relationship between instructional design and game design. Instructional Design Process consists of analysis, design, development, implementation phases and game design process consists of concept develoment, pre-production, production and post-production as shown in Table 1.1 (Hirumi et all, 2008).

Table 1.1: Relationship between instructional design tasks and game development

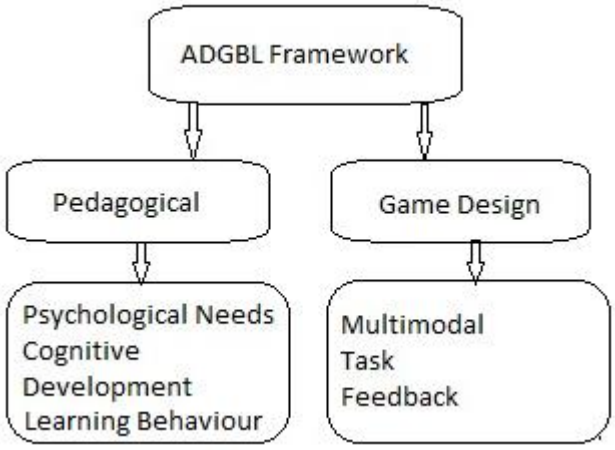
Instructional Design Process and Tasks	Game Design Process and Product
Analysis Phase • Assess needs and identity goal(s) • Analyze goal(s), learner and context	*Concept Development Phase* • Prepare pitch document • Prepare game concept document
Design Phase • Generate, cluster & sequence objectives • Determine learner assessment method • Generate instructional strategy • Select media	*Pre-Production Phase* • Create game design documents • Prepare art bible and production plan • Create technical design document
Development Phase • Acquire materials or outsource development • Create flowcharts and storyboards • Generate prototypes • Formatively evaluate and revise materials	*Prototype & Production Phases* • Develop analog or low-fidelity prototypes • Develop tangible prototypes • Produce Alpha Version • Produce Beta Version • Produce Gold Version
Implementation & Evaluation Phases • Deliver and manage instruction • Plan and conduct summative evaluations	*Post-Production* • Generate and release subsequent versions • Generate and release upgrades/expansions

Tan et al. (2007) suggest and discuss components that enhance the pedagogical aspects in designing game-based learning environment as shown in Figure 1.1. Their study investigates game frameworks according to pedagogical aspect and game design aspect. Both components have several criteria.

The interface design is one of the most important part in the process of game development. The interface provides connection between users and the game. A recent study by Rahadiani et al. (2012) focuses the design and implementation of visual interface game that has some principles: simplicity, feedback, similarity and familiarity. Simplicity gives simple but enough information to users. Feedback allows useful information about the process to users. Similarity changes the selected option but does not change the result. Familiarity let players recognize the design of norms. It is crucial

to bring out that each framework focuses on different aspects, thus they could append one another.

Figure 1.1: Adaptive digital game based learning framework

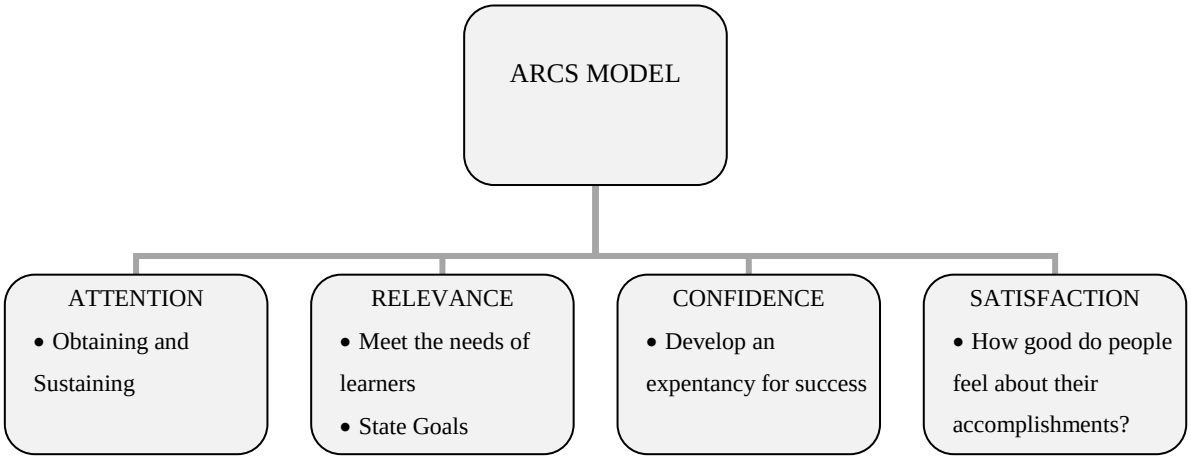


Another important study about game elements is Malone's (1981). Malone states that fantasy, curiosity, challenge and control are identified as four elements of simulation games. Also, Johnston et al. (1993) point out that the rules, goal and interaction are fundamental characteristics. Baranauskas et al. (1999) focus that challenge and risk are principles in playing. In Keller's (1987) study, it is said that using the ARCS Model of Motivational Design is a way to synthesize motivational elements of digital games. For precondition in an educational situation, ARCS model identifies four main features as follows (Attention, Relevance, Confidence, and Satisfaction). These features have to provide people get and remain motivated (Keller, 1987). For that reason, this paper will focus on ARCS Model.

ARCS model is divided into specific subcategories as shown in Figure 1.2. Attention (A) Strategies: giving learners the opportunity to select topics, humorous content, variability, various style of presentation, different analogies, problem solving activities at regular intervals, case studies and changing from student-teacher interaction to student- student interaction. Relevance (R) Strategies: allowing learners new skills in different ways for future, meaningful alternative methods to accomplish goal, revealing the leaner's existing skills, improving learning motivation. Confidence (C) Strategies:

providing self-evaluation, conquerable challenge, realistic goals, amounts of effort and ability, feedback of the game (grades, bonus), encouraging student to perform appropriate attributions for both success and failure, increasing level of difficulty. Satisfaction (S) Strategies: avoiding negative influences (the use of threats, observation), allowing natural consequences (reinforce a student's intrinsic motivation), giving surprise and non-contingent rewards, providing positive outcomes (helpful and motivating feedback, informative).

Figure 1.2: ARCS model



In this study, ARCS model has been used while designing this game model. For attention strategies, variability has been supplied in the game. Students get different time and score for each level they complete. For relevance strategies, students acquire an information that is helpful for the programming course by playing games. Students observe available success during games. When students get into a new level, they are able to use the information that they have acquired in previous level. For confidence strategies, students gain score when they get into next level. This score improves students' courage. In each level, difficulty range has been increased but this difficulty has achievable range. The time of each level has been organized according to its difficulty range. If the students can not complete the level in a definite time, they will lose one of the health points that was given at the beginning of the game. In this way, realistic goals have been supplied. For satisfaction strategies, score and health points are added to the game to provide students' satisfaction in the game. Students should do matching appropriately in a very short time while playing the game. To this, students

are able to reach the highest score that they can. Designers try to combine curriculum and entertaining side of a real game. Thus, so many researchers elaborate to increase reusability of the games as designing them. Zarraonandia et al. (2012) define game design model. This model contributes support to educational game design teams and it can be reusable and adaptive to other games. The teacher can easily turn into the designed game to a game which has the same goal.

1.1.3 Motivation Theory

Kleinginna et al. (1981) identify motivation as an internal state. This state can stimulate behavior, desire or want. They can energize and manage goal-oriented behavior and effects of needs and desires on the intensity and direction of behaviors.

Also, Franken (2006) defines motivation. Franken says that stimulation, direction and maintenance of behavior are motivation (Schunk, et al. 2007). Many researchers have highlighted that motivation is a great factor in influencing learning success (Ames, 1992). Deci et al. (1985) point out that educational materials strongly have effects on learner's motivation. As a consequence, many researchers have found out that computer games have positive sides to improve learner's motivation.

1.1.4 Adaptation of MSLQ

MSLQ (Motivated Strategies for Learning Questionnaire) is widely used for different students groups, in a lot of countries about different fields. MSLQ is used for defining motivation in learning strategies at primary, high school grades and universities or is used for adults education at various companies. Also this scale is used different fields as motivation and performance, learning strategies and success, self-efficacy, self-organization, e-learning and web-internet based learning. Moreover, this scale is applied to sum various fields like pedagogy, social sciences, economy, nourishment and teacher training (Chen, 2002; Duncan& McKeachie,2005).

MSLQ is also used to identify factors that effects students' academic performance at primary and high school grades in the world. In 2000, MSLQ is used in a research called PISA (Programme for International Student Assessment) which is applied on 26 countries over 15 year-old teenages to measure MSLQ learning control (Artelt, 2005).
To apply MSLQ on teenagers between the ages of 12-18 in Turkey, the adaptation is achieved with the project of SOBAG (Social Sciences and Humanities Research Group-104KD97) in 2008.

1.1.5 Types of Motivations

Motivation theory generally classifies into two types: intrinsic and extrinsic. Intrinsic motivation: In 1985, Deci et al. report that intrinsic motivation is in operation when learners perceive themselves as capable and self determining. In 2007, Schunk et al. publish a paper in which they describe that people engage in project or activity for no other aim than that they find it fun and pleasant. Intrinsic motivated people are not related to definite rewards or any other external things but they get rewards by performance of the task (Schunk et al., 2007).

Extrinsic motivated people are related to attractive rewards, teachers' positive attitude, caution of punishment, or getting present from parents to be able to be successful. They ignore the joyful side of the performance because motivation is effective on people's learning and behaviours (House, 2004; Tuzun 2004).

1.1.6 Achievement and Motivation

Educators have had great interest on the relationship between motivation and learning activities for a long time (Beesley et al., 2010). When students are motivated, they also completely engage in the learning activities. If students are engaged, they connect to their learning environment. If students give extra performance for learning and also completely take part in processing information, whether they have difficulties about tasks or challenge or not, they can be eager to be active in learning tasks. Student engagement is related to achievement because if students take responsibility, they think it is necessary to work for learning. Dotterer and Lowe (2011) mean that school

engagement (both psychogical and behavioral) has connection between classroom setting and academic achievement for students, ignoring previous achievement difficulties. On the other hand, previous achievement difficulties are about behavioral engagement, but not psychological engagement in terms of classroom settings for students. If students are engaged in only cognitive process and focused on thinking the learning task, the behavioral engagement can't be accomplished and if students are engaged only behaviorally, they can't think deeply about the task so learning occurs with motions; psychological engagement can't be achieved. As a result in both situations, learning goals may not be completed (Beesley, 2010). Games provide learning environment by combining these both situations. And this fact increases the motivation of students.

1.1.7 Motivation and Computer Games

In today's education system, learning process is not adequate for students to be motivated or engaged. Despite there are some digital natives who think that learning is interesting and are volunteer to be engaged in learning process, the rest doesn't think like that and is not eager to be in this process. Punishment and rewards externally provide student's motivation to effort in typical learning. Some people are motivated to learn and others need extra performance to desire. Rosen and Weil (1997) say that for increasing internal motivation, some short assignments and enough assistance can be presented to unmotivated students. In addition, Lepper & Hodell (1989) say that there are four important intrinsic motivation elements - challenge, curiosity, control, and fantasy. They claim that these four elements increase intrinsic motivation. Challenge is the first element that has been in students to take their attention while doing activities and the challenge provides interest to the students in solving problems or doing activities (Deci, 1975). Also Schunk et al. (2007) claim that the difficulty level of challenging activities ought to be intermediate level so students think that they have confidence and ability to success. The second element curiosity occurs with amazing or surprising information that involve stimulating activities which make students think about their present knowledge (Lepper&Hodell, 1989). Schunk et al., (2007) say that if curiosity exists, people believe that the gap is reachable and they are motivated to fulfill.

The third intrinsic motivation element; control is a way which the instructor lets the students get into the learning process effectively. Activities which give chance to choose or control the learning outcomes are useful for increasing intrinsic motivation (Schunk et al, 2007). Instructors should design activities which have fantasy. These activities should consist simulations and games for realism so intrinsic motivation can be enhanced (Lepper&Hodell, 1989).

The game designers have many strategies and functions while designing a game for making players remain engaged and interested because they are willing to keep the players engaged in playing. It is necessary to look at Moslow's hierarchy of need to apprehend how players are motivated while playing a game in game environment. The essential rules of the game should be identified clearly to the players who are at the physical level. Even if players understand all of the rules, assistance information and safety satisfaction are necessary to avoid failure and win the game. When they are in level that they like, players should be aware that they still have opportunity to gain and belonging in the game. When players get into next level, they should think that they have control to observe their self-esteem needs while playing the game. Then, they should look for strategies, solve problems and show their creativity to see self-actualization. Players desire to challenge different things (Siang&Rao, 2003).

Computer games have to be thought as a supplementary tool for learners' awareness in intrinsic motivation. The relationship between motivation and computer games have been argued by so many researchers. For instance, Malone (1982) finds out the way how games motivated learners and explore functions of the games which lead learners playing a game while learning the task in them. Malone (1982) also says that fun in the game isn't sufficient element to provide help them learn. Sophisticated educational games ought to have some important functions like imagination, challenge and curiosity. These functions are stimulators which effect intrinsic motivation and learner's interest so they let them go further and have better learning outcomes. In addition, Malouf (1998) explores the effects of continuing student motivation to engage in academic tasks after computer game-based instruction have significantly higher

continuing motivation in using their academic skills than those taught computer programming without use of game functions.

Tuzun (2004) highlights that continuing motivation should be supplied to learners directly by using the power of playing and learning. The fun while playing and learning have importance much more than learning outcomes.

1.1.8 Motivation Questionnaire

MSLQ has been applied to collect data at pre- and post-test for measuring student's motivation. MSLQ has been developed at the National Center for Research to Improve Postsecondary Teaching and Learning at the University of Michigan (Pintrich et al., 1991). It has been arranged to search college students' motivational orientations and use of learning strategies.

It has been claimed that the elements of the MSLQ are related with different aspects of motivation and learning strategies (Duncan and McKeachie, 2005). This instrument has experienced deep psychometric improvements and it has been proved to experience adequate overall internal consistency reliability (Pintrich et al., 1991).

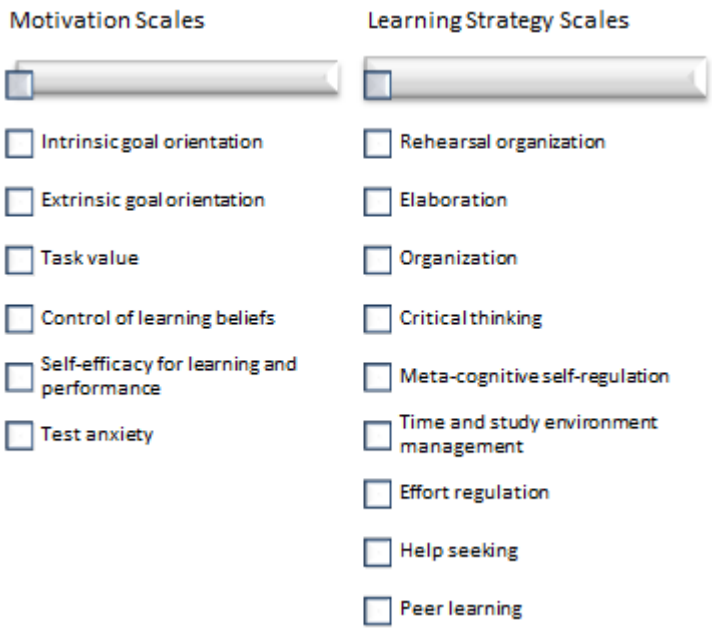
Kosnin (2007) says that, for the MSLQ, some other studies that prove equivalent internal consistency reliability estimates which have strong independent samples have been done. MSLQ is founded on a cognitive view of motivation. There are two sections in this motivation as a motivation section and a learning strategies section. This questionnaire occurs 81 items, and six motivational scales and nine learning strategies as shown in Table 1.3.

1.2. LIMITATION AND DELIMINATION

This study has been delimited to tenth grade high-school students in Istanbul. Therefore, the result can only be generalized to students with similar characteristics. The study has lasted only two courses but it can last longer. The sex rate is not equal because the number of male students are more than the female students. The sex rate can be equal in

this study. The content of the game has been designed according to Turkish high schools' computer science curriculum.

Table 1.3: Descriptive statistic of motivated strategies for learning questionnaire



2. LITERATURE REVIEW

The goal of Chapter two is to review literature related to each of the major components within the study. Two literature reviews have been conducted. The first review has examined motivation effects in digital games. The second review has investigated the empirical research and literature reviews on effectiveness of digital games on learning achievements.

2.1. MOTIVATIONAL EFFECTS IN DIGITAL GAMES

In 2000's, children and adolescents have been keen on computer games. Virvou et al. (2005) have made Intelligent Tutoring System (ITS) which works as a virtual reality educational game. Evaluation's results have indicated that as keeping or developing the educational effects on students, educational virtual reality games may be motivating. Furthermore, another interesting finding is that students who experience lack of performance in their domain taught according to their previous learning experience have high educational effectiveness of the game.

The effects of two kinds of interactive learning tasks have been studied by Vos et al. (2011).Interactive learning tasks have included simple games and the tasks have been identified with the aspects of student motivation and deep strategy use. In Netherlands, 235 students have attended the research from elementary schools. One group of students has designed a game by themselves; the other group has played an existing game. Analyses of covariance have showed that there are an important difference between intrinsic motivation and deep strategy use. Both motivation and deep strategy use have large effect sizes and these provide advantage for the construction condition. The results have claimed that constructing a game may provide benefits for improving student motivation and deep learning than playing an existing game. The low level of complexity of the games is the limitation of this study.

Miller et al. (2011) have tested the power of a web-based forensic science game among secondary students.The aim of Miller et al. (2011). is teaching content and motivating STEM careers.One of the three web-based forensic cases have been applied to more than 700 secondary school students for approximately 60 min.The scores got from pre-test have showed important gains in content knowledge. Besides, the usability ratings of the game are indicator of the learning .It has been seen that there is a positive correlation between role-play experience and science career motivation.This correlation provides a role for authentic virtual experiences in revealing students to think themselves as STEM careers.

In order to promote children's learning motivation, Tsai et al. (2012) have aimed to improve affective interface of the game-based adaptive learning in their study. Considering Ekam's FACS' recognization and classification of learners' facial emotion, different variety levels of a puzzle game and learning contents have been developed for adaptation to the learner's facial emotion. In the evaluation experiments, the elementary school students have been divided into three groups. These groups are for the adaptive game, for the adaptive learning content, and for no adaptive learning as control group. The affective usability scale has been applied by subjects for evaluating the system.The results have showed that learners' learning motivation and satisfaction can be increased by the game-based learning system. It can be also said that on the adaptive learning it has been suggested to use the affective interface designed by facial affective computing.

In a simulation game which has been designed to help students to get computational problem solving, the feedback and problem solving behaviors of 117 students has been analysed by Liu et al. (2011). It has become clear that during getting computational problem solving with the game, students apprehend a flow learning experience more than in traditional lectures. Learning with the simulation game has promoted the students' intrinsic motivation. Especially, a strong relationship between the students' learning experience states and their problem solving strategies has been reported in the study. Getting the computational problem solving skills, students who apprehend a flow experience state oftenly use trial-and-error, learning-by example, and analytical

reasoning strategies. But, some students that have states of boredom and anxiety has not shown indepth problem solving strategies.

ARG (Alternate Reality Games) which intends to enhance the motivations of secondary school grade students across Europe in the learning of modern foreign languages has been argued by Connoly et al. (2011) with the aspects of the design, development and evaluation .Educational value of ARGs has been described in their study. Especially the ARG, for encouraging the teaching of modern European languages and the specific activities that are improved around Web 2.0 and gaming that underpin the ARG, provide help to enhance collaboration and getting knowledge in an educational environment. On the whole, the students can have motivational experience which has been expected by the help of ARG, and this evidence has suggested that student behavior to the ARG are very positive. The most of the students that answer the post-test strongly engage that they can be eager to play the game in an extensive time as portion of a foreign language course. Besides, students admit that they get skills in terms of cooperation, teamwork, collaboration by applying the ARG.

Super Delivery which is an educational online game has been developed by Tsai et al. (2011). Super Delivery aims knowledge for saving electricity at first. Tsai et al have managed case studies to sixth-grade students in number of eight. By applying this game, in digital game-based learning (DGBL) the elements that effect students' knowledge acquisition are aimed to be discovered. Many elements such as students' learning motivation, learning ability, and playing skill which can be the key elements that interactively and collectively effect students' effectiveness of knowledge acquisition in DGBL. In addition, students' playing motivation, online game experience and also prior knowledge have influenced relatively their learning ability, learning motivation and playing skill. The findings of this study may make teachers think how influentially taking advantages in an educational game to promote students' learning effectiveness in DGBL.

2.2. EFFECTIVENESS OF DIGITAL GAMES ON LEARNING ACHIEVEMENTS

Deficiency of empirical research on distinctive effects of computer games on various learners has been analyzed by Kim et al. (2010). By basing on gender and language minority groups, 4th grade students' math achievement has been investigated with the aspects of the effects of playing computer games. A nationally representative database of the USA called the 2005 National Assessment of Educational Progress (NAEP) is used in this study. The findings have indicated that students who speak English and play computer math games in school every day demonstrate significantly worse math achievement than the students who do not play. In contrast to this, male students who speak another first language except from English indicate that daily computer use has positive effects. Male students in language minority group who daily play computer games in math show higher math achievement when it is compared with male native speaker of English who do not ever play.

To provide certain learning and analysis of Newtonian mechanics, the potential of a digital game that built upon popular game-play mechanics with formal physics representations and terminology has been investigated by Clark et al. (2011). Test data, survey data, and observational data, which are collected in a process of applications in Taiwan and the United States to 7th - 9th grade students are compared by the analysis. Findings have shown learning on some core disciplinary measures and high levels of learner engagement by implying the possible profits of this kind of conceptually-integrated games. And also it has been suggested that further research and development are required to use this potential completely. Incitingly, with the aspects of learning and engagement, remarkable similarities are noticed across the two countries. These similarities have indicated that this kind of learning games may have an appropriate proof to participate students in active exploration of core science concepts in many countries.

Admiraal et al. (2011) have examined that in order to promote student engagement in gaming process and in order to analyze effects on game performance and student

learning outcome, the concept of flow is harnessed as a framework. Frequency 1550 is a game about medieval Amsterdam merging digital and urban play game environment.It has been investigated as a model of game-based learning. In Amsterdam, 216 students of three secondary school play that 1-day game in teams. Despite solving problems in technology and navigation disturb students, they indicate mostly continuity in their game activities. Continuity have an an effect on students' game performance, on the other hand it does not have any effect on their learning outcome. The learning outcome of students is effected by distractive activities and competition between teams: a few students are disturbed from the game and most of the students participate in group competition, and learn about the medieval history of Amsterdam. The results of game-based learning design in secondary education have been argued.

A game-based learning implementation in teaching requirements collection and exploration at tertiary education grade has been improved by Hainey et al. (2011). Games-based learning has been a rapidly expanding area and it is a highly motivating, engaging design of media. From a pedagogical aspect, especially the evaluation of the requirements collection and analysis game are identified. To evaluate whether the game can role as an appropriate complement, traditional methods of software engineering education are applied. In comparison this to evaluate whether the game can handle deficiency, traditional techniques are used.

The specially designed digital games' efficiciency on student satisfaction and measurable academic performance has been examined by Kanthan et al. (2011). One hundred fourteen students of first-year pathology Medicine 102 apply specially designed content-relevant digital games in 8 of 16 lecture sessions.Relevant content sessions' performance scores are examined at midterm and final examinations. 114 first-year students get the highest success rate in midterm and final examinations which have questions related to the game-play sessions. The examination scores of the final examination are notably higher than the midterm examination scores among the 71 second-year student. Enhanced student engagement, increased personal learning and decreased student stress have been marked by positive satisfaction questionnaire. Examination results with enhanced student engagement and satisfaction evaluate

developed academic performance.This fact has been shown in specially constructed digital games-based learning in undergraduate pathology courses.

Hwang et al. (2012) has developed the model of a competitive online board game for managing web-based problem-solving activities. The players throw a dice so they decide their move. Every section of the game board has a gaming task. Every task may have a web-based information-searching question or a mini-game. A web-based information-searching question has been applied to help the participants to find information to reply questions about the target learning issue. Whereas mini-game has been applied to supply extra materials in the gaming process. An experiment has been done in natural science course at an elementary school for assessing the performance of target approach. The empirical findings have indicated that the target approach remarkably enhance the technology acceptance degree, the flow experience, learning interest, learning attitudes of the students. And also, target approach has developed learning achievements in the web-based problem-solving activity.

Chang et al. (2012) has developed a problem-posing system with four phases (posing problem, planning, solving problem, and looking back). Game-scenarios have implemented the "solving problem" phase in the system. The system encourages elementary students in problem-posing. It lets students entirely take part in mathematical activities. Totally, 92 students from 4 different classes at 5^{th} grades are ivolved into the experiment. The experimental group applies the problem-posing system, but the control group applies the traditional approach (paper - based). The effects of the problem-posing system on problem-solving ability, flow experiences and problem-posing ability of students have been investigated by the study. The experimental group results have more problem-posing abilities, higher problem-solving and flow experiences.

By considering game characteristics, Hung et al. (2012) have suggested a cognitive analysis approach to develop spatial learning tools. Furthermore, the validation of the cognitive components of the spatial sense test for constructing two different kinds of intervention has been verified, and the effects of the interventions have been compared.

In an elementary school an experiment is done on the maths course for evaluating the performance of the target approach. The empirical findings have indicated that the spatial learning enhances the learning achievement, as well as the students' spatial sense.

A digital game which has an educational aim in the computer programming subject has been described by Moreno et al. (2012). The game provides students opportunity to strengthen and develop their abilities on defined iteration, nesting and sequencing concepts. In this design, a problem solving approach is used and a score comparing mechanism is applied so that students can have courage to examine their solutions and search better solutions. For validation of the game, a study is made with 123 students, which indicate students' interest on the approach and its educational effectiveness.

Papastergiou (2009) has evaluated a computer game's learning effectiveness and motivational appeal. This game is about learning computer memory concepts and is formed according to the Greek high school Computer Science (CS) curriculum's subject matter and the curricular objectives. Taking a similar application into consideration, the game has identical learning objectives and content but it does not involve the gaming aspect. In game's learning effectiveness and motivational appeal, potential gender differences are also examined. Data analyses have indicated that in contrast to the non-gaming approach, the gaming approach is more motivational and more effective in enhancing students' knowledge of computer memory concepts. Despite boys are considered to have more involvement, more experience in computer gaming, and have more initial computer memory knowledge than girls, boys and girls achieve the same learning gains while using the game, and boys and girls have equal motivation in the game process. The findings have suggested that educational computer games can be used as effective and motivational learning environments within high school CS without regarding gender of students.

The effectiveness of digital game-based learning (DGBL) on academic achievement, problem solving and learning motivation of students has been searched by Yang et al. (2012). A quasi-experimental design is applied during the course of a full semester to

get substantive empirical evidence. Two ninth-grade Civics and Society classes including 44 students (15–16 years old) in total, are randomly recruited as a comparison group (taught using traditional instruction) and an experimental group (incorporating DGBL). The findings of this study are as follows: (1) In enhancing problem solving skills of students, the DGBL strategy has clear effect whereas the control group has no improvement. In Addition, the mid-test and post-test data have showed that, problem-solving as a higher order thinking skill needs a full semester to improve. (2).In the experimental group, students have better learning motivation through DGBL than students exposed TI as control group. (3) It is not found that there are certain difference between two groups in contrast to proposals that academic achievement can be inhibited by the digital games. The evaluation of cognitive domain's other higher order elements with the aspects of academic achievement skills and outcomes, like creative and ciritical thinking should be emphasized by future research about DGBL.

In previous studies it is shown that student motivation and satisfaction, academic performance/learning outcomes are improved by DGBL. On the other hand, Prensky and some researchers (2007) have discussed that a balance between educational value and fun must be accomplished by an effective game based learning design and it must also depend on national curriculum and must have instructional and psychological theories. Moreover, the differences may occur between students from different countries and these can enhance students' achievement in a digital game on multiple contexts.(Lee & Luykx, 2007).

As a result, this paper aims to demonstrate the effects of digital game based learning on performance for high school students in computer science education.

3. METHODS

3.1 RESEARCH DESIGN

This chapter describes the research methodology used in answering the research question. This study is experimental design to analyse student performance in motivation as well as their achievement in flow diagrams. The course provides algorithm development using Visual Programming.

In this study, we compare two learning methodology, traditional learning and DGBL with respect to their effect on student motivation and learning achievement. The research tools include the Learning Achievement Tests (LAT) and The Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich et al., 1991)

The students are participated into two groups in this study, one of which learned with gaming application (Group A) and the other one learned with traditional learning (Group B). Group A is assigned as experimental group and Group B is assigned as control group. The study follows a pretest/posttest experimental design, taking before and after measures of each group, in order to explore the effects of student motivation and learning achievement. The pre-test questionnaire consists two parts, biographical data (frequency of computer use, frequency of computer gaming, liking of computer games, computer experience and computer gaming experience) and MSLQ. The post-test includes LAT and MSLQ. LAT is developed by two experienced teachers. It consists of ten multiple-choice items with a top score of 100.

The research hypotheses for the main research questions as follows:

H_1- There are significant differences in learning achievements between Group A and Group B

H_2- There are significant differences in student motivations between Group A and Group B

The research hypotheses for the second research questions as follows:

H_3- There are significant differences between frequency of computer use and learning achievements.

H_4- There are significant differences between frequency of computer use and student motivations.

H_5- There are significant differences between frequency of computer gaming and learning achievements.

H_6- There are significant differences between frequency of computer gaming and student motivations.

H_7- There are significant differences between liking of computer games and learning achievements.

H_8- There are significant differences between liking of computer games and student motivations.

H_9- There are significant differences between computer experience and learning achievements.

H_{10}- There are significant differences between computer experience and student motivations.

H_{11}- There are significant differences between computer gaming experience and learning achievements.

H_{12}- There are significant differences between computer gaming experience and student motivations.

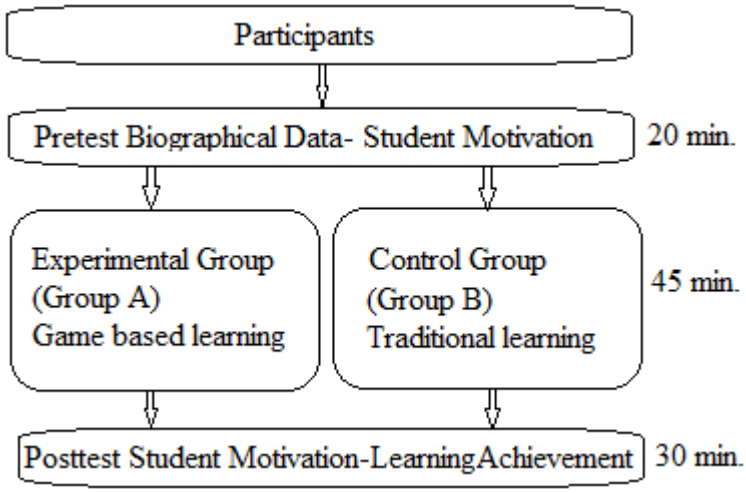
3.2. PROCEDURE

This study is conducted for two weeks school-periods from May 2013. Group A experiences the study in four labs which have 20-desktop in each for the duration of the project. Group B is traditional class. Generally, the course –period at high school is 45-50 minutes.

At first the students in Group A answer the pre-test, reply the pre-test in 15 minutes at laboratory. The explanation is given about procedure by the instructor. And then the game is played for 45 minutes. The students who complete the game reply the post-test in 15 minutes. Meanwhile, the students in Group B attend the traditional class. After

pre-test is replied in 15 minutes, the instructor teaches the course traditionally. Then pre-test is replied by the students as shown in Figure 3.1.

Figure 3.1: Diagram of experiment design



3.3 PARTICIPANTS

The population of the study is tenth grade students in high school. The participants of this study are 152 students, 22 girls and 130 boys, aged 15-17 in a vocational high school in Istanbul, who are enrolled in the Programming Fundamentals Course. The students are randomly selected. Group A includes 75 students (15 girls and 60 boys) and Group B includes 77 students (7 girls and 71 boys) as shown in Figure 3.2. They have been taught the same subject matter relevant to Programming Fundamentals according to the Turkish Scholastic Computer Science (CS) curriculum. All of the students are taught by the same instructor who has taught that Programming Fundamentals Course for more than six years.

3.4 INDEPENDENT AND DEPENDENT VARIABLES

In this study, the independent variable is instructional strategy (ie, Traditional Learning vs. DGBL). While the Group A learns entirely through DGBL, the Group B students are taught using Traditional Learning.

Student motivation and Learning Achievement measured by MSLQ and LAT are the dependent variables. The research design of the study is illustrated in Figure 3.3.

Figure 3.2: Participants

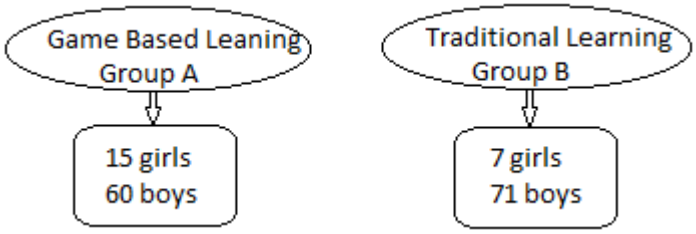
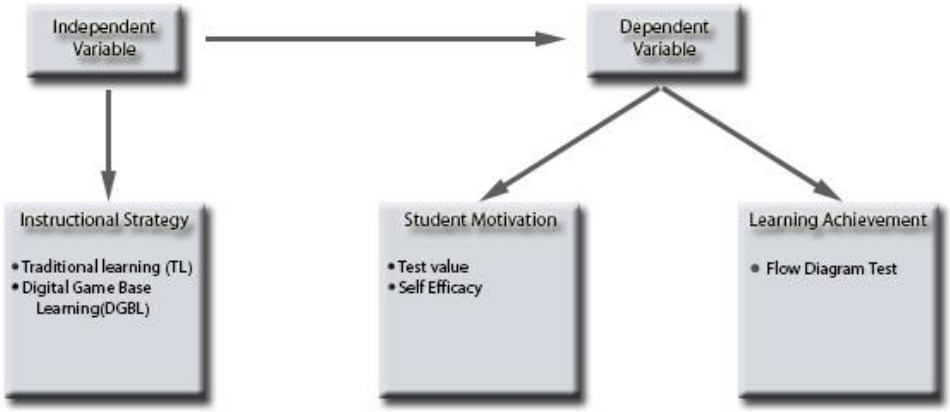


Figure 3.3: Independent and dependent variables



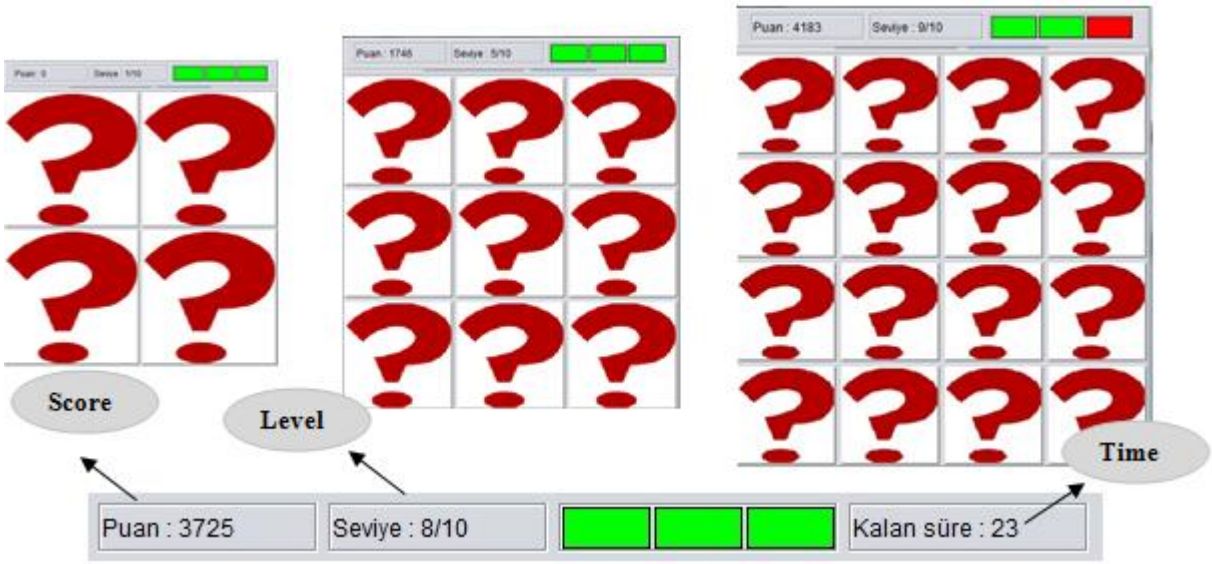
3.5 MATERIALS

3.5.1 Gaming Application

Match Game has been designed by using Java Programming Language. The game is a desktop based application. The aim of this game is learning flow diagrams. Graphical interface has been designed according to students familiar items such as pictures and colours. The game level has been developed in 10 levels and levels' difficulty increased with acceleration. The more the level has been completed, the more numbers of picture that students can match increase (Figure 3.3). Pictures are randomly choosen by the programme in each game. Three health points are given in games. When the students

complete the level in a shorter time, they can get more scores and vice versa. If the level is not completed in a definite time, one health point will be decreased. The game has no discouraging difficulty, beside this, it is designed to enhance students' desire to achieve. The desktop or laptop can be used in the game. The features of computer that used have to be appropriate with the features of the computers that used in school laboratory in Turkey. The game can have better solutions in computers which have sophisticated graphic card and processor. Each student should have a computer for the game.

Figure 3.4: Levels of match game



3.5.2. Traditional Learning

Traditional learning has been applied to Group B. Traditional Learning is implemented in classical classroom order according to Turkish Programming Fundamentals Course Curriculum by teacher. Blackboard has been used by teacher while lecturing. Students have been seated according to seating plan to be able to see the blackboard clearly. Identified source in curriculum has been taught to students. The timing has been determined as 45 minutes. The teacher who has taught traditional learning is professional and has been lecturing this course for 6 years.

3.6. INSTRUMENTS

3.6.1 Pretest -Posttest: student motivation inventory

Student motivation has been measured by MSLQ. The motivation section has consisted of 31 items and has three components divided into six subscales: intrinsic goal orientation; extrinsic goal orientation; task value; control of learning beliefs; self-efficacy for learning and performance, and text anxiety. The present study only has selected two components measured by 9 items on a 5-point scale ranging from 'strongly disagree' (1), 'strongly agree' (5) of the motivation scales: intrinsic goal orientation, extrinsic goal orientation as shown in Table 3.1. The post-test measure of student motivation has consisted of similar items as the pre-test questionnaire. These items have been reformulated to assess the students' intrinsic and extrinsic motivation.

The average difference between pre- and post- test total scores of value components intrinsic goal orientation, extrinsic goal orientation, has been used as an independent and a dependent variable. This study uses Cronbach's alpha value to verify the reliability standard of the questionnaire. As can be seen in Table 3.2 and Table 3.3, the corrected item total correlations for each pre- and post-test scale are satisfactory, as also the internal consistency (Cronbach's alpha) of all intrinsic and extrinsic motivation scales. The Cronbach's alpha values of the pre-test and post-test are 0,813 and 0,848.

3.6.2 Posttest: learning achievement inventory

The test has been harnessed to measure the academic achievement of students. The test has been designed to evaluate whether the students totally comprehend the subject or not. The test consists of 10 questions and each question has 10 points. The top score of the test is 100 points and students have been evaluated according to this grade. Multiple choice test technique has been implemented. Each question and its answer have been expressed definitely. The questions have been prepared by two 6 year- experienced teachers.

Table 3.1: The intrinsic and extrinsic goal orientation questionnaire

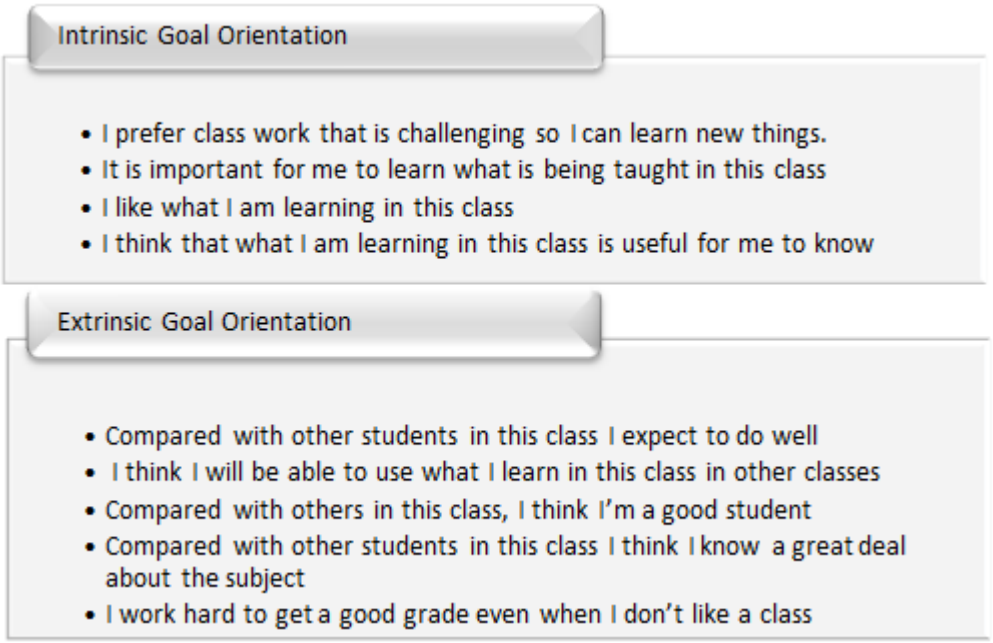


Table 3.2 Reliability statistics for pretest

Cronbach's Alpha	N of Items
,813	9

Table 3.3 Reliability statistics for posttest

Cronbach's Alpha	N of Items
,848	9

3.7. Data Analysis

The study has run the pre-test, post-test and flow diagram test data for the quantitative research questions with Independent-Samples T-Test, ANCOVA and One-way ANOVA in IBM SPSS Statistics 19.0 for both descriptive and statistical analysis. The descriptive analysis has taken account of standard deviation, mean scores, variance, standard error mean scores, range, minimum scores, maximum scores, and biographical data (i.e., number of students, gender, grade levels, frequency of computer use,

frequency of computer gaming, liking of computer games, computer experience and computer gaming experience).

One of the objectives of this study is to examine the effectiveness of the educational approach in terms of improving the learning achievement of the students. Independent-Samples T-Test has been used to analyse the difference between the academic achievement of the two groups by using the flow diagram test as test variable and Group A-Group B (group variables) as independent variables.

The motivations of the students obtained by the MSLQ have been analyzed so that we can gain a complete understanding of the effect of the simulation game on the students' motivations. Student motivation includes intrinsic and extrinsic motivations. More specifically, the student motivations associated with the traditional lectures and in the digital game approach have been compared with using Analysis of covariance (ANCOVA). ANCOVA has been used to exclude the difference between the prior knowledge of the two groups by using the pre-test scores as the covariate and post-test scores as dependent variables.

The biographical and flow diagram test variables of the study have been used to investigate potential initial differences between learning achievement and frequency of computer use. One-way between-groups analyses of variance (ANOVAs) have compared learning achievement and frequency of computer use. In this analysis, dependent variable is frequency of computer use and it is related with learning achievement. By using the same way, H_5, H_7, H_9 and H_{11} have been analysed with one-way ANOVA.

To examine the differences between post-test scores on student motivation and frequency of computer use, analyses of covariance (ANCOVA) have been performed with the pre-test scores as covariates. By using the same way, H_6, H_8, H_{10} and H_{12} have been analysed with ANCOVA.

4. EXPERIMENTAL RESULTS

In this chapter, the results from analysis which has been done against the hypothesis defined in introduction have been discussed. The accuracy of examined hypothesis has been argued.

4.1 THE DIFFERENCE IN LEARNING ACHIEVEMENTS BETWEEN GROUP A AND GROUP B

Is there a statistically significant difference between groups' learning achievements during experimental process (DGBL and traditional learning)? This question is the main research question. The learning achievement scores in the main research question have shown the scores which have been taken from the flow diagram applied to DGBL and traditional learning groups.

The result of Independent-Sample T-Test analysis has been shown in Table 4.1. According to the result of analysis, the DGBL mean scores (84.53) are higher than traditional learning mean scores (74.54). And there is a significant difference between Group A and Group B (p=0.000).

Table 4.1: T-test result of learning achievement between Group A and Group B

Group	N	Mean	SS	Sd	t	p
Group A	75	84.53	13.78	150	3.84	.000
Group B	77	74.54	17.95			

p<.05

These findings have shown that DGBL approach increases student academic achievement in compared to traditional approach. DGBL approach's balance between fun and educational value is thougt as the reason of high academic achievement (Prensky, 2007). Some of the previous researches support this finding (Papastergiou M. , 2010, Kim et al., 2010, Kanthan et al., 2011, Hwang et al. 2012, Hung et al., 2012)

4.2 THE DIFFERENCE IN STUDENT MOTIVATION BETWEEN GROUP A AND GROUP B

Is there a statistically significant difference between students' motivation during experimental process (DGBL and traditional learning)? This question is the second research question. The motivation scores have been investigated in two categories as intrinsic motivation and extrinsic motivation. The scores of intrinsic and extrinsic motivation have shown the scores which have been taken from MSLQ test applied to students.

The result of ANCOVA on student intrinsic motivation has been shown in Table 4.2. According to the result of analysis, compared the two groups as pre-test score F=0.02, p=.882 has been found. And there is no significant difference between Group A and Group B (p <0,05). According to another result of analysis, the difference between groups has been found as F=63.82, p=.000. There is a significant difference between Group A and Group B (p <0,05). This difference supports DGBL approach (p=0.000).

Table 4.2: Results of ANCOVA on student intrinsic motivation

Source	Sum of Squares	df	Mean Square	F	p
Corrected Model	39,18	2	19,59	39,16	,000
Intercept	34,59	1	34,53	69,04	,000
Pre_in	,011	1	,011	,02	,882
Groups	31,92	1	31,92	63,82	,000
Error	74,53	149	,500		
Total	2488,06	152			
Corrected Total	113,71	151			

p<.05

The result of ANCOVA on student extrinsic motivation has been shown in Table 4.3. According to the result of analysis, compared the two groups as pre-test score F=2.84, p=.094 has been found. And there is no significant difference between Group A and Group B (p>0,05). According to another result of analysis, the difference between

groups has been found as F=159,52, p=.000. There is a significant difference between Group A and Group B (p <0,05). This difference supports DGBL approach (p=0.000).

Table 4.3: Results of ANCOVA on student extrinsic motivation

Source	Sum of Squares	df	Mean Square	F	p
Corrected Model	82,57	2	41,28	82,43	,000
Intercept	99,95	1	99,95	199,57	,000
Pre_ex	1,42	1	1,42	2,84	,094
Groups	79,89	1	79,89	159,52	,000
Error	74,62	149	,501		
Total	2267,79	152			
Corrected Total	157,20	151			

p<.05

These findings have shown that DGBL approach effects positively students' intrinsic and extrinsic motivation in compared to traditional approach. DGBL approach attracts students' attention and reinforces students' achievement. So, this fact is thougt as the reason of the positive effects on students' intrinsic and extrinsic motivation. Some of the previous researches support this finding (Tsai et al., 2012, Liu et al., 2011, Connoly et al., 2011, Tsai et al., 2011).

4.3 THE DIFFERENCE BETWEEN FREQUENCY OF COMPUTER USE AND LEARNING ACHIEVEMENTS

Is there a statistically significant difference between frequency of computer use and learning achievements in DGBL approach? This question is the third research question. The result of one-way ANOVA has been shown in Table 4.4. According to the result of analysis, F=2.61, p=0.043 has been found. And there is a significant difference between frequency of computer use and learning achievements in DGBL approach (p <0,05).

Table 4.4: The result of one-way ANOVA between frequency of computer use and learning achievement

	Sum of Squares	df	Mean Square	F	p
Between Groups	1774,66	4	443,66	2,610	,043
Within Groups	11900,00	70	170,00		
Total	13674,67	74			

p<.05

These findings have shown that the learning achievement is higher in students who use computer frequently in DGBL than students who don't use so frequently. The easy adaptation of students who willingly spend a lot of time on computer and because of this comprehending the game immediately are shown as the reason of higher learning achievement.

4.4 THE DIFFERENCE BETWEEN FREQUENCY OF COMPUTER USE AND STUDENT MOTIVATIONS

Is there a statistically significant difference between frequency of computer use and student motivation in DGBL approach? This question is the fourth research question. The motivation scores have been investigated in two categories as intrinsic motivation and extrinsic motivation.

The result of ANCOVA on student intrinsic motivation has been shown in Table 4.5. According to the result of analysis, compared pre-test scores and post-test scores F=10.16, p=.002 has been found. And there is a significant difference between pre-test scores and student intrinsic motivation ($p < 0,05$). According to another result of analysis, the difference between frequency of computer use and student intrinsic motivation has been found as F=0.07, p=.935. There is no significant difference between students' frequency of computer use and intrinsic motivation ($p > 0.05$).

Table 4.5: Result of ANCOVA between frequency of computer use and student intrinsic motivation

Source	Sum of Squares	df	Mean Square	F	p
Corrected Model	7,34	3	2,45	3,40	,019
Intercept	13,25	1	13,25	18,44	,000
Pre_in	7,30	1	7,30	10,16	,002
FrequencyofComputerUse	,097	2	,049	,07	,935
Error	106,36	148	,719		
Total	2488,06	152			
Corrected Total	113,71	151			

p<.05

The result of ANCOVA on student extrinsic motivation has been shown in Table 4.6. According to the result of analysis, compared pre-test score and post-test scores F=2.36, p=.126 has been found. And there is no significant difference between pre-test scores and student extrinsic motivation (p>0,05). According to another result of analysis, the difference between frequency of computer use and student extrinsic motivation has been found F=0.30, p=.741. There is no significant difference between frequency of computer use and student extrinsic motivation.

Table 4.6: Result of ANCOVA between frequency of computer use and student extrinsic motivation

Source	Sum of Squares	df	Mean Square	F	p
Corrected Model	3,30	3	1,10	1,05	,369
Intercept	69,75	1	69,75	67,08	,000
Pre_ex	2,45	1	2,45	2,36	,126
FrequencyofComputerUse	,624	2	,312	,30	,741
Error	153,90	148	1,04		
Total	2267,79	152			
Corrected Total	157,20	151			

p<.05

These findings have shown that there is no effect on intrinsic and extrinsic motivation of students who use computer more frequently in DGBL approach.

4.5 THE DIFFERENCE BETWEEN FREQUENCY OF COMPUTER GAMING AND LEARNING ACHIEVEMENTS

Is there a statistically significant difference between frequency of computer gaming and learning achievements in DGBL approach? This question is the fifth research question. The result of one-way ANOVA has been shown in Table 4.7. According to the result of analysis, F=1.09, p=0.357 has been found. And there is no significant difference between frequency of computer gaming and learning achievements in DGBL approach (p >0,05).

Table 4.7: The result of one-way ANOVA between frequency of computer gaming and learning achievement

	Sum of Squares	df	Mean Square	F	p
Between Groups	604,19	3	201,39	1,09	,357
Within Groups	13070,47	71	184,09		
Total	13674,66	74			

p<.05

These findings have shown that the learning achievement of students who play computer game more frequently is not different from other students in DGBL approach and the findings have also shown that the homogeneity of learning achievement scores is approximately equal for students who play computer games.

4.6 THE DIFFERENCE BETWEEN FREQUENCY OF COMPUTER GAMING AND STUDENT MOTIVATIONS

Is there a statistically significant difference between frequency of computer gaming and student motivation in DGBL approach? This question is the sixth research question. The motivation scores have been investigated in two categories as intrinsic motivation and extrinsic motivation.

The result of ANCOVA on student intrinsic motivation has been shown in Table 4.8. According to the result of analysis, compared pre-test scores and post-test scores F=8.69, p=.004 has been found. And there is a significant difference between pre-test scores and student intrinsic motivation ($p < 0,05$). According to another result of analysis, the difference between frequency of computer gaming and student intrinsic motivation has been found as F=1.03, p=.377. There is no significant difference between students' frequency of computer gaming and intrinsic motivation ($p >0,05$).

Table 4.8: Result of ANCOVA between frequency of computer gaming and student intrinsic motivation

Source	Sum of Squares	df	Mean Square	F	p
Corrected Model	9,46	4	2,36	3,33	,012
Intercept	16,51	1	16,51	23,29	,000
Pre_in	6,16	1	6,16	8,69	,004
FrequencyofComputerGaming	2,21	3	,737	1,03	,377
Error	104,25	147	,709		
Total	2488,06	152			
Corrected Total	113,71	151			

p<.05

These findings have shown that there is no effect on intrinsic motivation of students who play computer games more frequently in DGBL approach.

The result of ANCOVA on student extrinsic motivation has been shown in Table 4.9. According to the result of analysis, compared pre-test score and post-test scores F=3.30, p=.071 has been found. And there is no significant difference between pre-test scores and student extrinsic motivation (p>0,05). According to another result of analysis, the difference between frequency of computer gaming and student extrinsic motivation has been found F=2.95, p=.034. There is a significant difference between frequency of computer gaming and student extrinsic motivation (p<0,05).

Table 4.9: Result of ANCOVA between frequency of computer gaming and student extrinsic motivation

Source	Sum of Squares	df	Mean Square	F	p
Corrected Model	11,47	4	2,87	2,89	,024
Intercept	92,99	1	92,99	93,80	,000
Pre_ex	3,27	1	3,27	3,30	,071
FrequencyofComputerGaming	8,80	3	2,93	2,95	,034
Error	145,72	147	,991		
Total	2267,79	152			
Corrected Total	157,20	151			

p<.05

These findings have shown that there is more effect on extrinsic motivation of students who play computer games more frequently in DGBL approach. The effection of students' willingness to get high score between each other is thought as the reason of this finding.

4.7 THE DIFFERENCE BETWEEN LIKING OF COMPUTER GAMES AND LEARNING ACHIEVEMENTS

Is there a statistically significant difference between liking of computer games and learning achievements in DGBL approach? This question is the seventh research question. The result of one-way ANOVA has been shown in Table 4.10. According to

the result of analysis, F=9.14, p=0.000 has been found. And there is a significant difference between liking of computer games and learning achievements in DGBL approach (p <0,05).

Table 4.10: The result of one-way ANOVA between liking of computer games and learning achievement

	Sum of Squares	df	Mean Square	F	p
Between Groups	4692,68	4	1173,17	9,14	,000
Within Groups	8981,98	70	128,31		
Total	13674,66	74			

p<.05

These findings have shown that the learning achievement of students who are more willing to play computer game in DGBL approach is higher. Students' enjoyment in playing computer games and comprehending the game more efficiently are thought as the reason of higher learning achievement.

4.8 THE DIFFERENCE BETWEEN LIKING OF COMPUTER GAMES AND STUDENT MOTIVATIONS

Is there a statistically significant difference between liking of computer games and student motivation in DGBL approach? This question is the eighth research question. The motivation scores have been investigated in two categories as intrinsic motivation and extrinsic motivation.

The result of ANCOVA on student intrinsic motivation has been shown in Table 4.11. According to the result of analysis, compared pre-test scores and post-test scores F=9.52, p=.002 has been found. And there is a significant difference between pre-test scores and student intrinsic motivation (p < 0,05). According to another result of analysis, the difference between liking of computer games and student intrinsic motivation has been found as F=1.30, p=.270. There is no significant difference between students' liking of computer games and intrinsic motivation (p >0,05).

Table 4.11: Result of ANCOVA between liking of computer games and student intrinsic motivation

Source	Sum of Squares	df	Mean Square	F	p
Corrected Model	10,93	5	2,18	3,10	,011
Intercept	14,93	1	14,93	21,21	,000
Pre_in	6,70	1	6,70	9,52	,002
LikingofComputerGames	3,68	4	,920	1,30	,270
Error	102,78	146	,704		
Total	2488,06	152			
Corrected Total	113,71	151			

p<.05

The result of ANCOVA on student extrinsic motivation has been shown in Table 4.12. According to the result of analysis, compared pre-test score and post-test scores F=2.89, p=.091 has been found. And there is no significant difference between pre-test scores and student extrinsic motivation (p>0,05). According to another result of analysis, the difference between liking of computer games and student extrinsic motivation has been found F=1.46, p=.216. There is no significant difference between liking of computer games and student extrinsic motivation (p>0,05).

Table 4.12: Result of ANCOVA between liking of computer games and student extrinsic motivation

Source	Sum of Squares	df	Mean Square	F	p
Corrected Model	8,64	5	1,72	1,69	,139
Intercept	82,83	1	82,83	81,40	,000
Pre_ex	2,94	1	2,94	2,89	,091
LikingofComputerGames	5,96	4	1,49	1,46	,216
Error	148,56	146	1,01		
Total	2267,79	152			
Corrected Total	157,20	151			

p<.05

These findings have shown that there is no effect on intrinsic and extrinsic motivation of students who like playing computer games in DGBL approach.

4.9 THE DIFFERENCE BETWEEN COMPUTER EXPERIENCE AND LEARNING ACHIEVEMENTS

Is there a statistically significant difference between computer experience and learning achievements in DGBL approach? This question is the nineth research question. The result of one-way ANOVA has been shown in Table 4.13. According to the result of analysis, F=3.63, p=0.010 has been found. And there is a significant difference between computer experience and learning achievements in DGBL approach (p <0,05).

Table 4.13: The result of one-way ANOVA between computer experience and learning achievement

	Sum of Squares	df	Mean Square	F	p
Between Groups	2349,53	4	587,38	3,63	,010
Within Groups	11325,12	70	161,78		
Total	13674,66	74			

p<.05

These findings have shown that the learning achievement of students who have more computer experience in DGBL approach is higher. Computer experienced students' having more adaptation to learn with using computer is thought as the reason of higher learning achievement.

4.10 THE DIFFERENCE BETWEEN COMPUTER EXPERIENCE AND STUDENT MOTIVATIONS

Is there a statistically significant difference between computer experience and student motivation in DGBL approach? This question is the tenth research question. The

motivation scores have been investigated in two categories as intrinsic motivation and extrinsic motivation.

The result of ANCOVA on student intrinsic motivation has been shown in Table 4.14. According to the result of analysis, compared pre-test scores and post-test scores F=9.87, p=.002 has been found. And there is a significant difference between pre-test scores and student intrinsic motivation (p < 0,05). According to another result of analysis, the difference between computer experience and student intrinsic motivation has been found as F=0.881, p=.477. There is no significant difference between students' computer experience and intrinsic motivation (p >0,05).

Table 4.14: Result of ANCOVA between computer experience and student intrinsic motivation

Source	Sum of Squares	df	Mean Square	F	p
Corrected Model	9,76	5	1,95	2,74	,021
Intercept	13,34	1	13,34	18,74	,000
Pre_in	7,03	1	7,03	9,87	,002
ComputerExperience	2,51	4	,628	,881	,477
Error	103,95	146	,712		
Total	2488,06	152			
Corrected Total	113,71	151			

p<.05

The result of ANCOVA on student extrinsic motivation has been shown in Table 4.15. According to the result of analysis, compared pre-test score and post-test scores F=1.91, p=.168 has been found. And there is no significant difference between pre-test scores and student extrinsic motivation (p>0,05). According to another result of analysis, the difference between computer experience and student extrinsic motivation has been found F=0.813, p=.519. There is no significant difference between computer experience and student extrinsic motivation (p>0,05).

Table 4.15: Result of ANCOVA between computer experience and student extrinsic motivation

Source	Sum of Squares	df	Mean Square	F	p
Corrected Model	6,04	5	1,20	1,16	,328
Intercept	80,66	1	80,66	77,90	,000
Pre_ex	1,98	1	1,985	1,91	,168
ComputerExperience	3,36	4	,842	,813	,519
Error	151,16	146	1,03		
Total	2267,79	152			
Corrected Total	157,20	151			

p<.05

These findings have shown that there is no effect on intrinsic and extrinsic motivation of students who have computer experience in DGBL approach.

4.11 THE DIFFERENCE BETWEEN COMPUTER GAMING EXPERIENCE AND LEARNING ACHIEVEMENTS

Is there a statistically significant difference between computer gaming experience and learning achievements in DGBL approach? This question is the eleventh research question. The result of one-way ANOVA has been shown in Table 4.16. According to the result of analysis, F=4.23, p=0.004 has been found. And there is a significant difference between computer gaming experience and learning achievements in DGBL approach (p <0,05).

Table 4.16: The result of one-way ANOVA between computer gaming experience and learning achievement

	Sum of Squares	df	Mean Square	F	p
Between Groups	2662,13	4	665,53	4,23	,004
Within Groups	11012,53	70	157,32		
Total	13674,66	74			

p<.05

These findings have shown that the learning achievement of students who have more computer gaming experience in DGBL approach is higher. Computer gaming experienced students' reaching the goal of game faster, finding easier ways to comprehend the game and adapting this stiation to learn with computer are thought as the reason of higher learning achievement.

4.12 THE DIFFERENCE BETWEEN COMPUTER GAMING EXPERIENCE AND STUDENT MOTIVATIONS

Is there a statistically significant difference between computer gaming experience and student motivation in DGBL approach? This question is the twelveth research question. The motivation scores have been investigated in two categories as intrinsic motivation and extrinsic motivation.

The result of ANCOVA on student intrinsic motivation has been shown in Table 4.17. According to the result of analysis, compared pre-test scores and post-test scores F=8.88, p=.003 has been found. And there is a significant difference between pre-test scores and student intrinsic motivation ($p < 0,05$). According to another result of analysis, the difference between computer gaming experience and student intrinsic motivation has been found as F=0.418, p=.795. There is no significant difference between students' computer gaming experience and intrinsic motivation ($p >0,05$).

Table 4.17: Result of ANCOVA between computer gaming experience and student intrinsic motivation

Source	Sum of Squares	df	Mean Square	F	p
Corrected Model	8,45	5	1,69	2,34	,044
Intercept	15,49	1	15,49	21,48	,000
Pre_in	6,40	1	6,40	8,88	,003
ComputerGamingExperience	1,20	4	,302	,418	,795
Error	105,25	146	,721		
Total	2488,06	152			
Corrected Total	113,71	151			

p<.05

The result of ANCOVA on student extrinsic motivation has been shown in Table 4.18. According to the result of analysis, compared pre-test score and post-test scores F=2.03, p=.156 has been found. And there is no significant difference between pre-test scores and student extrinsic motivation (p>0,05). According to another result of analysis, the difference between computer gaming experience and student extrinsic motivation has been found F=0.742, p=.565. There is no significant difference between computer gaming experience and student extrinsic motivation (p>0,05).

Table 4.18: Result of ANCOVA between computer gaming experience and student extrinsic motivation

Source	Sum of Squares	df	Mean Square	F	p
Corrected Model	5,75	5	1,15	1,11	,358
Intercept	93,32	1	93,32	89,96	,000
Pre_ex	2,11	1	2,11	2,03	,156
ComputerGamingExperience	3,07	4	,770	,742	,565
Error	151,44	146	1,037		
Total	2267,79	152			
Corrected Total	157,20	151			

$p<.05$

These findings have shown that there is no effect on intrinsic and extrinsic motivation of students who have computer gaming experience in DGBL approach.

5. DISCUSSION

In this chapter, the experimental results are summarized, starting with a discussion of findings for the hypotheses. This study is designed to investigate the effects of digital game based learning on performance and motivation. Outline of the findings is shown in Table 5.1.

Table 5.1: Outline of the findings

h1	learning achievements between group a and group b	✓
h2	student motivation between group a and group b	✓
h3	frequency of computer use and learning achievements	✓
h4	frequency of computer use and student motivations	✗
h5	frequency of computer gaming and learning achievements	✗
h6	frequency of computer gaming and intrinsic motivations	✗
	frequency of computer gaming and extrinsic motivations	✓
h7	liking of computer games and learning achievements	✓
h8	liking of computer games and student motivations	✗
h9	computer experience and learning achievements	✓
h10	computer experience and student motivations	✗
h11	computer gaming experience and learning achievements	✓
h12	computer gaming experience and student motivations	✗

Although it seems that it cannot be reached to the expected results in so many hypothesis which are defined at the chart below, in this study, first and second hypothesis are determined as the most important ones. The reason of this is comparing of DGBL and traditional learning approaches. The aim of this study is comparing these two learning approaches. Hereunder, the students (the group) who learn according to DGBL Approach have high academic performance and student motivation. The studies done before have supported these facts. (Papastergiou M., 2010, Kim et al., 2010, Kanthan et al., 2011, Hwang et al. 2012, Hung et al., 2012, Tsai et al., 2012, Liu et al., 2011, Connoly et al., 2011, Tsai et al., 2011). In the other hypothesis that defined, the students' biographical data (frequency of computer use, frequency of computer gaming,

liking of computer games, computer experience and computer gaming experience) in DGBL group is compared to learning achievement or student motivation. Other hypothesis highlight the studies that have been done at least as hypothesis 1 and 2. DGBL Approach presents an approach which is suitable with the education styles that have changed with the technology revolution in 21st century. This approach has taken attention to the students because of its visual and auditory facilities when it is compared to other approaches. At the same time, the games provide feedback to the students in very short time, so students can evaluate themselves. Digital game stikes a balance between education and fun. So DGBL approach has more advantages than traditional learning.

6. CONCLUSION AND SUGGESTIONS

This study gives information about the positive effects of DGBL on tenth grades students learning achievement and student motivation in contrast to Traditional Learning. Research data has been collected by applying pre and post-test that are implemented the students who are divided into two groups as experimental and control. This data has been analyzed with using T-test, ANOVA ve ANCOVA.It has been concluded that DGBL approach has improved students' learning achievement, intrinsic and extrinsic motivation. Some of the previous researches support this finding (Papastergiou M. , 2010, Kim et al., 2010, Kanthan et al., 2011, Hwang et al. 2012, Hung et al., 2012, Tsai et al., 2012, Liu et al., 2011, Connoly et al., 2011, Tsai et al., 2011). It can be suggested so many reasons about students' motivation and learning achievement. One of the reasons, as Oblinger (2004) says, can be claimed that designing game has been arranged as appropriate both multi-sensory, active, interactive, feedback immediately, improving self-assessment, extending different levels, sufficient information and fun. Other reason can be suggested that children willingly spend a lot of time, energy and have engagement, and also they get great pleasure from this experience (Rieber, Smith & Noah, 1998). Moreover, the game provides children both willingness and motivation in new ways in order to learn. (Prensky, 2007, Pivec, 2007) Also digital games let the educational paradigm change over from teaching-centered to learner-centered classrooms**.** Besides this, the fact that although the frequency of computer use, liking of computer games, computer experience and computer gaming experience have no positive effects on students' motivation, frequency of computer use, liking of computer games, computer experience and computer gaming experience have positive effects on learning achievement of students has been observed. The positive effects of frequency of computer gaming on students' learning achievement and students' motivation have been examined in DGBL approach.

Match game has been simply designed according to learning goal and curriculum and it has been applied in a short school term. It is a once time game because of the reason

that it has been designed to reach only a learning goal. The game has been formed as appropriate to the ARCS motivation model that is developed to enhance students' motivation. ARCS model identifies four main features as follows (Attention, Relevance, Confidence, and Satisfaction).These features have to provide people get and remain motivated (Keller, 1987).

The game has lack of sophisticated graphic design and sound effect. The game can be still an example for the future researches by means of the positive effects on both learning achievement and students' motivation. This study can be generalized only for the students aged 15-17 in Turkey in Computer Programming course. For the future research, the experiment process can be lasted to long term school period, the sophisticated graphical interface of the game can be designed, the content of the game can be developed as a game which can be played more than once. The amount of sex ratio in the groups can be equated. Also, it is taught that designing a game which has game environment that provides student interaction with each other has more positive effects on students' intrinsic and extrinsic motivation.

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