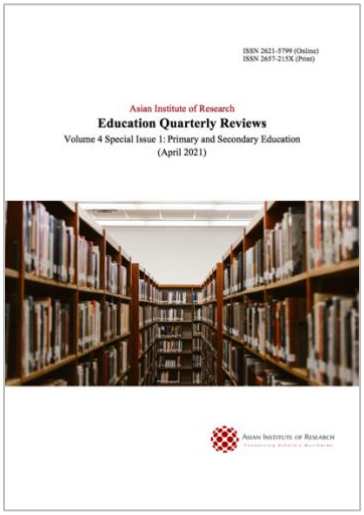

Education Quarterly Reviews

Bilgin, Enes Abdurrahman. (2021), A Mobile Educational Game Design for Eliminating Math Anxiety of Middle School Students. In: *Education Quarterly Reviews*, Vol.4 Special Issue 1: Primary and Secondary Education, 354-361.

ISSN 2621-5799

DOI: 10.31014/aior.1993.04.02.251

The online version of this article can be found at:
https://www.asianinstituteofresearch.org/

Published by:
The Asian Institute of Research

The Asian Institute of Research *Education Quarterly Reviews* is a peer-reviewed International Journal. The journal covers scholarly articles in the fields of education, linguistics, literature, educational theory, research, and methodologies, curriculum, elementary and secondary education, higher education, foreign language education, teaching and learning, teacher education, education of special groups, and other fields of study related to education. As the journal is Open Access, it ensures high visibility and the increase of citations for all research articles published. The *Education Quarterly Reviews* aims to facilitate scholarly work on recent theoretical and practical aspects of education.

ASIAN INSTITUTE OF RESEARCH
Connecting Scholars Worldwide

The Asian Institute of Research
Education Quarterly Reviews
Vol.4 Special Issue 1: Primary and Secondary Education, 2021: 354-361
ISSN 2621-5799

DOI: 10.31014/aior.1993.04.02.251

A Mobile Educational Game Design for Eliminating Math Anxiety of Middle School Students

Enes Abdurrahman Bilgin[1]

[1] Van Yuzuncu Yil University, Van, Turkey. ORCID: 0000-0003-3003-9259

Correspondence: Enes Abdurrahman Bilgin, Faculty of Education, Van Yuzuncu Yil University, Van, Tusba 65080, Turkey. E-mail: enesbilgin@yyu.edu.tr

Abstract
All over the world and especially in Turkey, the success level regarding math is well below the desired rate. The main reasons for this situation are negative attitudes and anxiety towards math. It is observed that the students and the teachers experience anxiety about the Arithmetic Operations, which is one of the beginning subjects of math. On the other hand, it is stated in the literature that educational games can be used to eliminate anxieties about math. In this context, an educational math game, which can be used on mobile devices, was tried to be developed in this study in order to reach more users. The product obtained as a result of this study, which was realized according to the design and development research method, was evaluated by 69 middle school students taking classes in city of Van in Turkey. In the evaluation, it was seen that the students gave positive opinions about the game developed. The students stated that they thought the application was highly interesting and could contribute to their math successes. After the evaluation process, the application was put into use around the world and it was installed on 6500 devices from 180 different countries in a three-month period. It was observed that the number of users who did not delete the game after installing and kept it on their device is 2735. Therefore, it is thought that the product developed as a result of the research can serve its purpose.

Keywords: Educational Game Software, Math Anxiety, Middle School Students, Mobile Learning

1. Introduction

Math is a tool used in all activities of life since it reveals human abilities and forms a systematic and logical mindset. So, individuals should have at least a basic knowledge of math (Bulut, 1994). However, the math knowledge of the students is generally not at the desired level. This level is even lower especially for Turkey. Turkey ranked third from the last in 2003 and second from the last in 2006 among the participating countries in The Program for International Student Assessment - PISA Report (Program for International Student Assessment) (Saban, 2019). Although there was a relative increase in the 2018 report, it was seen that Turkey was still below the average. On the other hand, the difficulties in teaching math are not a problem just for Turkey but also is seen as a common problem all over the world (Gokbulut, Sidekli & Sayar, 2013).

Although there are many different reasons why the students fail in math in general, the two most important variables to consider are math anxiety (Abebe, 2015) and negative attitudes towards math (Abebe, 2015; Baykul, 2009). However, math anxiety does not only cause failure in math class, but also prevents the gain of many necessary skills in a technology-based society (Zavlovsky, 1994). Therefore, the efforts to eliminate these anxieties have great importance. It is known that the anxiety especially on the arithmetic operations, which is one of the most fundamental topics of math, is present in a large part of the society. For example, Doruk and Kaplan (2013) reported that anxieties on arithmetic operations do not only exist in students but also in teacher candidates. Of course, this situation can lead to bigger problems. It is known that the teachers, who work at primary and secondary school levels and have math anxieties, transfer these anxieties to their students (Norwood, 1994; Baydar & Bulut, 2002). So, it is understood that eliminating the anxieties about this issue and supporting the positive attitudes are important for the society. Especially when evaluating the findings obtained from the data of countries showing high success in international exams (TIMSS, PISA), which is one of the important indicators of success in the field of math, it was seen that affective variables have an important role in influencing the students' successes. Therefore, it is important to prepare environments that increase students' attitudes and motivations towards the math class at the ages between 9-11, which is the critical period for developing affective reactions towards math (Sari & Ekici, 2018).

When the literature is examined, it is seen that, although there are reasons such as carelessness, lack of knowledge and misconception related the problems experienced by students in the arithmetic operations; the problems faced by the students with the concepts of addition, subtraction, multiplication and division are defined as difficulty rather than misconception and mistake (Varol & Kubanc 2012). The most commonly used methods for addressing these difficulties are the use of computer, the visualization and the use of proper materials (Tatar & Dikici, 2008). It is seen that application development studies were carried out especially to identify and to eliminate difficulties (Kheong, 1988; Woerner, 1980; Bilgin, 2015; Guler & Bilgin, 2017; Bilgin, 2018a) and various educational applications for arithmetic operations were tested (Kula & Erdem, 2005). Therefore, it is understood that to perform mathematics teaching in which conceptual knowledge and operational knowledge are balanced in order to eliminate the difficulties about the theme; and to benefit from the materials that will reduce the abstraction of the concept to be explained (Tatar & Dikici, 2008); and to use software-based materials related to the subject are important. Of course, one of the most important concepts in software-based materials is educational games.

Educational games are defined as software prepared as game format to enable the students to learn school subjects and to develop their problem solving skills (Demirel, Seferoglu & Yagci, 2003). It is known that the use of educational games in math education provides benefits such as motivating the students, changing the negative perception towards the class, overcoming math fears and breaking the prejudices against math (Kebritchi, Hirumi, & Bai, 2010). Therefore, as explained in the previous sections, it is seen that these softwares are frequently used in order to increase students' attitudes and motivations towards math. Considering its benefits especially for the students of primary and secondary school levels, game development studies for math class are frequently encountered (Cankaya & Karamete, 2008; Bilgin 2018b; Gok, 2020; Tural, 2005). Also, it is understood that these materials should be integrated into online environments in order to be used more widely and to benefit the students having math anxieties, and they should be developed for more subjects (Ozata & Coskuntuncel, 2019).

On the other hand, considering the platforms where educational games take place, it is seen that the mobile technologies instead of computer-enhanced softwares, are developing rapidly and have substantial effects on education (Cakir, 2019). Therefore, considering today's conditions, it is understood that educational software used in mobile environment should be given importance, and the materials to be developed should be prepared to be used in mobile devices such as tablet and phone (Karaarslan, Boz & Yildirim, 2013).

In the light of the information given above, it is understood that a mobile educational game should be designed in order to increase the motivation of middle school students for arithmetic operations, which is an important reason for math anxieties, and thus to contribute to the success. Therefore, in this study; it was aimed to design a mobile teaching software for the subject of arithmetic operations, which is one of the most fundamental subjects

of math, and to present students' opinions about the developed software and performance reports of the application.

2. Method

In this study, the Design and Development Research (DDR) method, which is one of the quantitative research methods, was used. DDR is a research method in which a new product, vehicle, model, or processes is developed (Buyukozturk, Cakmak, Akgun, Karadeniz & Demirel, 2018). In such researches, not only the product is developed, but also the applicability, effectiveness and efficiency of the developed product should be demonstrated via experiments (Richey & Klein, 2014). Contrary to traditional research methods, in the DDR researches it is targeted to find a solution for a problem and the development, application and evaluation of the innovative products are carried out (Buyukozturk et al., 2018). Therefore, a game was designed to eliminate the students' anxieties on the Arithmetic Operations in this study.

In the development researches, particularly the ADDIE (Analysis, Design, Development, Implementation, Evaluation) design model and many other models such as Dick and Carey, Kemp and 4C instructional design are used (Buyukozturk et al., 2018; ESMER, 2018). On the other hand, the models for the educational game software development process also exist in the literature. These models are sorted mainly as EFM (Effective Learning Environment), FIDGE (Fuzzified Instructional Design Development of Game-like Environments), GOM (Game Object Model), DGBL (Digital Game Based Learning), GAM (Game Achievement Model), EGM (Experiential Gaming Model) and Spiral Educational Game Design Model. However, it is understood that these models will not be enough to develop an educational game from beginning to end and can only guide game designers (Korkusuz & Karamete, 2013). Also, it is seen that these models are mostly compatible with the general design model. The common point of all these different game development models is the necessity of including the elements of struggle and motivation in the game (Korkusuz & Karamete, 2013).

Therefore, in the study the general design model (ADDIE) was used and the process was carried out in accordance with the model's steps, which are analysis, design, development, application and evaluation.

3. Results

In this section, the transactions and findings obtained during the steps of the research carried out in accordance with the ADDIE design model are presented.

3.1 Analysis

The investigations on arithmetic operations were conducted in the Analysis step, which is the entry step in the development studies and where the current situation is analyzed. Considering the lack of educational software for the subject, which is presented in detail in the introduction section of the study, it is understood that such an educational software for middle school students is needed. On the other hand, it is known that one of the biggest reasons why the students have difficulties in the subject of four operations called as arithmetic operations is that they confuse the rules of addition, subtraction, multiplication and division operations or memorize these rules incorrectly (Varol and Kubanc 2012). Therefore, it is understood that the level of operational knowledge regarding the subject should be increased. So, it is understood that there is a need for an application that can increase the mathematical operation skill and can help to eliminate errors by providing to do practice.

3.2 Design

Studies were conducted to determine the visual structure of the software to be developed in the design section, which is the second step in the development process. In order to design the application about arithmetic operations for middle school students, care has been taken to make the visuals more colorful and interesting. Also, attention has been paid to the sound effects to be lively and fun. Especially when designing a game, considering that the students learn its rules by experiencing in the game environment and with the feedback they

receive (Funk, 2003), it was tried not to include any parts that could cause additional cognitive load on the students. For this purpose, a single interactive button has been added to the visual interface on the game's splash screen. The user proceeds and receives feedback by clicking this button. Siang and Rao (2003) stated that, instead of reading help files or following instructions, the players learn by playing the game directly and experiencing. Therefore, it was tried to form a simple structure that is far from confusion.

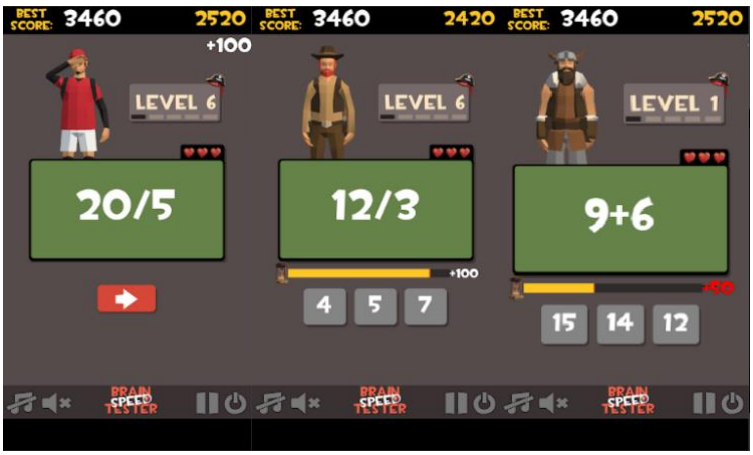

Figure 1: User Interface

As seen in Figure 1, the red-colored progress button is located in the middle of the screen. The user gets a new problem just clicking this button. The instant that the question appears on the screen, the yellow-colored time indicator gets smaller. At the same time, as the yellow indicator decreases, the point that can be earned gradually decreases, thus a sense of competition is given to the participant.

3.3 Development

The development step includes the transactions done in order to develop the algorithms for the functioning of application, to test them and to make the game workable. In this context, various scripts in c# language were written over the Unity platform for the purpose. The application generally generates random questions for the students and forms answers and distractors for these questions. The formed distractors are randomly assigned to the choices and their relationship with the correct answer is again randomly generated. In this way, a logical relationship cannot be found between the multiple choices and the correct answer choice, and the student cannot find the correct answer without solving the given problem. Within the developed algorithms, a structure that can generate 50 different types of random questions was formed. These 50 types consist of stages within themselves and the difficulty level increases gradually. For example, while the sum of smaller numbers is asked in the addition operation in the first levels, the sums of the three-digit numbers are also asked in the following sections. Similarly, the algorithms that generate random questions for other arithmetic operations were prepared. The users improve their level by answering 5 questions correctly and they have to give correct answers 250 times to complete all levels. In addition, in every wrong answer given, a feedback is given to the user by showing the correct answer. The user who gave the wrong answer three times loses the game. When the game is over, the score is shown on the screen and the highest score is updated by comparing it with the previous ones. In this way, a competition and motivation process is carried out in the application. In addition, each time the user switches to a new question, the time indicator progresses, and the score that will be received decreases as the answering time increases. On the other hand, the speed of time progress is reduced by the algorithm as questions become more difficult, thus giving the student enough time to solve the question. Finally, as stated in the literature, it was mentioned that the developed materials should be integrated into online environments in order to be used more widely (Ozata & Coskuntuncel, 2019). Therefore, the application obtained at the end of the development process was integrated into the Google Play Store and made accessible all over the world. The application, which is compatible with the Android devices, has a size of 25.7 MB.

3.4 Application

The application process includes the testing transactions of the developed application by the targeted audience. In this context, the middle school students taking education in the city of Van were asked to try the application and to tell their opinions by using the communication tools such as WhatsApp, Facebook and Instagram. Some updates were made according to the feedbacks received from the pre-assessment of 50 person. Showing the correct answers for the questions which were answered wrong, increasing the numbers of the choices and changing the difficulties of levels are in the updates.

3.5 Evaluation

In this section, there is a general evaluation of the product completed at the end of the design process. After the updates done according to the pre assessments in the previous section, the final version of the application was evaluated again by 69 middle school students taking classes in the city of Van and used the application. The 36.8% of the participants were male and the 63.2% were female students. On the basis of class, the 5th grade students present at the rate of 42.6% , the 6th grade students present at the rate of 36.8%, the 7th grade students present at the rate of 13.2% and the 8th grade students present at the rate of 7.4%. For the evaluation process, a questionnaire form consisting of 10 questions as 5-point Likert type was used by the researcher. The responses given to the items in the form were presented as percentage in Table 1.

Table 1: Survey Results

No	Item	1(%)	2(%)	3(%)	4(%)	5(%)
1	Did you like the application?	4,4	2,9	5,9	29,4	57,4
2	Did you find the application useful?	3,1	3,1	1,5	21,5	70,8
3	Did you enjoy the application?	6,0	,0	13,4	17,9	62,7
4	Did you experience any difficulty when using the application?	63,2	14,7	10,3	5,9	5,9
5	Would you recommend the application to your friends?	5,9	,0	4,4	20,6	69,1
6	Do you think that the application can contribute to your lessons?	4,4	1,5	5,9	13,2	75,0
7	Can the application contribute to your math skills?	5,9	,0	5,9	13,2	75,0
8	Can the application be helpful in your exams?	7,5	4,5	9,0	6,0	73,1
9	Do you think the questions in the application are appropriate to your level?	5,9	1,5	7,4	22,1	63,2
10	Do you think the questions in the application are challenging for you?	32,8	4,5	3,0	20,9	38,8

* Answers are listed as 1-Strongly disagree,…, 5-Strongly agree.

When the answers given to the questionnaire are examined, it is seen that the students gave mostly positive answers. For example, 86.8% (29.4 + 57.4) of the participants stated that they agree with the item of "I like the application." Similarly, it is understood that they found it useful with a rate of 92.3% and did not experience difficulty in using it with a rate of 77%. On the other hand, when the answers for the question of "Do you think the questions in the application are challenging for you?" were examined, it was seen that the participants were dispersed approximately similarly to all the answers. So, it is understood that it is suitable for the students' levels. Finally, in the answers the students gave for the question of "Do you think the application can contribute to your lessons?" it is seen that the 88.2% of the students marked the choices of “I agree” and “I strongly agree.”

When the performance reports obtained from the Google Play Store at the end of the three-month process that passed after the development and evaluation process of the application, it was seen that the user score of the application was 4.83 over 5. In addition, it was detected that the application was downloaded 6499 times in three-month period and is still on 2735 devices as installed. On the other hand, the number of views of the application in the store, the numbers of downloads and the download rates per view were presented in Table 2.

Table 2: Download Rates

Country	Views	Download	Transformation	Country	Views	Download	Transformation
India	3,687	936	25.39%	South Korea	154	1	0.65%
Pakistan	3,328	871	26.17%	Cambodia	152	22	14.47%
Philippines	1,739	419	24.09%	Somalia	144	52	36.81%
Nepal	1,424	427	29.99%	Malaysia	140	44	31.43%
Bangladesh	955	296	30.99%	Papua	105	33	31.43%
Nigeria	785	253	32.23%	Tobago	103	38	36.19%
Ghana	695	231	33.24%	Russia	102	11	10.78%
Kenya	616	206	33.44%	Iraq	97	26	26.80%
Ethiopia	478	148	30.96%	Jamaica	86	22	25.58%
Turkey	446	134	30.04%	Afghanistan	84	25	29.76%
Egypt	407	125	30.71%	Algeria	84	21	25%
USA	374	81	21.66%	Mongolia	79	13	16.46%
South Africa	352	67	19.03%	Morocco	77	16	20.78%
Iranian	351	87	24.79%	Jordan	76	21	27.63%
Lebanon	233	67	28.76%	Namibia	75	17	22.67%
Sri lanka	227	70	30.84%	Zimbabwe	75	27	36%
Japan	195	1	0.51%	Mauritius	74	21	28.38%
Zambia	185	63	34.05%	Tanzania	70	22	31.43%
Indonesia	183	17	9.29%	United Kingdom	68	23	33.82%
Myanmar	175	52	29.71%	All countries	21,604	5,726	26.50%

When Table 2 is examined, considering all countries, it is seen that approximately 1 out of every 4 people, who viewed the application, installed it. The top five countries that downloaded the application most are India, Pakistan, Philippines, Nepal and Bangladesh respectively. It is seen that the country with the highest download rate per view is Somalia, and the lowest is Japan among the countries. Turkey has outperformed the average rate of 26.5%.

4. Discussion

This research, which aims to develop an educational game for arithmetic operations, was carried out according to the DDR research model. Unlike the traditional research methods, the products in DDR researches are developed, applied and evaluated during the research process (Buyukozturk et al., 2018). Therefore, in this section, there is a general evaluation of the product, which was developed as a result of the research.

As a result of the research, a mobile application / game with a size of 25.7 MB that can run on android operating systems was obtained. In the game, the students are asked questions about arithmetic operations prepared with the help of the numbers, which are randomly generated by the algorithm. The students get points by giving correct answers to the questions and they lose the game with three wrong answers. Also, the game keeps the highest score so the student can compete with himself or with other users (e.g. classmates) whose score (s)he knows. On the other hand, it is thought that the elements of struggle and motivation, which should be in the game (Korkusuz & Karamete, 2013), are provided with the presence of answer durations for the questions.

The educational math game obtained as a result of the research was evaluated by 69 middle school students who were taking classes in Van, the city of Turkey, and used the application via questionnaire form. The findings show that the application was found highly interesting and enjoyable by the students. Also, the students think that the application will contribute to their success in the math class. Again since the questions directed to the

users for the purpose of gaining points in the application challenge more than the half of the students (Table 1, Item 10), it can contribute to the development of their success levels in arithmetic operations. This result supports the information presented in the literature that educational math games will reduce the prejudices against math and make the lesson fun (Ozata & Coskuntuncel, 2019).

On the other hand, the performance reports obtained from the Google Play Store at the end of the 3-month period following the launching of the application all over the world, were also used to evaluate the application. According to the findings, the application has been installed 6500 times in total from 181 countries during this period and is present actively approximately on 2750 devices. It is seen that application showed success approximately at the rate of 42% in terms of rates of loading and keeping on device. Also, it was seen that the application was liked at the rate of 96% (4.83 points) in terms of user evaluation.

Therefore, it can be thought that the developed product contributes to the attitudes and motivations of the students and is attractive. In this context, it can be said that the product serves the purpose of development. On the other hand, it can be tested whether it contributes to the arithmetic operations in particular and to the math success in general, by testing the application with experimental methods. In addition, whether the anxieties about the subject have been eliminated or not should also be tested using similar experimental methods.

References

Abebe, G. (2015). *Anxiety, attitude towards mathematics and mathematics achievement of tenth grade students at government and private schools in kolfe keranio sub city of Addis Ababa.* (Doctoral dissertation), Addis Ababa University, Addis Ababa, Ethiopia.

Baydar, S. & Bulut, S. (2002). The importance of teachers' beliefs about the nature and teaching of mathematics in mathematics education. *Hacettepe University Journal of Education*, 3 (5).

Baykul, Y. (2009). *Elementary Mathematics Teaching (6-8 classes).* Ankara, Turkey: Pegem A. Publishing.

Bilgin, E. A. (2015, August). *Development of an educational software for basıc statistics.* Paper presented at International Conference on Pure and Applied Mathematics, Van, Turkey (p.50).

Bilgin, E. A. (2018a). The effect of an instructional software developed for statistics teaching on academic achievement. *Yuzuncu Yil University Journal of Education*, 15 (1), 1212-1231.

Bilgin, E. A. (2018b). *Evaluation of different technology supported learning environments for secondary education mathematics curriculum data sub-learning area.* (Doctoral dissertation). Ataturk University, Erzurum, Turkey.

Bulut, S. (1994). Methods and techniques used in mathematics teaching. *TED XII. Teaching Meeting Papers*

Buyukuzturk, S., Cakmak, E. K., Akgun, O. E., Karadeniz, S. & Demirel, F. (2018). *Scientific research methods*. Ankara, Turkey: Pegem A. Publishing.

Cakır, Y. (2019). *Scale development study for student attitudes regarding the use of mobile learning in primary school mathematics lessons.* (Master dissertation). Adnan Menderes University, Aydin, Turkey.

Cankaya, S. & Karamete, A. (2008). The effect of educational computer games on students' attitudes towards mathematics lessons and educational computer games. *Mersin University Journal of Education Faculty*, 4 (2). 115-127

Doruk, M. & Kaplan, A. (2013). Investigation of mathematical anxiety of primary and primary mathematics teachers. *Kastamonu Education Journal*, 21 (4), 1505-1522.

Esmer, E. (2018). A model in instructional design: Dick, Carey and Carey. *Journal of Education*, 8 (2), 274-284.

Funk, J. B. (2003). How children experience playing video games. *Proceedings of Acm International Conference*, (s. 1-14).

Gok, M. (2020). A Mobile Game Experience of Pre-service Elementary Teachers: The Fundamental Theorem of Arithmetic. J*ournal of Computer and Education Research Year*, 8(15), 41-74.

Gokbulut, Y., Sidekli, S. & Sayar, N. (2013). How to develop four processing skills. *International Journal of Turkish Educational Sciences*, 2013 (1), 31-41.

Guler, C. & Bilgin, E. A. (2017). *The effect of a natural numbers subjected educational software on students' attitudes and success.* Paper presented at International Conference on Pure and Applied Mathematics, Van, Turkey (p.72).

Karaarslan, E., Boz, B. & Yıldırım, K. (2013). *Technology-based approaches in mathematics and geometry education.* Paper presented at International Conference on XVIII. Internet Conference. Turkey.

Kebritchi, M., Hirumi, A. & Bai, H. (2010). The effects of modern mathematics computer games on mathematics achievement and class motivation. *Computers & education*, 55(2), 427-443.

Kheong, F. H. (1988). Using the Computer to Diagnose Students' Difficulties with Fractions, *Singapore Journal of Education, 9:2, 43-51*

Korkusuz, M. E., & Karamete, A. (2013). Educational game development models. *Necatibey Faculty of Education Electronic Journal of Science and Mathematics*, 7 (2), 78-109.

Kula, A. & Erdem, M. (2005). The effects of instructional computer games on the development of basic arithmetic processing skills. *Hacettepe University Journal of Education*, 2005 (29), 127-136.

Norwood, K. S. (1994). The effect of instructional approach on mathematics anxiety and achievement. *School science and mathematics*, 94(5), 248-254.

Ozata, M. & Coskuntuncel, O. (2019). Secondary school mathematics teachers' views on the use of educational mathematics games in teaching mathematics. *Mersin University Journal of Education Faculty*, 15 (3), 662-683.

Richey, R. C. & Klein, J. D. (2014). *Design and development research: Methods, strategies, and issues.* New York: Routledge.

Sarı, M. H. & Ekici, G. (2018). Determination of affective variables that affect primary school 4th grade students' mathematics achievement and arithmetic performance. *OPUS – International Journal of Society Research*, 8 (15), 1562-1594.

Siang, A. C. & Rao, R. K. (2003). *Theories of learning: A computer game perspective.* Paper presented at International Conference on IEEE Fifth International Symposium on Multimedia Software Engineering (ISMSE'03), (s. 239-244).

Saban, I. H. (2019). *Investigation of Questions Related To Algebra Learning In Mathematics Textbooks With Respect To The Competency Levels of PİSA.* (Master dissertation). Hacettepe University, Ankara, Turkey.

Tatar, E. & Dikici, R. (2008). Learning difficulties in mathematics education. *Mustafa Kemal University Journal of Social Sciences Institute*, 5 (9), 183-193.

Tural, H. (2005). *The effects of teaching mathematics in elemantary school by games and activities on achievement and attitude* (Doctoral dissertation). Dokuz Eylül University, Izmir, Turkey.

Varol, F. & Kubanc, Y. (2012). Common difficulties students experience with arithmetic operations. *Journal of Turkish Studies*, 7 (1) .2067-2074

Woerner, K. L. W. (1980) *Computer based diagnosis and remediation of computational errors with fractions.* Unpublished Doctoral Dissertation, The University of Texas, Austin.

Zavlovsky, C. (1994). *Fear of math:how to get over it and get on with your life.* New Bronc- wick: Rutgers University Press.