The Effect of Individual and Group Learning on Block-Based Programming Self-Efficacy and Robotic Programming Attitudes of Secondary School Students

Esra ARSLAN [1], Onur İŞBULAN [2]

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[1] arslnnesra@gmail.com, Sakarya University, Turkey

[2] oisbulan@sakarya.edu.tr, Sakarya University, Department of Computer Education and Instructional Technologies, Turkey

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ABSTRACT

In this research, the effects of individual and teamwork activities on perceptions of block-based programming self-efficacy and attitudes towards robotic programming tried to be determined. The research has conducted in a private school located in Sariyer, district of Istanbul province in the 2nd academic year of 2018-2019 with 32 students from 7th Grade. The study fulfilled a semi-experimental pattern on the teamwork and individual work groups using the pretest-posttest design. The individual group consists of nine females (56.3%) and seven males (43.8%) and the teamwork group consists of eight females (50%), eight males (50%) students. According to the research results, individual work and teamwork did not affect secondary school students' perceptions of block-based programming self-efficacy and their attitudes towards robotic programming. In addition to this, it has been determined that there was a significant difference in attitudes of block-based programming self-efficacy perceptions and robotic programming for both individual and teamwork group students.

Keywords: *Block-based programming, scratch, self-efficacy, robotic programming, attitudes towards robotic programming*

INTRODUCTION

Technology has developed and changed continuously from past to present. As a result of the development and change in technology, the 21st century we are in has started to be named with different names. As a matter of fact, one of the prominent names is, Polat's (2006)"The information age" concept foreseen for our age comes as a result of the development of information and communication technologies. The continuous use of information and communication technologies by individuals while processing information has led to the definition of the information age concept (Polat & Odabaş, 2008). When we examine this concept, today's individuals discovered the importance of knowledge and began to produce and share information; Therefore, knowledge has increased considerably both in terms of quantitative and diversity, causing the age to be named as the information age (Gömleksiz, Kan & Bozpolat, 2013).

With the numerical and diversity of information, individuals have come across a lot of information. It has become very important for individuals among the pile of information to access the right information by complying with the needs of the age and to complete their lifelong learning in the most effective way. For this, individuals need to have the skills and competencies to acquire, use and share information, and to have information literacy as the age requires by using technology effectively in this process (Kurbanoğlu & Akkoyunlu, 2001).

Traditional information sources such as encyclopedias, books, and magazines, which were used to access information in the processes before the information age, have changed shape with the introduction of the internet into our lives. The Internet communication network, which is used worldwide and is constantly expanding, offers individuals the opportunity to access and share information quickly, easily, and at low cost (Gönenç, 2003).

The birth of the Internet brought with it the concept of the World Wide Web (www). The Web first launched as Web 1.0. Web 1.0 provided users with a text-only and reading-oriented structure (Morkoç & Erdönmez, 2014). The basic action of users in Web 1.0; accessing the source of information, getting the information that can meet their needs from the accessed source, and leaving the web pages. With the development of technology, there has been a transition to Web 2.0. Web 2.0 hosts multiple applications and services (blog, wiki, podcast, instant messaging, etc.), allowing users to share content, interact, and collaborate through these tools (Horzum, 2010). With Web 2.0, individuals have become able to use powers such as commenting, producing, and sharing content as well as accessing the content (Genç, 2010). Thanks to these changes, individuals started to download the files they wanted from the library websites to media such as computers, tablets, or smartphones without changing their location (Tonta, 2009).

Technologies such as the internet, computer, tablet, mobile devices, camera, Web 2.0 tools, etc., which are used frequently and by almost everyone today are described as digital technologies. (Timur, Timur, & Akkoyunlu, 2014; Cabı, 2016). It can be inferred that in the age we are in, technology is dominant and these technologies are used while searching for, accessing, or sharing information and that digitalization has become commonplace today. With this inference, it is possible to say that digitalization affects both technology and age. With these situations, it is aimed to reveal that the information age of the 21st century has turned into a digital age. Therefore, it is thought that it would be more appropriate to use the concept of the digital age for the 21st century, which is called the information age. Considering the digital age as a concept; It is seen that it is explained as the digitalization of duties or responsibilities of individuals and their status and knowledge as well (Altınay Gazi, 2016).

The acceleration of technological movements and the widespread use of computers necessitated the use of computers in educational environments (Çevik & Baloğlu, 2007; Keleş, Dündar Öksüz, & Bahçekapılı, 2013). With the participation of the computer in the education process, digitalization in education has been made and the Ministry of National Education (MEB) came up with the FATIH Project (Movement for Increasing Opportunities and Improving Technology), which aims to integrate technology into education in 2010. Basically, with this project, it is among the objectives of the project that individuals should have 21st-century skills such as problem-solving, analytical thinking, cooperation by providing equal educational environments, accessing the necessary information for their needs easily, and having the competence to work in cooperation (MEB, 2019a). Within the scope of the FATIH Project, traditional boards used with chalk in schools have been replaced by interactive boards (MEB, 2019b). In addition, tablets were distributed within the scope of the project in order to ensure that students and teachers can access the course contents anytime and anywhere (MEB, 2019c).

Digitalization in education and training has not only brought about this but also brought the concept of "e-learning" before us. E-learning is expressed as individuals using internet technologies to produce different solutions by increasing knowledge and performance, and at the same time, instead of this concept, the concepts of web-based learning, online learning, and internet-based learning can be used (Jethro, Grace, & Thomas, 2012). In other words, e-learning is the use of technological resources such as computers and the internet in learning-teaching activities (Albayrak & Albayrak, 2016). With this concept, the traditional classroom environment was abandoned and the transition to the internet and web environment was made.

In the 21st century, which has been blended with information and communication technologies, some skills and competencies that individuals should have been mentioned. Problem-solving, critical thinking, collaboration, and communication skills have been described as 21st-century skills that must be possessed in order to call today's individuals successful (P21, 2019). Coding helps to apply 21st-century skills such as problem-solving, collaboration, and analytical thinking (European Commission, 2019). It is possible to say that these skills are related to coding and at the same time, coding is effective in gaining popularity. For this reason, it was thought that each individual should have coding skills and coding lessons were added to the curriculum (Baz, 2018).

With the introduction of coding into the education system, different coding environments have begun to appear. For example; Alice, Code.org, Blockly, Scrath, App Inventor are some of these environments and they offer block-based programming (Numanoğlu & Keser, 2017). In block-based programming, individuals are expected to code by combining blocks of code with click-drag or jigsaw logic without the need to write lines of code. It can also be said that block-based coding environments are widely used for teaching coding to younger age groups (Aytekin, Sönmez Çakır, Yücel, & Kulaözü, 2018).

The language and environment used during the programming education must be suitable for the student audience it will address. Otherwise, the complex structures for the student will affect their attitudes towards programming negatively. Saygıner and Tüzün (2017) stated that the programming languages used during programming education were at a more advanced level, that these languages were foreign, that students had difficulties in programming and suggested that block-based programming environments could be used to eliminate this problem. In addition to this statement, they stated that thanks to block-based programming environments, students can be able to learn programming by embodying abstract codes. Demirer and Sak (2016) also conveyed that the basic structure of programming can be learned by users with tools such as Scratch and MIT App Inventor. Ersoy, Madran, and Gülbahar (2011) stated that robotic programming can also be used to concretize programming concepts. Numanoğlu and Keser (2017) stated that students embody concepts and structures with robotic programming, can get a direct physical output of codes, and the use of robots can be effective in students' positive attitudes towards programming. Based on this information, it can be argued that the basic level of robotic programming and other programming languages for younger students are block-based programming environments. The attitudes of students who feel competent and self-efficacious in block-based programming towards robotic programming or other programming languages are shaped and become measurable. Within the scope of this study, it was aimed to measure the students' self-efficacy perceptions of block-based programming and their attitudes towards robotic programming.

When individuals code in block-based programming environments, they will first make an application in line with their own thoughts, and if there is an error in their application, they will try to correct it. In addition, individuals will make arrangements in their applications through collaboration, another 21st-century skill, by getting ideas from their peers or friends (Demirer & Sak, 2016). Cooperation in question can be explained as valuing the contributions of each individual in line with a common goal within the framework of respect (Gelen, 2017). Based on this, It can be said that individuals may need a different perspective in processes such as coding, problem-solving, and design, and this level of need is minimized thanks to the ability to cooperate.

With the introduction of computer and coding education to the schools, it has been expected that individuals will produce products by working in cooperation and practice. While computer laboratories in schools in our country provide a computer to each student within the bounds of possibility, in some schools or situations more than one student may need to use one computer. In such cases, the programming course is explained to help individuals learn.

Within the scope of this study, it was aimed to determine the self-efficacy perceptions of middle school students towards block-based programming environments along with their attitudes towards robotic programming and the problem sentences of the study are presented below.

• Does individual and group learning affect middle school students' perceptions of self-efficacy towards block-based programming?

• Does individual and group learning affect middle school students' attitudes towards robotic programming?

RESEARCH METHOD

Research Model

Within the scope of the study, the effect of individual and group learning on secondary school students' self-efficacy perceptions and attitudes towards robotic programming was examined. However, the study was carried out using a quasi-experimental design with a pretest-posttest. Experimental designs are in scientific research methods that enable us to compare the processes used within the scope of the research and make clear inferences about the effectiveness of the processes (Büyüköztürk, Çakmak, Akgün, Karadeniz, & Demirel, 2019).

Working Group

The study group of the research consists of 32 7th grade students studying in the 2nd semester of the 2018-2019 academic year in a private school located in the Sarıyer district of Istanbul province. Participants were divided into two experimental (16-16 people) groups. The students in the first experimental group worked in groups of two, while the others worked individually. Normal distribution tests were applied for both groups. According to the results of the Shapiro-Wilk Test, it was observed that the individual work group and the teamwork group were normally distributed. Demographic information of the participants is given in Table 1.

Table 1. Demographic Information of the Study Group

		Teamwork		Individual Work	
		n	%	n	%
Gender	Male	8	50%	9	56.3%
	Female	8	50%	7	43.8%
Already Taken Programming Lesson with Scratch	Yes	3	18.8%	10	62.5%
	No	13	81.3%	6	37.5%
Already Taken a Robotic Coding Lesson	Yes	5	31.3%	8	50%
	No	11	68.8%	8	50%

Data Collection Tool

Within the scope of the "Problem Solving and Programming" unit included in the elective Information Technologies and Software course curriculum, the subjects and lesson plan to be explained to the students in the study group using the Scratch 2.0 Offline Editor program were determined and used in the study by taking expert opinion.

The "Self-Efficacy Perception Scale for Block-Based Programming" developed by Altun and Kasalak (2018) was used to measure students' self-efficacy perceptions regarding block-based programming skills. Scale consists of 12 items in total, 5 items for simple programming tasks and 7 items for complex programming tasks. However, the scale consisting of 2 factors is in the 5-point Likert type. Likert types; 1- I do not trust at all, 2- I trust a little, 3- 50% / 50%, 4- I quite trust, 5- I completely trust. A reliability coefficient for the whole scale was found .893, the reliability coefficient of the factors was found higher than .80.

"Robotic Activities Attitude Scale" developed by Şişman and Küçük (2018) is the other data collection tool of the study. The scale has 4 factors (intention to learn, self-confidence, computational thinking, and teamwork) and 24 items. The scale is 5-point Likert type and is 1- Strongly Disagree, 2- Disagree, 3- Undecided, 4- Agree, 5- Strongly Agree. The reliability coefficient of the scale is .932. Reliability coefficients according to the factors of the scale is determined as; willingness to learn .925, self-confidence .860, computational thinking .815, teamwork .732.

Collection of Data

Preliminary tests were conducted to determine the Scratch programming self-efficacy perceptions and attitudes towards robotic programming of the students in the study group. Then, the same content was transferred to all the students in the study group in the Scratch programming environment using the same method/technique (narration, demonstration, question-answer) in a 5-week period. After the lecture process was completed, post-tests were conducted to determine the final status of Scratch programming self-efficacy perceptions and attitudes towards robotic programming.

Data Analysis

The data obtained within the scope of the research were analyzed by using IBM SPSS Statistics 22.0 program and MS Office Excel program and the level of significance (p) was accepted as 0.05. T-test for independent samples and t-test for dependent samples were used for the obtained data, and ANCOVA test was used for detailed analysis of the data.

FINDINGS

In this section, an analysis of the data collected within the scope of the study has been made and the obtained results are presented in tables and interpreted.

Self-efficacy Perception Scale Regarding Block-Based Programming Belonging to Experimental Groups Comparison of Pre-Test and Post-Test Results

In order to test whether there is a significant difference between the pre-test scores of the students in two different groups, the "Self-Efficacy Perception Scale for Block-Based Programming-SEPS" t-test was applied to independent samples from parametric tests.

Table 2. T-Test Results for the Experimental Groups' Pre-Test Scores of SEPS (SEPS-Pre)

Group	N	X̄	S.S	Sd	t	p
Teamwork	16	27.94	9.970	30	0.191	0.850
Individual Work	16	27.19	12.161			

Block-based programming self-efficacy pre-test scores of students in the groups are shown in Table 2. As a result of the t-test, it was concluded that there was no significant difference between the average scores ($\bar{X}$=27.94) of the teamwork group and individual work group ($\bar{X}$=27.19) (t_{30}= 0.191, p> 0.5). Thus, at the beginning of the study, it was determined that the block-based programming self-efficacy perceptions of the students in both groups were at the same level.

However, it was aimed to control the effect of the students being in the teamwork or individual work group on the scores of the Self-Efficacy Perception Scale for Block-Based Programming, and for this reason, ANCOVA was performed by transferring scores to the control variable. ANCOVA is a test that compares between groups and is thought to be quite effective (Büyüköztürk, 2016).

Table 3: Corrected Post-Test Scores of the Experimental Groups According to the SEPS-Pre Points

Group	N	X̄	S.S	Corrected X̄
Teamwork	16	39.56	12.987	39.569
Individual Work	16	37.44	11.564	37.431

When Table 3 is examined, it has been corrected according to the scores of the experimental group students after the experimental procedures. The corrected average scores of SEPS-Post for teamwork group is 39,569, and the corrected average scores of SEPS-Post for individual work group is 37,431.

The results of the ANCOVA test analysis made between teamwork and individual work students, which were corrected according to the SEPS-Pre scores, are presented in Table 4.

Table 4: Corrected Post-Test Scores of the Teamwork and Individual Work Groups According to the SEPS Pre-Test Points

Source of Variance	Total of Squares	Sd	Average of Squares	F	p	η^2
Pre Test (Reg.)	1,028	1	1,028	0.007	0.936	0.000
Group	**36.506**	**1**	**36.506**	**0.233**	**0.633**	**0.008**
Error	4534.847	29	156.374			
Total	4572.000	31				

According to the ANCOVA results in Table 4, it is seen that there is no significant difference according to the mean Self-Efficacy Perception Scale for Block-Based Programming scores of the students studying in the teamwork and individual work groups ($F_{1\text{-}31}$= 0.233, p≥ 0.05). When examined in terms of partial effect size, being in different groups has an effect of 0.008 on the posttest scores of the students. As a result of ANCOVA, it was concluded that the students did not differ according to the group in which they were in.

In order to determine whether there is a significant difference between the pre-test and post-test scores of both the teamwork group and the individual work group themselves, the t-test was applied to the dependent samples.

Table 5: T-Test Results of the Teamwork Group's SEPS Pre Test - Post Test Score Differences

Test	N	X̄	S.S	Sd	t	p
SEPS-Pre	16	27.94	9.970	15	-2.810	0.013
SEPS-Post	16	39.56	12.987			

Table 5 shows the analysis results of the teamwork group students' SEPS pre-test and post-test scores. According to the parametric test results regarding the pre-test and post-test scores of the group, it was determined that there is a significant difference between the students' mean SEPS-Pre (X̄ = 27.94) and their SEPS-Post average score (X̄ = 39.56) (t_{15}= -2.810, p <0.05). The program applied to the teamwork group students in the period between the pre-test and the post-test was successful, and the students' perception of block-based programming self-efficacy increased.

Table 6: T-Test Results of the Individual Work Group's SEPS Pre Test - Post Test Score Differences

Test	N	X̄	S.S	Sd	t	p
SEPS-Pre	16	27.19	12.161	15	-2,433	0.028
SEPS-Post	16	37.44	11.564			

Table 6 shows the analysis results of the individual work group's pre-test and post-test scores. As a result of the parametric test applied, a significant difference was determined between the group students' mean SEPS-Post score (X̄ = 27.19) and SEPS-Post score averages (X̄ = 37.44) (t_{15}= -2.433, p <0.05). The program applied to the individual work group students in the period between the pre-test and the post-test was successful, and the students' perception of block-based programming self-efficacy increased.

Comparison of Teamwork and Individual Work Groups' Robotic Activities Attitude Scale (RAAS) Pre Test and Post Test Results

In order to test whether there is a significant difference between both the pre-test and post-test scores of the students in two different groups, the t-test was applied to the independent samples from the parametric tests.

Table 7: T-Test Results for RAAS Pre-Test Scores of Teamwork and Individual Work Groups

Group	N	X̄	S.S	Sd	t	p
Teamwork	16	70.13	20.765	30	-0.487	0.630
Individual Work	16	74.38	28.052			

Table 7 shows the analysis results of RAAS Pre-Test (Robotic Activities Attitude Scale Pre-Test) scores of the teamwork and individual work group students. As a result of the analysis, there was no significant difference between the teamwork group students' RAAS Pre-Test average score (X̄ = 70.13) and the individual work group students' RAAS Pre-Test average score (X̄ = 74.38) (t_{30}= -0.487, p≥0.05). Thus, it can be said that students in both the teamwork group and the individual work group have the same attitudes towards robotic programming at the beginning.

Also, it was aimed to control the effect of the students' group (teamwork and individual work group) on RAAS Post-Test (Robotic Activities Attitude Scale Post-Test) scores and therefore, ANCOVA was performed by transferring the pre-test scores to the control variable.

Table 8: Corrected Post-Test Scores of the Teamwork and Individual Work Groups According to the RAAS Pre-Test Points

Group	N	X̄	S.S	Corrected X̄
Teamwork	16	84.44	14.487	84.400
Individual Work	16	75.56	27.018	75.600

In Table 8, the RAAS Post-Test average scores the teamwork group students received after the experimental procedures and corrected according to the RAAS Pre-Test scores is 84,400, and the corrected RAAS Post-Test score average of the individual work group students is 75,600.

The results of the ANCOVA test analysis made between the RAAS Post-Test scores of the teamwork and individual work group students, which were corrected according to the RAAS Pre-Test scores, are presented in Table 9.

Table 9: ANCOVA Test Results Between RAAS Post-Test Scores Corrected According to the RAAS Pre-Test Scores of the Groups

Source of Variance	Total of Squares	Sd	Average of Squares	F	p	η^2
Pre Test (Reg.)	5.719	1	5.719	0.012	0.914	0.000
Group	**614.633**	**1**	**614.633**	**1.265**	**0.270****	**0.042**
Error	14092.156	29	485.936			
Total	14728.000	31				

According to the ANCOVA results in Table 9, it is seen that there is no significant difference according to the mean RAAS Post-Test scores of the students studying in the teamwork and individual work groups (F_{1-31}= 0.233, p≥ 0.05) corrected according to RAAS Pre-Test. When examined in terms of partial effect size, being in different groups has an effect of 0.008 on the posttest scores of the students. As a result of ANCOVA, it was concluded that students' attitudes towards robotic programming did not differ according to the group they were in.

In order to compare the pre-test and post-test scores of the students in the teamwork and individual work groups within the groups, a t-test was applied to the dependent samples.

Table 10: T-Test Results of the Teamwork Group's RAAS Pre Test - Post Test Score Differences

Test	N	X̄	S.S	Sd	t	p
RAAS Pre-Test	16	70.13	20.765	15	-2.642	0.018
RAAS Post-Test	16	84.44	14.487			

Table 10 presents the analysis results of the teamwork group's RAAS pre-test and post-test scores. As a result of the analysis, it was concluded that there was a significant difference between the RAAS Pre-Test average score (X̄ = 70.13) and the RAAS Post-Test average score (X̄ = 84.44) of the students in the teamwork group (t_{15}= -2.642, p <0.05). The program applied between the pre-test and post-test increased by positively affecting the attitudes of the teamwork group students towards robotic programming.

Table 11: T-Test Results of the Individual Work Group's RAAS Pre Test - Post Test Score Differences

Test	N	X̄	S.S	Sd	t	p

RAAS Pre-Test	16	74.38	28.052	15	-0.114	0.911
RAAS Post-Test	16	75.56	27.018			

Table 11 shows the analysis results of the RAAS pre-test and post-test scores of the individual work group. As a result of the analysis, no significant difference was found between the RAAS Pre-Test average score ($\bar{X}$ = 74.38) and the RAAS Post-Test score average ($\bar{X}$ = 75.56) of the students in the individual work group (t_{15}= -0.114 p≥0.05). The program applied between the pre-test and the post-test did not have any effect on the individual work group students' attitudes towards robotic programming.

DISCUSSION AND CONCLUSION

Within the scope of the study, the perceptions of self-efficacy towards block-based programming and attitudes towards robotic programming of middle school students who learn individually and in groups were examined. As a result of the research, it was concluded that there was no significant difference between the block-based programming self-efficacy perceptions of the teamwork group performing group learning and the individual work group students performing individual learning. However, it was determined that there was a significant difference between the SEPS-Pre scores and the SEPS-Post scores of the students in both the teamwork and individual work groups, and there was an increase in the block-based programming self-efficacy perceptions of the students in both groups. When studies on different age groups are examined in the literature, Mazman and Altun (2013) found that students' self-efficacy perceptions increased after taking programming lessons in the study they conducted with university students. Aydoğdu (2020) stated in his study on university students that block-based programming activities showed positive results on students' self-efficacy perceptions. Kasalak (2017), in his study on middle school students, stated that robotic programming activities had a positive effect on students' perceptions of programming self-efficacy.

Attitudes of teamwork group students and individual work group students towards robotic programming were examined, and it was found that there was no significant difference between students' attitudes towards robotic programming activities. In addition, it was determined that there was a significant difference between RAAS Pre-Test scores and RAAS Post-Test scores of the students in the teamwork group, but there was no change in the RAAS scores of the students in the individual work group. Sümer, Gülen, Aydın, Yeşiltepe, and Gezgin (2019), in their research on high school students, concluded that there was no significant difference in robotic programming attitudes of students working individually or in groups. Akman Selçuk (2019), in his study on middle school students, concluded that students' robotic programming attitudes are at a good level and they have a positive attitude towards robotics.

It was concluded that there was no significant difference between the teamwork and individual work group students' previous robotic coding course and their RAAS scores. Korucu and Taşdöndüren (2019) concluded that there is a significant difference between students using Scratch outside of the classroom and their robotic programming attitudes. However, it was determined that the attitudes of students already taken a programming course towards robotic programming were higher than students who did not take a programming course.

Suggestions

In this study, the perceptions of block-based programming self-efficacy and attitudes towards robotic programming of middle school students who learn individually and in groups were examined. In future studies, this study can be carried out in different education and grade levels (primary school, high school, university, 5th, 6th, 8th, etc.) in both public and private schools. A larger sample can be selected for future studies and it can be brought to the literature by making a comparison with the results of this study. Studies on block-based programming environments and applications can be carried out by using various variables (such as awareness levels, interest levels, extracurricular use situations, programming achievements, motivations) for parents, teachers, and students. In future studies, different methods and techniques can be used to work on students' block-based programming self-efficacy perceptions and attitudes towards robotic programming. In the education faculties that train future teachers, courses on block-based programming and robotics programming can be given within the relevant departments. Both the next generation and today's teachers, students and, parents can be informed about block-based programming and robotic programming.

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