THE EFFECT OF BLOCK-BASED PROGRAMMING ON THE COMPUTATIONAL THINKING SKILLS OF MIDDLE SCHOOL STUDENTS

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ABSTRACT
The aim of the study was to determine the effect of the programming instruction process carried out by using mBlock programming tool on the students' computational thinking skills. The study design was one group pre-test-post-test experimental design. Study group was consisted of 82 students enrolled to a secondary school in Edremit district of Van province / Turkey. 39 of the participants were female and 43 of them were male. Participants were 6th grade students in three different classes. Instruction process was leaded in 2017-2018 academic year. MBlock tool was used in computer programming instruction process. Teaching sessions were two hours per week, 12 weeks in total. In the instruction process *concepts of software, the problem concept, algorithm concept, algorithm steps belonging to a problem, geometrical shapes in the flow chart, mBlock characters, events & control blocks, coordinate axis & scene section, perception blocks, operator blocks, and variable concepts* were handled respectively. Exercises about these subjects were done. Data were collected by Computational Thinking Levels Scale (CTLS) developed by Korkmaz, Çakır & Özden (2015). CTLS has five sub-dimensions, namely, Creativity, Algorithmic thinking, Collaboration, Critical thinking, and Problem solving. The collected data were corresponding to the normal distribution. The data were analyzed through paired samples t tests. According to the findings, post-test scores of the CTLS were statistically higher than the pre-test scores. In addition to this, all scores for sub dimensions statistically differ in favor of post-tests except problem solving dimension. In other words, the development of higher order thinking skills such as computational thinking can be provided with programming courses where block based tools used. In 2018, Problem Solving and Programming Unit were added to Information Technology and Software curriculum in 5th and 6th grades in Turkey. In the lights of the findings, it seems that the decision taken by Turkish Ministry of Education is correct.
Keywords: computational thinking, block based programming, middle school students.

INTRODUCTION

Contemporary technological developments are used by all areas. These technologies make life easier. In addition to this, it is expected that Information and Communication Technologies (ICT) have a potential to improve higher order thinking skills (Korkmaz &Altun, 2014). At this point first higher order thinking skill that comes to mind is Computational Thinking (CT). "CT is the thought processes involved in formulating problems and their solutions so that the solutions are represented in a form that can be effectively carried out by an information processing agent" (Wing, 2011). There are some methods to bring higher order thinking skills to people via technology. One of them is orienting individuals' computer programming. Thus, they use various technologies, develop projects and products (Akpınar &Altun, 2014; Çakıroğlu, Sarı, &Akkan, 2011).

After discourses about computer programming by celebrity people, worldwide projects have been started. New projects have started concerning integration of computer programming to education systems. Private sector administrators also support this progress (Numanoğlu & Keser, 2017). Turkish Ministry of Education (MoE) also followed this process. In 2018, Problem Solving and Programming Unit has been added to Information Technology and Software curriculum in 5th and 6th grades in Turkey (MoE, 2018). With the aim of make popular and teach computer programming some programming languages, implementation software and virtual platforms have been emerged. Within the scope of Information Technology and Software curriculum usually free tools are used. Blockly, AppInventor, Alice, Code Org and mBlock, Scratch and KoduLab are some examples for these platforms. MBlock, a block based programming tool, consists of robotic platforms (e.g., Mbot, MegaPi and Arduino) and Scratch 2.0. Scratch has graphical interface and it is a visual programming language. mBlock has an easy programming property. Via mBlock, we can program robots, produce with Arduino or Mbot and we do not need cable connection. Thus, robots can be programmed with various ways. With the graphical interface property we can develop interactive applications (e.g., animations, games, stories) (Numanoğlu & Keser, 2017). mBlock is an open source tool. We can use it for programming circuit boards which is besed on Ardunio. Additionally, we can use it with other Arduino compatible boards. Manufacturer Company stated that they will provide support for new platforms (Makeblock, 2017). New versions of mBlock are based on Windows, MAC, Linux, and Ipad. They support 20 languages and one of them is Turkish. It works independently and do not need additional application. It supports wireless communication protocols. Those are the reasons show why mBlock's range of use is wide.

To examine the effect of programming instruction leaded with mBlock in a certain period of time, on higher order thinking skills (e.g. Computational thinking) is important. Thus, programming instructors could observe the results and contribute to the literature about its effect.

THE STUDY

For Information Technology and Software course, coding has an important position. In the study, we aimed to determine the effect of mBlock based instruction on middle school students' Computational thinking skills. The study group consisted of 82 students enrolled to a secondary school in Edremit district of Van province / Turkey. Participants were 6^{th} grade students in three different classes. Teaching activities were conducted in the 2017-2018 academic year. One sample pretest-posttest experimental design was used. In the one sample pretest-posttest experimental design, the effect of the experimental process was determined with the study of one group. In the design, the differences between participants' pre-test and post-test scores were considered (Büyüköztürk et al., 2009).

The computational thinking levels scale (CTLS) was used as a measurement tool. CTLS was developed by Korkmaz, Çakır & Özden (2015). CTLS has five sub-dimensions. Creativity, Algorithmic thinking, Collaboration, Critical thinking, and Problem solving are the names of sub-dimensions. Creativity has 4 items; Algorithmic thinking has 4 items; Collaboration has 4 items; Critical thinking has 4 items; Problem solving has 6 items, and CTLS has 22 items in total. Cronbach alpha reliability coefficient is 0.640 for Creativity, 0.762 for Algorithmic thinking, 0.811 for Cooperativity, 0.714 for Critical thinking and 0.867 for Problem solving. Cronbach alpha reliability coefficient is 0.809 for whole scale. Scales goodness of fit indexes are as [$\chi 2_{(d=195, N=241)}= 448.11628$, $p<0.01$, CMIN/DF=2.298, RMSEA= 0.074, S-RMR= 0.078, GFI= 0.89, AGFI= 0.84, CFI= 0.91, NNFI= 0.91, IFI= 0.90]. MBlock tool was used in computer programming instruction process. The computational thinking skills were measured before and after the instruction process.

The participants received 24-class hour training that took 12 weeks (i.e., each week two-hour training was provided). In the first week, concepts of software and the problem concept were explained. Daily life problems presented and problem solving steps were showed. It was highlighted that, computers also apply commands step by step and solve problems.

In the second week, algorithm concept was explained. Algorithm steps, belonging to example problem, were shown. The use of geometrical shapes in the flow chart and their purposes were expressed. Flowchart representation of sample algorithms was explained. Finally, a problem situation was given. The participant students were asked to write algorithm steps for the solution of the problem given and prepare the flow chart.

In the third week, the students started to study with mBlock. Other characters (e.g., puppets etc) from Character tab were shown. Events and control blocks were introduced. The name application was made by using letters in the puppets. Students wrote their names with the help of puppets. They gave simple movements to their names with simple commands (e.g. magnify, minimize, increase color effect).

In the fourth week, coordinate axis and scene section were introduced. Puppets motion on the X Y location, direction concepts and various motion commands were introduced.

In the fifth week, students created some characters. They gave motion to the characters. Finally, they made some studies about the characters' appearance.

In the sixth week, aquarium application was shown to the students. Fish character and how to change the scene was shown. Then how to give motion to fish with motion block commands was shown. Finally, teacher asked the students to prepare an aquarium application themselves. In this week Events, Control, Motion and Appearance block commands were used by students actively.
In the seventh week, Perception block commands were introduced. Labyrinth application was made. Owing to this application all commands from all blocks were used.

In the eighth week, all commands learned earlier weeks, were remembered. Small samples were made about them. Pinball application was shown to the students. How to characters motion, what do they do when they touch each other and etc. was explained. Then students realized similar pinball application.

In the ninth week, operator block commands were shown. Small samples were made about it. With this commands a question bank was prepared. The question bank consisted of 5 questions. Teacher wanted to the students enlarge the question bank with different questions. In this exercise, the final question bank must consist of 15 questions.

In the tenth week, variable concept was introduced. Variable block commands were shown. Teacher asked students to make a fish catch application. Within the scope of this application scores must be shown to the users. The scores must be saved in some variables.

In the eleventh week, pen object commands were shown. Small samples were made the commands. Then teacher asked the students to make a mBlock application that draws geometric shapes.

In the twelfth week, code blocks, are subject of earlier weeks, were recalled again. Teacher asked questions about them and students answered. A prepared table hockey application was presented as an example. Helpful questions were asked to the students for building the game's algorithm. With the answers, students could build the algorithm. Further, students created their games in collaborative learning environment.

FINDINGS

The paired samples t-test was used to analyze research data. 0.05 significance level was accepted in the interpretation of the results. Table 1 shows the comparison of CT scores before and after the instruction process of the students.

Table 1: t-test results for CTLS pre-test post-test scores

Measurement	N	x̄	Sd	df	t	p
Pre-test	82	2.01	0.40894	81	-10.323	0.000*
Post-test	82	2.59	0.57299			

*p<0.01

When the Table 1 is examined, it is seen that there is a significant difference between CTLS' pre-test post-test scores ($t_{(81)}$=-10.323, p<0.05). According to the mean values, it is seen that the mean score of post-test is higher than that of pre-test. With this result, we can say mBlock based instruction process has a positive effect on students' computational thinking skills.

Table 2 below presents the details of the changes in Creativity sub-dimension scores of the CTLS before and after the instruction process.

Table 2: t-test results for CTLS creativity sub-dimension

Measurement	N	x̄	Sd	df	t	p
Pre-test	82	2.17	0.805	81	-6.223	0.000*
Post-test	82	2.77	0.873			

*p<0.01

According to Table 2, there is a significant difference between the pre-test and post-test scores of the creativity sub-dimension of the CTLS ($t_{(81)}$=-6.223, p<0.05). Considering the change in mean values, it is concluded that mBlock programming tool has a positive effect on students' creativity skills within the scope of 6^{th} grade information technologies and software course.

Table 3 below presents comparisons of the change in the Algorithmic thinking sub-dimension of the CTLS before and after the instruction process.

Table 3: t-test results for CTLS algorithmic thinking sub-dimension

Measurement	N	x̄	Sd	df	t	p
Pre-test	82	1.65	0.702	81	-9.051	0.000*
Post-test	82	2.51	0.747			

*p<0.01

According to Table 3, there is a significant difference between the pre-test and post-test scores of the algorithmic thinking sub-dimension of the CTLS ($t_{(81)}$=-9.051, p<.05). Considering the change in mean values, it is concluded that mBlock programming tool has a positive effect on students' algorithmic thinking skills within the scope of 6th grade information technologies and software course.

Table 4 below presents comparisons of the change in the Cooperativity sub-dimension of the CTLS before and after the instruction process.

Table 4: t-test results for CTLS cooperativity sub-dimension

Measurement	N	x̄	Sd	df	t	p
Pre-test	82	1.96	0.846	81	-8.037	0.000*
Post-test	82	2.83	0.766			

*p<0.01

According to Table 4, there is a significant difference between the pre-test and post-test scores of the cooperativity sub-dimension of the CTLS ($t_{(81)}$=-8.037, p<0.05). Considering the change in mean values, it is concluded that mBlock programming tool has a positive effect on students' cooperativity skills within the scope of 6th grade information technologies and software course.

Table 5 below presents comparisons of the change in the Critical thinking sub-dimension of the CTLS before and after the instruction process.

Table 5: t-test results for CTLS critical thinking sub-dimension

Measurement	N	x̄	Sd	df	t	p
Pre-test	82	1.68	0.665	81	-7.725	0.000*
Post-test	82	2.45	0.762			

*p<0.01

According to Table 5, there is a significant difference between the pre-test and post-test scores of the critical thinking sub-dimension of the CTLS ($t_{(81)}$=-7.725, p<0.05). Considering the change in mean values, it is concluded that mBlock programming tool has a positive effect on students' critical thinking skills within the scope of 6th grade information technologies and software course.

Table 6 below presents comparisons of the change in the Problem-solving sub-dimension of the CTLS before and after the instruction process.

Table 6: t-test results for CTLS problem solving sub-dimension

Measurement	N	x̄	Sd	df	t	p
Pre-test	82	2.38	0.638	81	-0.778	0.439
Post-test	82	2.46	0.826			

According to Table 6, there is no significant difference between the pre-test and post-test scores of the problem solving sub-dimension of the CTLS ($t_{(81)}$=-0.778, p>0.05). MBlock tool based instructional process did not contribute significant effect to the problem solving skills of the students.

CONCLUSIONS

The aim of the study was to examine the possible effect of mBlock based instruction to middle school 6th grade students' Computational thinking skills. According to the results obtained, a significant difference has occurred in the students' computational thinking skills. According to this result, it can be said that it is useful to perform computer programming instruction in middle school with block based and graphical interface tools like mBlock. At the same time, it is seen that the mean scores of creativity, algorithmic thinking, cooperativity, and critical thinking sub-dimensions of the CTLS increased significantly from pre to post-test.

According to the findings of the study, cooperativity and algorithmic thinking sub-dimensions of the CTLS have the highest mean values and they have significant difference from pre to post test. Pre-test mean values of cooperativity sub-dimension was x̄=1.96; post-test average measurements of cooperativity sub-dimension was x̄=2.83. Similarly, in the study of Korkmaz et al. (2015) with university students, the highest score was observed in the cooperativity sub-dimension. For the critical thinking dimension, while the pre-test mean score was x̄=1.68, the post-test mean score was x̄=2.45. This result shows that mBlock programming tool positively affects students' critical thinking skills. Critical thinking is an important output of the National education system. Additionally, it is important for information literacy (MoE, 2005). At the end of the instructional process, there was no significant change in the problem solving sub-dimension of the CTLS, while all sub-dimensions of CTLS were improved. This result may suggest that 24-hour training may not be sufficient to develop problem-solving skill. In the future studies, it may be useful to give longer training to participants and pay specific attention to that sub-dimension. Finally, the results of this study are limited to 82 students who were 6th grade in Edremit district of Van. In the future studies, similar research should be conducted with larger groups in different parts of Turkey. In doing so, clearer and richer results will inform the literature.

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