World Journal on Educational Technology

Vol 6, Issue 2, (2014) 132-138

www.awer-center/wjet

The effect of Scratch environment on student's achievement in teaching algorithm

Mehmet Tekerek*, Department of Computer Education and Instructional Technology, Kahramanmaraş Sütçüimam University, Kahramanmaraş, Turkey - Computer Engineering Department Kyrgyz Turkish Manas University, Bishkek, Kyrgyzstan

Tuğba Altan, Department of Computer Education and Instructional Technology, Middle East Technical University, Ankara, Turkey.

Suggested Citation:

Tekerek, M., & Altan, T. (2014). The effect of Scratch environment on student's achievement in teaching algorithm. *World Journal on Educational Technology,* 6(2), 132-138.

Received May 12, 2014; revised June 19, 2014; accepted July 23, 2014

Selection and peer review under responsibility of Prof. Dr. Steven M. Ross, John hopkins University.

Abstract

In this study, the effect of Scratch environment in teaching algorithm in elementary school 6th grade Information and Communication Technologies course was examined. The research method was experimental method. Control group, pretest-posttest design of experimental research method and a convenience sample consisting of 60 6th grade students were used. The research instrument was achievement test to determine the effect of Scratch on learning algorithm. During the implementation process experiment group studied using Scratch and control group studied with traditional methods. The data was analyzed using independent-samples t-test, paired-samples t-test and ANCOVA statistics. According to findings there is no statically significant difference between posttest achievement scores of experiment and control groups. Similarly, In terms of gender there isn't a statically significant difference between posttest scores of experiment and control groups.

Keywords: distributed learning environments, programming and programming languages, elementary education

*ADDRESS FOR CORRESPONDENCE: **Mehmet Tekerek**, Department of Computer Education and Instructional Technology, Kahramanmaraş Sütçüimam University, Kahramanmaraş, Turkey, *E-mail address*: ekerek@ksu.edu.tr

1. Introduction

The word "algorithm" is originated Abdullah Muhammad ibn Musa al-Khwarizmi's name and he is known for his work in the field of algebra in the ninth century (Dasgupta, Papadimitriou & Vazirani, 2006; Fellows, Bell & Witten, 2005). In the fifteenth century, Fibonacci created his sequence of numbers that is called with his name based on al-Khwarizmi's studies and this method was applied in the field of computer programming with some other fields (Dasgupta et al., 2006). Algorithm is defined commonly as "…the way for solving a problem…" (Aydın, Hoşcan & Özkul, 2004, p. 294) or "… a set of instructions…" that are required to follow "… for completing a task…" (Fellows et al., 2005). In the process of creating an algorithm that is the most important step of computer programming, the flow including instructions to solve the problem and decisions that will be taken is determined (Aydın et al., 2004).

The traditional methods with using paper-pencil are used to teach algorithm and instructors avoid using object-oriented programming in this process. But this method doesn't allow testing whether the algorithm is correct, studying individually is too hard and causes time wasting in classroom (Vobornik, 2011). For these reasons, it is "…one of the problems of the computer science… course is developing algorithmic and logical thinking…" (Ziatdinov & Musa, 2012) and students consider that learning algorithm is difficult and boring (Futschek & Moschitz, 2010). In order to find solutions to these problems, methods such as multimedia and computer-supported instructional technologies (Crescenzi, Malizia, Verri, Díaz & Aedo, 2012; Gültekin, 2006; Vobornik, 2011), different mathematical methods (Ziatdinov & Musa, 2012) and discovery learning, role-playing (Futschek & Moschitz, 2010) are benefited in teaching algorithm. Also, in order to facilitate learning programming and make programming can be learned by anyone, various programming languages and learning environments have been developed (Conway, 1997; De Bonte, 1998; Resnick, et al., 2009; Utting, Cooper, Kölling, Maloney & Resnick, 2010). Scratch is one of these learning environments. Scratch that is one of the first developed programming languages for K-12 students was designed by focusing student engagement in programming environment and core computational concepts such as sequencing, iteration, and conditionals (Sivilotti & Laugel, 2008). Students create program procedures by snapping together graphical blocks like Lego bricks or jigsaw puzzle pieces. In this learning environment, it was tried to prevent students from syntax errors by presenting different data types as blocks of different shapes and fitting together in only correct syntaxes. The other features of Scratch learning environment are using and editing the desired images, adding sound or music and creating animations (Resnick et al., 2003).

Students can share their projects that they develop in Scratch environment with other user in a web environment and thus Scratch offers a social environment as the same like video-sharing website YouTube. Student learn both important mathematical and computational concepts and creative thinking , systematically reasoning and studying collaboratively via making programs and sharing their projects in learning environment (Resnick et al., 2009). It is advocated that Scratch ensures that situation with the design that combines 21st century skills such as information and communication skills, creative and critical thinking, problem solving, communicating clearly, analyzing systematically, self-direction skills, collaborating effectively, designing iteratively and learning continuously (Learning with Scratch, 2012).

Computer programming is taught at university and high school levels and although little level in K-12 level in Turkey. In K-12, 1st-8th graders' Information and Communication Technologies (ICT) curriculum there are some acquisitions related with algorithm and computer programming subjects (Talim ve Terbiye Kurulu Başkanlığı, 2012). This situation shows an attempt for teaching algorithm and computer programming subjects from young ages of children in our country. Similarly, Scratch was developed with considering students can learn programming earlier as they learn writing (Utting et al., 2010). Also, some researchers emphasize that development of algorithmic thinking can start at K-12 level (Futschek & Moschitz, 2011; Ziatdinov & Musa, 2012).

It was exposed by some researchers that there was an increase on student's performance in the implementations of different methods for teaching programming and algorithms in the literature (Crescenzi et al., 2012; Futschek & Moschitz, 2010; Futschek & Moschitz, 2011; Gültekin, 2006; Monroy-Hernández & Resnick, 2008; Peppler & Kafai, 2005, Resnick et al., 2009; Vobornik, 2011). Hence in this study, it was aimed to examine the impact of Scratch environment that was developed to provide an easy and funny way for learning computer programming by students, on student's achievement in sixth grade ICT course algorithms subject.

1.1. Research Question

What is the impact of Scracth on student's achievement in teaching sixth grade ICT course algorithms subject?

1.1.1. Sub-Questions

1. What is the impact of "Scracth" on student's achievement?
2. Is there a difference between students' achievements in terms of gender?

2. Methodology

2.1. Research Design

In the study control group pre-test post-test experimental design that is one of the quantitative research methods was used. At the beginning of the study, two groups were formed as experimental and control groups. During implementation process for game based instruction Scratch was used while teaching in experimental group. On the other hand lecturing was used in control group.

2.2. Participants

Sample of the study consist of 60 6th grade students in an elementary school in Kahramanmaraş city center. One of the selected classes was assigned as experimental group and the other one was assigned as control group. There are 30 students in both groups. The numbers of girl and boy students in both groups are equal (15 girls and 15 boys).

2.3. Instruments

In the study an achievement test was developed for measuring algorithms units' objectives as a data collection tool. This test includes 10 items that are easy to difficult.

2.4. Implementation Process and Data collection

Implementations were conducted between 27 April and 18 May 2012 in an elementary school in Kahramanmaraş. Before implementation Scratch program orientation was given to experimental group. Then pre-test was conducted to control and experimental groups and class implementations were done. In control group 'Algorithms' subject was taught by lecturing and in experimental group for game based learning Scratch was used. After three weeks implementation post-test was conducted to both groups.

2.5. Data Analysis

In the study for data analysis independent sample t-test was used to determine whether there is a statistically significant difference between pre-test scores. Paired sample t-test was used to understand whether teaching methods have effect on students' achievements. Additionally to determine whether there is a statistically significant difference between post-test scores and whether there is a statistically significant difference between students' achievements in terms of gender, two-way ANCOVA was used for analyzing these data. In all statistical analyses significance level was taken as 0.05.

3. Results

3.1. The Effects of Scratch Program on Students' Achievements

To determine whether there is a significant difference between students' pre-test mean scores in experimental and control groups, pre-test results (Table 1) were examined.

Table 1. Independent Sample t-test results of Control and Experimental Groups' Pre-test Mean Scores

Groups	N	$\overline{x}$	SS	Sd	t	p
Control	30	4,1	1,446	58	-1,198	0,236
Experimental	30	4,56	1,568			

As it was seen in Table 1, there is no significant mean difference between control (4,1) group and experimental (4,56) group (t_{58} = -1,198; p>0,05). It means students in control and experimental groups were not different in terms of having information about information technologies course algorithms subject.

To determine whether learning occurs or not at the end of implementations in experimental and control groups, pre-test and post-test results (Table 2, Table 3) were compared.

Table 2. Paired Sample t-test results of Control Group's Pre-test and Post-test Scores

Tests	N	$\overline{x}$	SS	Sd	t	p
Pre-test	30	4,10	1,44	29	-9,261	0,000
Post-test	30	7,46	1,27			

In Table 2, control groups' post-test scores (7,46) are higher than pre-test scores (4,10) and there is a statistically significant mean difference between these tests (t_{29}= -9,261; p<0,05). This finding indicates that in control group with regular instruction there is a positive change on students' leanings.

Table 3. Paired Sample t-test results of Experimental Group's Pre-test and Post-test Scores

Tests	N	$\overline{x}$	SS	Sd	t	p
Pre-test	30	4,56	1,56	29	-3,848	0,001
Post-test	30	6,63	2,40			

According to Table 3, there is a statistically significant mean difference between pre-test and post-test scores of experimental group students with Scratch program (t_{29}=-3,848; p<0,05). Post-test mean scores of experimental groups' students (6,63)higher than their pre-test mean scores(4,56). This finding indicates that in experimental group with regular instruction there is a positive change on students' leanings.

In Table 4, post-test mean scores and standard deviations of students in control and experimental groups were given.

Table 4. Post-test Mean Scores and Standard Deviations of Students in Control and Experimental Groups

Grups	$\overline{x}$	S	N
Experimental Group	6,63	2,40	30
Control Group	7,46	1,27	30
Total	7,03	1,95	60

According to Table 4, it can be seen that post-test mean scores (7,46) of students in control group are higher than post-test mean scores (6,63) of students in experimental group.

After it was seen that there is a positive change in both groups' learning, the effect of Scratch program on learning was examined. For this purpose pre-test scores were used as covariate, teaching method and gender were used as constant factors then two-way ANCOVA was conducted. This analysis was also used for examine whether there is a difference in achievements according to gender and group-gender interaction. Related findings were given in Table 5.

Table 5. ANCOVA Results of Post-test Scores of Students in Control and Experimental Groups

Source of Variance	Sum of Squares	sd	Mean Square	F	p
Corrected Model	12,179(a)	4	3,045	0,783	0,541
Pre-test	0,379	1	0,379	0,098	0,756
Group	10,323	1	10,323	2,656	0,109
Gender	0,223	1	0,223	0,057	0,812
Group*Gender	0,440	1	0,440	0,113	0,738
Error	213,754	55	3,886		
Total	3194,000	60			
Corrected Total	225,933	59			

According to Table 5, there is no statistically significant difference between post-test mean scores ($\overline{x}_{Control}$ = 7,46; $\overline{x}_{Experimental}$ =6,63) of experimental group with Scratch program instruction and control group with traditional methods ($F_{(1-55)}$= 2,656; p>0,05).

3.2. Student Achievement in terms of Gender

To determine whether there is a difference between experimental group students' and control group students' post-test mean scores, pre-test scores were used as covariate, teaching method and gender were used as constant factors then two-way ANCOVA was conducted(Table 6).

Table 6. Post-test Means, Standard Deviations and Sample Sizes of Groups in Terms of Gender

Group	Gender	$\overline{x}$	S	N
Experimental Group	Girls	6,46	2,32	15
	Boys	6,73	2,54	15
	Total	6,60	2,40	30
Control Group	Girls	7,46	1,35	15
	Boys	7,46	1,24	15
	Total	7,46	1,27	30
Total	Girls	6,96	1,93	30
	Boys	7,10	2,00	30
	Total	7,03	1,95	60

In Table 6, post-test scores and standard deviations of students in control and experimental groups in terms of gender variable. Posttest mean scores of girl students in control group (7,46) are higher than post-test mean scores of girl students in experimental group(6,46). Similarly; posttest mean scores of boy students in control group (7,46) are higher than post-test mean scores of boy students in experimental group (6,73). In Table 5, the results that were obtained from covariance analysis indicated that there is no statistically significant difference between post-test mean scores in control and experimental groups in terms of gender($F_{(1-55)}$=0,812; p>0,05). This means students' algorithms achievements in control and experimental groups do not differ in terms of gender.

4. Discussion and Conclusion

In this study, it was aimed to examine the impact of Scratch environment that was developed to provide an easy and funny way for learning computer programming by students, on student's achievement in sixth grade ICT course algorithms subject. In the implementation process, it was observed that students were in positive attitudes towards Scratch and wanted to use such computer applications. According to results Scratch promotes students' learning in sixth grade ICT course "algorithms" subject and it creates no significant difference on learning in contrast to traditional methods. This finding has similarity with some research results (e.g. Bayırtepe & Tüzün, 2007; Sert, 2009). In the literature, it was exposed by some researchers that there was an increase on student's performance in the implementations of different methods for teaching programming and algorithms (Crescenzi et al., 2012; Futschek & Moschitz, 2010; Futschek & Moschitz, 2011; Gültekin, 2006; Monroy-Hernández & Resnick, 2008; Peppler & Kafai, 2005, Resnick et al., 2009; Vobornik, 2011). Factors such as less implementation time period and students' unfamiliarity with learning environment structure may be affective on these different results than literature.

Another research result is that student's achievement has no significant difference in terms of gender. This result has parallelism with Sert' s (2009) research results.

In this study, it was examined the impact of Scratch environment on student's achievement in sixth grade ICT course algorithms subject. It may be useful to determine the impact of Scratch on learning with implementations of the learning environment in different grades in further research. Additionally, it may be conducted a qualitative research that has a long-term implementation process to determine impacts of the learning environment on learning.

References

Aydın, C. H., Hoşcan, Y. ve Özkul, A. E. (2004). Temel Bilgi Teknolojileri. Anadolu Üniversitesi, Eskişehir.

Bayırtepe, E. ve Tüzün, H. (2007). The effects of game-based learning environments on students'achievement and self-efficacy in a computer course. *Hacettepe University Journal of Education*, 33, 41-54.

Conway, M. J. (1997). *Alice: easy-to-learn 3d scripting for novices*. Unpublished Doctoral Dissertation, University of Virginia, Charlottesville.

Crescenzi, P., Malizia, A., Verri, M. C., Diaz, P., & Aedo, I. (2012). Integrating algorithm visualization video into a first-year algorithm and data structure course. *Educational Technology & Society*, *15*(2), 115–124.

Dasgupta, S., Papadimitriou, C. H., & Vazirani, U. V. (2006). Chapter 6 dynamic programming'. *Algorithms,* Retrieved from: http://www.cs.berkeley.edu/~vazirani/algorithms/all.pdf

De Bonte, A. M. (1998). *Pet park: a virtual learning world for kids*. Unpublished Master Thesis, MIT. Retrieved from: http://llk.media.mit.edu/papers/archive/deBonte-MEng/

Fellows M., Bell T., & Witten I. (2005) *Computer Science Unplugged*. Retrieved from: http://csunplugged.org/

Futschek, G., & Moschitz, J. (2010). Developing algorithmic thinking by inventing and playing algorithms. *Constructionism 2010: Constructionist approaches to creative learning, thinking and education*, 28-30 June, Paris, France.

Futschek, G. & Moschitz, J. (2011). Learning algorithmic thinking with tangible objects eases transition to computer programming. *5th International Conference on Informatics in Schools: Situation, Evolution and Perspectives, ISSEP 2011*, 26- 29 October, Bratislava, Slovakia.

Gültekin, K. (2006). *The effects of multimedia on computer programming achievement*. Unpublished Master Thesis, Hacettepe University, Ankara.

Learning with Scratch (2012). *Scratch and 21st century learning skills.* Retrieved from: http://info.scratch.mit.edu/sites/infoscratch.media.mit.edu/docs/Scratch-21stCenturySkills.pdf

Monroy-Hernández, A., & Resnick, M. (2008). Empowering kids to create and share programmable media. *Interactions*, *15*(2), 50-53.

Peppler, K., & Kafai, Y. (2005). Creative coding: The role of art and programming in the K-12 educational context. Retrieved from: http://download.scratch.mit.edu/CreativeCoding.pdf

Resnick, M., Kafai, Y., Maloney, J., Rusk, N., Burd, L., & Silverman, B. (2003). A networked, media-rich programming environment to enhance technological fluency at after-school centers in economically-disadvantaged communities. *Proposal to National Science Foundation*.

Resnick, M., Maloney, J., Monroy-Hernández, A., Rusk, N., Eastmond, E., Brennan, K., Millner, A., Rosenbaum, E., Silver, J., Silverman, B., & Kafai, Y. (2009). Scratch: programming for all. *Communications Of The Acm*, *52*(11), 60-67.

Sert, S. (2009). *The effect of educational computer games on high school students' performance level related to internet knowledge:The case of quest atlantıs*. Unpublished Master Thesis, Hacettepe University, Ankara.

Sivilotti, P. A. G., & Laugel, S. A. (2008). Scratching the surface of advanced topics in software engineering: a workshop module for middle school students. *39th Technical Symposium on Computer Science Education*, March 12-15, Portland, OR, USA.

Talim ve Terbiye Kurulu Başkanlığı. (2012). İlköğretim 1-8. Sınıflar Bilişim Teknolojileri Öğretim Programı. Retrieved from: http://ttkb.meb.gov.tr/www/ogretim-programlari/icerik/72

Utting, I., Cooper, S., Kölling, M., Maloney, J., & Resnick, M. (2010). Alice, greenfoot, and scratch – a discussion. *ACM Transactions on Computing Education*, *10*(4), 1-11.

Vobornik, P. (2011). Teaching algorithms using multimedia tools. *8th International Conference on Efficiency and Responsibility in Education*, June 9-10 Prague, Czech Republic.

Ziatdinov, R., & Musa, S. (2012). Rapid mental computation system as a tool for algorithmic thinking of elementary school students development. *European Researcher*, *25*(7), 1105-1110.