The Effect of 3D Virtual Learning Environment on Secondary School Third Grade Students' Attitudes toward Mathematics

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ABSTRACT
With this research, in Second Life environment which is a three dimensional online virtual world, it is aimed to reveal the effects of student attitudes toward mathematics courses and design activities which will enable the third grade students of secondary school (primary education seventh grade) to see the 3D objects in mathematics courses in a concrete way, access the information outside of the school and provide them with an education through games.

In order to achieve this aim, this research was carried out with 28 secondary school third grade students having their education in Istanbul province, Uskudar district, in Fatih Secondary School in 2014-2015 academic year. Research data was collected by Mathematics Attitude Scale which is prepared by Ministry of Education. The data collected in the research, analyzed with nonparametric statistical methods as the group number is less than 30. In order to compare the pretest and posttest total scores of the experiment group, Wilcoxon signed rank test, which is considered appropriate to be used in relational measuring, was used and quantity analysis of the research was carried out by "SPSS 21 for MacOS X" package program. Wilcoxon signed rank test results related to whether the students' pre-experimental and post-experimental attitudes towards mathematics have a significant difference or not, is shown on the table. The analysis result has shown that there is a significant difference between the students'pre-experiment and post-experiment scores, taken from Mathematics Attitude Scale ($z=2.95$, $p<.05$). When the mean rank and rank sums of the difference scores are taken into account, this difference is in favor of positive rank,namely in favor of post-test score. According to these results, it can be stated that Mathematics robot developed in Second Life environment has an important effect on students' attitude towards mathematics.

Keywords: Mathemnatics Educaiton, Three-dimensional Virtual Worlds, Second Life, Education Principles, Mastery Learning, Cartesian Coordinate System

INTRODUCTION

The rapid change in science and technology made information more valuable in the information age we live in. Rapidly evolving technology and accompanying increasing informaion flow require the change of stereotypes and shallow knowledge with renewable and improving generations. For this reason posession of information is not enough solely, it is necessary to use the information correctly, transfer it into new situations and produce new information. Accordingly, together with the information it is a necessity to equip individuals with skills enabling them to adapt new situations.Thanks to these skills, named under creative thinking and problem solving, besides adapting to the innovations, individuals will be able to cope with the difficulties thay face and produce new information. The inventions and the discoveries leading to the improvement of the societies came as a result of creative thinking and problem solving. In this context in order to raise creative individuals, education programs need to be rearranged in such a way (Akdağ ve Güneş, 2003; Senemoğlu, 1996). In this century, the graduated individuals are expected to define the problems encountered, solve them and contribute to the society they live in. Therefore current education system adopts a student-based and structural learning understanding through which students form the information. In the frame of this understanding, context and methods of the education need to be reorganized in a way to gain critical thinking, scientific thinking, relational thinking, reasoning and creative thinking skills. Providing students with learning opportunities suitable to their skills and expectations and raising man power equipped with the qualities required in our age is only possible through a technology based structure within the education system. Since raising individuals and ensuring the creative thoughts to emerge, is only possible with a contemporary education perception (Özden, 1997; Alkan, 2005).

Under the light of these ideas technology has started to take its place in learning-teaching process. During this period, computer technologies has also begun to be used in material development in order to provide more effective education as used in consulting and asessment-evaluation services. The rapid improvement of science

and technology bound to affect computer technologies which is used in education process and it also provides possibilities to overcome the limitations which can occur in computer based learning environments. In the current period a transition started from internet based learning to three dimensional, multiple user, online virtual learning environments.These three dimensional online environments allow multiple users to do activities and communicate other users with the help of virtual self (avatar) that represent them in the same environment at the same time. These environments provide a powerful visual interface structure that evokes the sense of reality in social communication,which becomes an alternative for them by eliminating the drawbacks of other Internet-based systems. These environments eliminate the distance concept as it can bring the users together in remote places . In addition, according to Barkand and Kush, virtual learning environments are described as: instant messaging, discussion boards ,e-mails ,blogs and podcasts (Dickey, 2005; Dede et al., 2004; Mennecke et al., 2011; Barkand and Kush, 2009).

Sert (2009), in his research, defines game based learning environments as: the environment that learning is carried out through games to ensure the learning process to be more fun and higly motivatational. In the study by Salmon at al. (2010) due to the environment designs made by the participants, it is found out that they entertain and have a higher motivation for studying in the environment. In another study, researchers state that student-student interaction in virtual environments is very important for the formation of social learning (Beldarrain, 2006; Kongmee et al., 2011; Can & Şimşek, 2015).

The methods and the techniques used in learning-teaching process in our country are inefficient especially in the courses with abstract subjects like in mathematics. According to Piaget, cognitive development of the individuals is completed in four phases and these are: Sensorimotor Stage, Preoperational Stage, Concrete Operational and Formal Operational Stages. Concrete operational stage: It applies to the individual's age range 7-11 and this age range corresponds to the span between the primary school third grade and secondary school third grade. In this stage individual can achieve the basic operational series on condition that every step is clearly explained. Additionally, individual improves the concepts of the substance amount of the objects, reversibility and conservation of length and weight. Next stage, Formal Operational Stage applies to the age 11 and above, and this corresponds to the secondary school fourth grade and above in educational life. In this period individual improves the skills of hypotetico- deductive reasoning, identification and control of the variables ,imagining ,comprehending abstract events and concepts by interpreting them (Gültekin, 2005; Özmen, 2004).

Upon examining the mathematics curriculum of the schools, by the second grade of secondary school, an abstract subject like algebraic expressions has been taught to the students. The students are in concrete operational stage at this age and comprehension of abstract subjects like this is made impossible by the methods and techniques used while teaching. Furthermore, for example presentation of cube ,a three dimensional object ,on a two dimensional board creates a separate paradox .The low number of the materials designed to present the abstract subjects to the student in concrete operational stage do not allow each student to use them and the users are also limited with the school. In this context three dimensional online virtual learning environments are needed. The materials formed in three dimensional interfaces provided by these environments not only concretize the subject but also provide the opportunity to use them in required place and time. Besides the cost and the time spent for copying these materials according to the number of the students are being close to zero, it also serves the educational policy of cost saving (economy) policy. (Küçükahmet, 2006; Ergün ve Özdaş, 1997).

THE STUDY

In this study "One group Pre-test - Post-test Experimental Model of the Experimental Design (Balci, 1997; Captain, 1998)" is used.As experimental design is used in the research, population and sample are not assigned. The working group of the research is formed by 28 students studying at the third grade of Fatih Secondary School in 2014-2015 academic year.

Data Collection

Test, as a word meaning, is described as a tryout used for evaluating and understanding natural or acquired abilities, knowledge and skills of a person or a group. Tests are benefited in two ways in educational period. First one is a diagnostic test benefited for defining the insufficiencies in a unit (subject or activity) and making up the lacks before passing to a new unit. Another purpose is to determine the learning level of the student in a section covering several units of the course. On one hand these are achievement tests that are putting forth the success of the students and on the other hand they help to take precautions in order to eliminate the problems to be faced

(Özçelik, 2010).
In the context of this research, Mathematics Attitude Scale, developed by Ministry of Education, is used to measure the attitude toward Mathematics.

Process

The steps followed during the research can be listed as follows:

- Three dimensional Mathematics Robot was developed in Second Life environment to be used in the research.
- Practicality tests of the system were carried out before usage and the necessary improvements were done to make it operational.
- A written exam was prepared by the researcher, covering the objective 'Student is able to explain two dimensional Cartesian coordinate system and use it.' which takes place in the education program of 3rd grades' mathematics courses.
- Permission was granted by the principle of Uskudar Fatih secondary school which is identified as the practice school for the research to be carried out in 2014-2015 academic year.
- Parent permission forms were taken from each of the 28 students' families to allow them partake in the application.
- Before the application started, first the written exam prepared by the researcher and Mathematics Attitude Scale prepared by the ministry of education, applied as pretest.
- A field trip was organized to Istanbul University for working group to observe the similarities between the SL and real environment and to understand how the application, prepared in SL environment, works.
- As the duration of the objective, defined by the ministry, was 3 hours; the course was carried out at a defined day and time with the working group by logging into SL environment from their houses.
- At the end of the application the same achievement test and the attitude scale were applied to the students as post-tests.

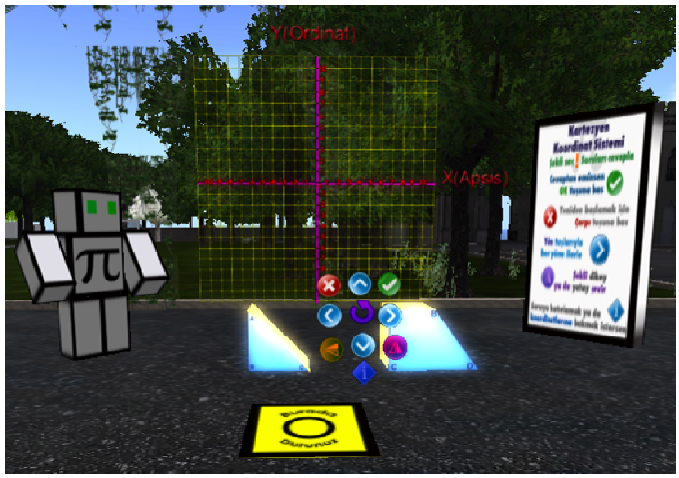

Figure1. 3D Mathematic Robot in Second Life.

Data Analysis

Wilcoxon signed rank test is used to identify whether there is a significant difference among the distributions by comparing the distributions of two relational variables. The data related to the dependent variable is as follows;
It needs to be expressed in numeric characters.

- It has to be permanent data.
- It has to be in interval or ratio scale.

Wilcoxon signed rank test is used instead of T-test for relational measurements in case the conditions related to the usage of parametric tests are failed to be provided (Ural ve Kılıç, 2006). In this research the effect of mathematics course taught with Mastery learning and supported by Second Life on student success is examined. Tha data collected from the research is analyzed with nonparametric statistical methods as the group number is less than 30. In order to compare the pre-test and post-test total scores of the experiment group, Wilcoxon signed rank test is used, which is considered to be appropriate to use in relational measurings rk, 2003).

FINDINGS

Findings of the research are as follows:
In accordance with the experiment, Wilcoxon signed rank test results, as to whether the answers taken from the

Mathematics Attitude Scale which is applied before and after the training with the Mathematics Robot developed in SL environment show a significant difference or not, are given in Table 1.

Table 1. Wilcoxon Signed Rank Test Results of Pre-Experimental and Post-Experimental Mathematics Attitude Test Scores.

Second Life Education After-Before	n	Mean Rank	Sum of Ranks	z	p
Negative Ranks	11	13.27	146.00		
Positive Ranks	12	10.83	130.00		
Ties	5			-.245	.806
Total	28				

*Base of negative ranks

According to the test results in Table 1 , it is noted that there is no significant difference between the answers given to the questions in attitude scale before and after the SL learning application (z=0.25, p>.05).
Items chosen among the attitude pre-test and post-test applied to the SL learning group in the research are as below;
Mathematics is not interesting for me,

- I would like to reserve most of my time for Mathematics
- I am not afraid of Mathematics,

and the item groups formed by these items are as below;

- Mathematics is not intersting for me - I love Mathematics
- I can learn Mathematics - I am afraid of Mathematics,
- I would like to reserve most of my time for Mathematics- I would like to have advanced level information about Mathematics.

These items and item groups are observed seperately and findings of the observation are given below.
Wilcoxon signed rank test results, in relation to whether answers to the question 'Mathematics is not interesting for me.' in the test applied in order to evaluate pre-experimental and post-experimental mathematics attitudes of SL learning group show a significant difference or not, are given in Table 2.

Table 2. Wilcoxon Signed Rank Test Results of Pre- experimental and Post-experimental Mathematics Attitude Test Scores regarding the item of ' Mathematics doesn't attract my attention'.

Second Life Education After-Before	n	Mean Rank	Sum of Ranks	z	p
Negative Ranks	18	10.92	196.50		
Positive Ranks	3	11.50	34.50		
Ties	7			-2.951	.003
Total	28				

*Base of negative ranks

According to the results shown in Table 2, the difference between the answers given to the item 'Mathematics is not interesting for me.' before and after the SL learning application indicates .05 significance level (z=2.95, p<.05).

Mean rank in Table 2 shows that the scores of the answers given after the application are higher. In other words the difference is in favor of positive rank, namely in favor of post test score. This result can be interpreted as Mathematics robot that is developed in SL environment, has a positive effect on Mathematics attitudes of SL learning group.

Wilcoxon signed rank test results, in relation to whether answers to the item 'I would like to reserve most of my time for Mathematics' in the test applied in order to evaluate pre-experimental and post-experimental Mathematics attitudes of SL learning group show a significant difference or not, are given in Table 3.

Table 3. Wilcoxon Signned Rank Test Results of Pre- experimental and Post-experimental Mathematics Attitude Test Scores regarding the item of ' I would like to reserve most of my time for Mathematics'.

Second Life Education After-Before	n	Mean Rank	Sum of Ranks	z	p
Negative Ranks	2	6.50	13.00		

Positive Ranks	15	9.33	140.00		
Ties	11			-3.139	.002
Total	28				

*Base of negative ranks

According to the analysis results shown in Table 3 , the difference between the answers given to item' I would like to reserve most of my time on Mathematics.' before and after the SL learning application indicates a .05 significance level (z=3.14, p<.05).

When the mean rank and rank sums of the difference scores are taken into account, this indicates that the observed difference is in favor of positive rank, namely in favor of post-test scores. This result can be interpreted as Mathematics robot that is developed in SL environment has a positive effect on Mathematics attitudes of SL learning group.

Wilcoxon signed rank test results, in relation to whether answers to the item 'I am not afraid of Mathematics.' in the test applied in order to evaluate pre-experimental and post-experimental Mathematics attitudes of SL learning group show a significant difference or not, are given in Table 4.

Table 4. Wilcoxon Signned Rank Test Results of Pre- experimental and Post-experimental Mathematics Attitude Test Scores regarding the item of ' I am not afraid of Mathematics'.

Second Life Education After-Before	n	Mean Rank	Sum of Ranks	z	p
Negative Ranks	8	6.75	54.00		
Positive Ranks	13	4.00	12.00		
Ties	17			-1.925	.054
Total	28				

*Base of negative ranks

According to the analysis results shown in Table 4, no significant difference was found between the answers given to item 'I am not afraid of Mathematics' before and after the SL learning application (z=1.93, p>.05).
Upon examining the research findings, it is noted that the students find SL acitivities more intetresting and different compared to the acitvities in the classroom. These results show similarities with the results of Koenraad (2008) indicating that participators consider the courses more intetresting and different compared to the routine courses.

Wilcoxon signed rank test results, in relation to whether answers to the items 'I am not interested in Mathematics' and 'I love Mathematics.' in the test applied in order to evaluate pre-experimental and post-experimental Mathematics attitudes of SL learning group show a significant difference or not, are given in Table 5.

Table 5. Wilcoxon Signned Rank Test Results of Pre- experimental and Post-experimental Mathematics Attitude Test Scores regarding the item of ' I am not afraid of Mathematics'.

Second Life Education After-Before	n	Mean Rank	Sum of Ranks	z	p
Negative Ranks	14	8.86	124.00		
Positive Ranks	2	6.00	12.00		
Ties	12			-3.011	.003
Total	28				

*Base of negative ranks

According to the test results shown in Table 5 , the difference between the answers given to items 'Mathematics is not interesting for me' and 'I love Mathematics' before and after the SL learning application indicates a .05 significance level (z=3.01, p<.05).

Mean rank in Table 5 indicates that the scores of the answers given after the application are higher. In other words the difference is in favor of positive rank ,namely in favor of post test score. This result can be interpreted as Mathematics robot that is developed in SL environment has a positive effect on Mathematics attitudes of SL learning group.

Wilcoxon signed rank test results, in relation to whether answers to the items 'I can learn Mathematics' and 'I am not afraid of Mathematics' in the test applied in order to evaluate pre-experimental and post-experimental

Mathematics attitudes of SL learning group show a significant difference or not, are given in Table 6.

Table 6. Wilcoxon Signned Rank Test Results of Pre- experimental and Post-experimental Mathematics Attitude Test Scores regarding the items of 'I can learn Mathematics ' and 'I am not afraid of Mathematics'.

Second Life Education After-Before	n	Mean Rank	Sum of Ranks	z	p
Negative Ranks	8	7.75	62.00		
Positive Ranks	4	4.00	16.00		
Ties	16			-1.847	.065
Total	28				

*Base of negative ranks

According to the test results shown in Table 6 , no significant difference was found between the answers given to items 'I can learn mathemantics' and 'I am not afraid of Mathematics' before and after the SL learning application ($z=1.85$, $p>.05$).

Wilcoxon signed rank test results, in relation to whether answers to the items 'I would like to reserve most of my time for Mathematics' and 'I would like to have advanced information about Mathematics.' in the test applied in order to evaluate pre-experimental and post-experimental Mathematics attitudes of SL learning group show a significant difference or not, are given in Table 7.

Table 7. Wilcoxon Signned Rank Test Results of Pre- experimental and Post-experimental Mathematics Attitude Test Scores regarding the items of 'I would like to reserve most of my time for Mathematics' and 'I would like to have advanced information about Mathematics'.

Second Life Education After-Before	n	Mean Rank	Sum of Ranks	z	p
Negative Ranks	5	8.30	41.50		
Positive Ranks	17	12.44	211.50		
Ties	6			-2.824	.005
Total	28				

*Base of negative ranks

According to the test results shown in Table 7 , the difference between the answers given to items 'I would like to reserve most of my time for Mathematics.' and 'I would like to have advanced level information about Mathematics.' before and after the SL learning application indicates a .05 significance level ($z=2.82$, $p<.05$).
Mean rank in Table 7 indicates that the scores of the answers given after the application are higher. In other words the difference is in favor of positive rank ,namely in favor of post test score. This result can be interpreted as Mathematics robot that is developed in SL environment has a positive effect on Mathematics attitudes of SL learning group.

CONCLUSIONS

When the findings of the research are examined, thanks to the three dimensional Mathematics Robot developed in SL environment, affective qualities are improved; for instance students' interests toward Mathematics increased, they started to like Mathematics, they would like to reserve more time for Mathematics and they would like to have advanced level information about Mathematics. Besides, an increase of academic success regarding the objectives, which is a cognitive quality, has been noted. It can be stated within the light of this finding that the increase in the sympathy and the motivation toward mathematics mobilized the academic success in a desired course. Furthermore having an independent environment from the school and encouraging them to ask questions to each other, sharing more things enable social learning by increasing student interaction. And these results also support the researches of Sert (2009), Salmon et al. (2010), Beldarrain (2006) and Kongmee et al (2011)

As a result;
It is determined that there is no significant difference between the attitude pretest and posttest scores, through which the effect of mathematics courses, taught by three dimensional Mathematics robot on students attitudes. However when the items chosen from the attitude test examined the following results are obtained:

1. Mathematics courses taught with "Three dimensional Mathematics Robot" increase the interest of students toward Mathematics at a significance level of ($p<.05$) .

2. The courses taught with "Three dimensional Mathematics Robot" increase the duration of the working hours that the students reserve for Mathematics at a significance level of " ($p<.05$)
3. The courses taught with "Three dimensional Mathematics Robot" have no effect on Mathematics fear of the students.
4. With the help of "Three dimensional Mathematics Robot" developed in SL environemnt, the sympathy and the interest of the students toward mathematics increase at a siginificnce level of ($p<.05$).
5. The courses taught with "Three dimensional Mathematics Robot" have no effect on the belief of learning Mathematics and mathematics fear.

With the help of "Three dimensional Mathematics Robot" developed in SL environemnt, the duration that the students would like to reserve for Mathematics and the wish to have advanced level of information about Mathematics inrease at a significance level of ($p<.05$)

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REFERENCES

Akdağ, M. & Güneş, H. (2003). Öğretmen Rolünün Yaratıcı Bir Sınıf Ortamı Oluşturmasındaki Önemi. *Milli Eğitim Dergisi*. 159.

Alkan, C. (2005). *Eğitim Teknolojisi*. Anı Yayıncılık, Ankara. ISBN:975-6376-42-2.

Barkand, J. & Kush, J. (2009). GEARS a 3D Virtual Learning Environment and Virtual Socialand Educational World Used in Online Secondary Schools. *Electronic Journal of e-Learning*. 7(3), 215-224.

Balci, O. (1997). Verification validation and accreditation of simulation models. In Proceedings of the 29th conference on Winter simulation. *IEEE Computer Society*. 135-141.

Beldarrain, Y. (2006). Distance Education Trends: Integrating new technologies to foster student interaction and collaboration. *Distance Education*. 27(2), 139-153.

Can, T., Şimşek, İ. (2015). The Use of 3D Virtual Learning Environments in Training Foreign Language Pre-Service Teachers.*The Turkish Online Journal of Distance Education (TOJDE)*.16(4).114-124.

Dede, C., Ketelhut, D., & Ruess, K. (2004). Designing for motivation and usability in a museum-based multi-user virtual environment. *Meeting of the American Educational Research Association*. San Diego, CA.

Dickey, M.D. (2005). Three-dimensional virtual worlds and distance learning: two case studies of Active Worlds as a medium for distance education. *British Journal of Educational Technology*. 36(3), 439–451.

Ergün, M. & Özdaş, A. (1997). *Öğretim ilke ve yöntemleri*. Kaya Matbaacılık, İstanbul.

Gültekin, M. (2005). *Öğretimde Planlama ve Değerlendirme*.. Anadolu Üniversitesi, Eskişehir. 975-06-0062-2.

Kaptan, S. (1998). Bilimsel araştırma teknikleri ve istatistik yöntemleri. Ankara: Tekışık Matbaası.

Koenraad, T. (2008). *How Can 3D Virtual Worlds Contribute to Language Education?*http://www.3dles.nl/documents/worldcall2008-koenraad-revised2.pdf [Erişim Tarihi: 15.04.2015]

Kongmee, I., Strachan, B., Montgomery, C. & Pickard, A. (2011). Using massively multiplayer online role playing games (MMORPGs) to support second language learning: Action research in the real and virtual world. *2nd Annual IVERG Conference: Immersive Technologies for Learning*. Middlesborough, UK.

Küçükahmet, L. (2006). *Öğretimde planlama ve değerlendirme*. Nobel Yayın Dağıtım, Ankara.

Mennecke, B.E., Triplett, J.L., Hassall, L.M., Conde, Z.J., & Heer, R. (2011). An examination of a theory of embodied social presence in virtual Worlds. *Decision Sciences*. 42(2), 413-450.

Özmen, H. (2004). Fen öğretiminde öğrenme teorileri ve teknoloji destekli yapılandırmacı öğrenme. *The Turkish Online Journal of Educational Technology*. 3(1), 100-111.

Özçelik, D. A. (2010). *Test Hazırlama Kılavuzu*. Pegem Akademi, Ankara. ISBN:9786054282869.

Özden, Y. (1997). *Öğrenme ve öğretme*. Pegem A Yayıncılık, Ankara.

Salmon, G., Nie, M. & Edirisingha, P. (2010). Developing a five-stage model of learning in Second Life. *Educational Research*. (52), 169-182.

Senemoğlu, N. (1996). *Yaratıcılık ve öğretmen nitelikleri*. http://yunus.hacettepe.edu.tr/~n.senem/makaleler/yaratici.htm, [Ziyaret Tarihi: 14.03.2014].

Sert, S. (2009). *Eğitsel bilgisayar oyunlarının lise öğrencilerinin internete ilişkin bilgi düzeyi performansına etkisi: Quest atlantis örneği*. Yüksek Lisans Tezi, Fen Bilimleri Enstitüsü, Ankara.