International Journal of Progressive Education, Volume 16 Number 1, 2020

An Investigation the Effect of STEM Practices on Fifth Grade Students' Academic Achievement and Motivations at The Unit "Exploring and Knowing the World of Living Creatures"

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Abstract

This study aims to investigate the effects of Science Technology Education Math (STEM) practices on academic achievement and motivations of students in the 5th grade of middle school in "Exploring and Knowing the World of Living Creatures" section in Science lecture. The study was designed in a semi-experimental pattern with pre-test post-test control group. A middle school in the center of Antakya was selected by appropriate sampling method. The sample of the study was formed by the 5th grade students who were studied in 2 sections where the same teacher taught. A group of students in one section formed the control group of students while the other branch formed experimental group. The unit 'Exploring and Knowing the World of Living Creatures' was explained through the lesson plans prepared according to the STEM applications in the experimental group and through the methods appropriate to the course book in the control group. As a data collecting tool, both groups were given the "Exploring and Knowing the World of Living Creatures Achievement Test (EKWLCAT) and "Motivation Scale toward Science Learning" (MSSL) were applied. The obtained data were analyzed by statistical analysis utilizing the mean, standard deviation, frequency and percentage values of these data using an appropriate statistical program. As a result, it has been determined that STEM applications have a positive effect on academic achievement. However, when the subcategories of the motivation scale were examined, a statistically significant difference was not found in the subcategories of performance communication and participation, while a positive increase was found in favor of research and cooperation.

Key Words: STEM, academic achievement, motivation

DOI: 10.29329/ijpe.2020.228.10

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INTRODUCTION

In today's world, rapid developments in science and technology provide significant opportunities for countries seeking to build a strong future. The countries that are aware of the power of science and technology make plans using all their means in order to keep up with the technological developments. They improve their infrastructures and question their existing systems (Şenol, 2012).

In this context, the primary education curriculum was updated by the Ministry of National Education in 2004-2005 academic year and the name of science lesson changed to "Science and Technology". Thus, it is aimed to give more weight to applying science subjects to everyday life and to the direction of technology. With Turkey's Vision 2023, Ministry of National Education of (MONE) aims set out in the strategic documents, implies that science-technology-engineering-mathematics (STEM) need to be defined at the national level of education (Çorlu, Adıgüzel, Ayar, Çorlu and Ozel, 2012).

STEM education generally focuses on science and mathematics disciplines as well as technology and engineering fields (Bybee, 2010; Şahin, Ayar and Adıgüzel, 2014). The aim of the STEM education is to achieve a holistic approach to learning by establishing a relationship between disciplines (Smith and Karr-Kidwell, 2000; Yamak, Bulut and Dündar, 2014). It plays an important role in acquiring the skills that people with science and mathematical characteristics should possess. Being aware that education is crucial to produce technology and knowledge, countries place great importance on science and mathematics education. On the other hand, technology and engineering, which is the field of application of science and mathematics, is spreading to every field of modern life and providing solutions to the problems of humanity (National Research Council [NRC], 2012; Next Generations Science Standards [NGSS], 2013; Brophy, Klein, Porstmore and Rogers, 2008; Yamak et al., 2014).

Since the problems encountered in the changing and developing world are interdisciplinary, the solutions must be interdisciplinary like STEM concepts (Garmire & Pearson, 2006; Höbek 2014). Existing studies aimed at increasing interest in STEM issues and encouraging STEM literacy; developing courses in the classroom (Adelman, 2006; Tyson, Lee, Borman and Hanson, 2007; Şahin, Ayar and Adıgüzel, 2014), increasing the interest of students in the field of STEM (Cleaves, 2005; Şahin et al. 2014) and STEM focused activities to gain experience in the classroom environment (Cleaves, 2005; Munro and Elsom, 2000; Şahin et al. 2014).

When the engineering design process used in STEM training is examined; it is understood that there is a way to discover problems or needs, to examine problems or needs in detail, to produce possible solutions, to choose the best solution, to create the first design example, to test and evaluate the solutions, to communicate with the experts for solution and finally to redesign (Massachusetts Department of Education, 2006; Bequette and Bequette, 2012; Deveci and Çepni, 2014; Tate, Chandler, Fontenot and Talkmıtt, 2010). Technology produces solutions to real problems by changing the world and developing new information to meet people's needs (Ceylan, 2014; Sanders, 1999). Technological products have come to fruition using science and mathematical knowledge to understand, design and implement engineers' problem-oriented solutions (Ceylan, 2014). In this sense, most modern technology that exists today is a product of science, mathematics and engineering.

The Organization for Economic Co-operation and Development (OECD) has a distinct place among the institutions that determine educational policies due to its global impact. The results of PISA and similar international student assessment programs organized by this institution are utilized by some researchers to logically explain the need for STEM training; the number of students below the average level of science and mathematics literacy is presented as a fulcrum (Çorlu, 2014; Kuenzi, 2008).

In the United States, the forerunner of this practice, the work of incorporating engineering education into primary education was carried out in the 1990s and spread to a wider range of elementary schools. According to a report (Katehi, Pearson and Feder, 2009) prepared by the commission established by the National Engineering Academy and the National Research Council in 2009 in the same country, the benefits of including engineering education in primary education are listed as follows:

- Students will learn more about mathematics and science and will be more successful in these matters,
- Students become more interested in engineers and engineering applications,
- It is ensured that the professions that the students will choose in the future are directed more towards engineering fields,
- It is ensured that students become more knowledgeable about technology

The period in which decision that if the students are interested in science and mathematics made, was determined as the second stage of primary education (Hanson, Carpenter and Rizk, 2003).

In the literature, there are many studies showing that STEM integrated mathematics and science (Bragow, Bragow and Smith, 1995) has a positive effect on students' learning motivation (Gutherie, Wigfield and VonSecker, 2000) and success (Höbek, 2014; Hurley, 2001) on student attitudes and interests in school.

This study aims to determine whether fifth grade students of STEM applications have an impact on their academic achievement and motivation in the unit "Exploring and Knowing the World of Living Creatures".

METHOD

Research Model

The research design is a semi-experimental design with pre-test and post-test control group (Quasi Experimental Design). The purpose of the semi-experimental model is to discover the cause and effect relationship between the variables in the research (Büyüköztürk, 2011). Because this study aims to measure the effect of teaching materials prepared according to STEM applications on the academic success and motivation of students, there is cause-effect relation, so semi-experimental design is preferred in this research.

Sample

64 students who are studying at two sections of the 5th grade in 2015-2016 education year in a middle school located in the center of Antakya participated in the study. Then, one of these sections was randomly selected as the experimental group, and the other was the control group.

Data Collection Tools

The data collection tools were presented in the following headlines.

Exploring and Knowing the World of Living Creatures Achievement Test (CDGT)

Exploring and Knowing the World of Living Creatures Achievement Test was developed by the researcher to test the achievement.

Exploring and Knowing the World of Living Creatures Achievement Test (CDGT) was prepared by the researcher in the fall of 2014. A total of 11 open-ended questions were prepared, including at least 3 questions about each achievement, including 3 acquisitions of Exploring and Knowing the World of Living Creatures unit. The opinion of a specialist in studying in the field of science education was taken into consideration to determine the suitability of the questions for the achievements. The opinion of a Turkish language expert has been taken into consideration to determine the suitability of the rules of language.

In a secondary school in Antakya district of Hatay, 75 students who had already worked on the Exploring and Knowing the World of Living Creatures unit (CDGT). From the student answers, 21 test questions were formed and the 3 wrong answers were also written from student answers.

In the field of the appropriateness of the questions, necessary corrections have been made by showing again to the specialist academicians. The "explanation" part was added to the lower part of each question and applied to 6th grade students in different sections. The students were given the final two-step test by adding 3 incorrect explanations and 1 correct explanation to the questions.

Exploring and Knowing the World of Living Creatures (CDGT) unit test consists of 21 questions. A maximum of "100" points can be earned, each question is 4.76 points. To be able to calculate the validity and reliability of the test, pilot test was applied to the test by applying the 177 students who were in the 6th grade of the CDGT achievement test of Exploring and Knowing the World of Living Creatures (CDGT). Based on the data we obtained, the item strength, distinctiveness, standard deviation, mean, mode, median, and KR-20 calculations were made and the following results were obtained.

In order to be able to calculate the reliability and validity of the test, to 177 students who were in 6th grade in a secondary school in Antakya district of Hatay province, pilot application of the two-stage test was applied. For each question in the test, item distinctiveness index, item difficulty index, KR-20 coefficient was calculated.

First exported to Excel, entered as 1 and zero, and total scores were found. The points are ranked from highest to lowest in the total score. The results of the reliability test were presented in Table 1, Table 2 and Table 3.

Table 1. Travelling and Knowing the World of Life Achievement Test (CDGTBT) Frequency Results

Point	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Frequency	8	11	16	16	16	16	11	18	13	8	5	5	5	4	5	2	2	6	7	3

- Top group was formed by taking 27% of the top.
- Subgroups were created by taking 27% of the lowest level.

Table 2. Exploring and Knowing the World of Living Creatures Achievement Test (CDGTBT) Item Strength, Distinctiveness Index, Test Difficulty

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
30	28	22	36	37	34	21	20	35	33	22	31	36	37	31	31	33	36	40	36	41	max 20%
13	7	2	6	7	4	2	4	5	2	1	0	3	3	4	5	4	3	3	2	2	min 20%
0.35	0.44	0.42	0.63	0.63	0.63	0.40	0.33	0.63	0.65	0.44	0.65	0.69	0.71	0.56	0.54	0.60	0.69	0.77	0.71	0.81	rjx
0.45	0.36	0.25	0.44	0.46	0.40	0.24	0.25	0.42	0.36	0.24	0.32	0.41	0.42	0.36	0.38	0.39	0.41	0.45	0.40	0.45	p

The arithmetic mean of our test is 7, the total number of questions in the test is 21; The average item difficulty of the test is; p = 7/21 = 0.33.

- The difficulty index varies from 0 to +1.
- if it is close to 0, it means it's difficult,
- if it is close to 1, it means it is easy,
- 0.5 indicates that the test is moderately difficult.

The average item difficulty of the test we conducted was found to be 0.33, which was found to be a difficult test as it was close to 0.

Table 3. Exploring and Knowing the World of Living Creatures Achievement Test (CDGTBT) KR-20 Result

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
0,55	0.64	0.75	0.56	0.54	0.60	0.76	0.75	0.58	0.64	0.76	0.68	0.59	0.58	0.64	0.63	0.61	0.59	0.55	0.60	0.55	Q
0.25	0.23	0.19	0.25	0.25	0.24	0.18	0.19	0.24	0.23	0.18	0.22	0.24	0.24	0.23	0.23	0.24	0.24	0.25	0.24	0.25	p*q
																				4.81	Topp*q
																				0.19	p*q/vary
																				0.81	1-
																				KR-20 1.05	
																				KR-20=0.85	

$$KR-20=\frac{K}{K-1}.[1-\frac{\sum(p.q)}{SS^2}$$

K= Number of questions q= Wrong answer ratio (1-p)

P= Correct answer ratio SS= Standard deviation

In the test, KR-20 was found to be 0.85.

Motivation Scale toward Science Learning

The "Motivation Scale toward Science Learning" was developed by Dede and Yaman (2008) and the Cronbach alpha reliability coefficient is 0.80. There are answers in the form of a total of 23 items with a 5-point Likert type that students can reflect on their expressions in the form of "I absolutely agree", "I agree", "Neutral", "I do not agree" or "I definitely do not agree". In the positive statements, 5, 4, 3, 2, 1 points were given in response to the above answers, 1, 2, 3, 4, 5 points were given in the negative statements and the scores were determined with all points gathered. The maximum score that can be taken from the scale is 115, while the minimum score is 23. The distribution of the items in the motivation scale toward science learning according to sub-factors is shown in Table 4.

Table 4. The Distribution of the Items in the Motivation Scale toward Science Learning according to Sub-factors

Factors	Questions
Factor 1- Motivation for research	1, 5, 8, 12, 15, 21
Factor 2- Motivation for Performance	3, 4, 6, 11, 16
Factor 3- Motivation for Communication	13, 14, 17, 20, 22
Factor 4- Motivation for Cooperative Work	9, 10, 19, 23
Factor 5- Motivation for Participation	2, 7, 18

EXPERIMENT SETUP

Application of STEM Method

In the study, STEM method was applied in two sections in the sample school. The STEM method was introduced by the researcher to the students during one lecture hour and the sample lesson plan was applied during another lecture hour before the application started. Groups have been created to implement activities and design tasks. Pre-test application was considered when creating groups. It was noted that the groups were heterogeneous in themselves in terms of success and gender, and homogeneous among the groups. During the first week of application, each group was assigned a project task related to environmental problems. This project has been expressed to the students who will be presented at the end of the course. It was introduced with a story that would enhance the readiness of the students to draw attention to the application. Students are informed about the different activities and design they will come across throughout this application. During the activities, the students filled in activity papers individually while working in groups.

In the exploration step of the application, students have tried to associate the student life with the subject by conducting various activities and experiments. First, the "living beings" activity was implemented. The students were asked to think like a scientist and used the brain storm method and asked their opinions about the question "how are the living beings classified?". They are then asked to make their own classification. A variety of living being photographs brought to the school are shown to the students and "Think that you are a scientist. In this case, how would you classify the living beings in the following photographs?" They were asked to make their own classification and to compare it with the classification of scientists. After this activity, the "beings we cannot see" activity has been implemented. The students were asked "Are there any living things we cannot observe other than the ones we see in our environment?" And the opinions of the students were taken. Later, to observe that there are living things that students cannot see, a jar of water were taken from any puddle, ornamental pond or aquarium into which dry leaves, fruit peels, dumped and kept in warm and bright environment for several days. The slide was prepared with a drop of water from this jar and examined under a microscope. The pictures of the creatures observed in the microscope are drawn. The students were asked "how can we see the living things we cannot see in the microscope" and their ideas were taken. It is explained that a microscope's magnification power is determined with the eye lens and the objective together, and students are asked to decide how much of the living things we have examined in the microscope have grown. Thirdly, we have also given our "reality under the hat" activity. The moldy bread, lemon and jam brought to the school are shown to the students. "why are your crops, lemon, green cotton pattern on jam planted?" question are directed to students and they are asked to investigate the cause of this situation. At the next activity, "plants", various plant pictures were shown to the students and several plant species were introduced. A flowerless and a flowering plant brought to the school was studied by the students. They are asked to list similarities and differences in a chart. In the "How the flowers are colored" activity, two water glasses are filled with water until half, then one drop of blue ink is added to one and one drop of red to the other. Once the white cloves were placed in the water glasses, they were kept in a sunlight area for an hour to observe the change. Students are asked to observe the changes in the cloves. The teacher who performed the lesson in the explanation step of the application realized the subject narration. In this step, the subject has been tried to be explained in as much detail as possible. Question-and-answer method, brain storming, demonstration methods are frequently used in the course. Smart board has been actively used, Various EBA and VITAMIN videos, visuals and animations related to the subject are displayed. At the end of the course, tests were sent by the teacher to the students with the EBA system as homework and they were followed up through the EBA system. In the deepening step of the application, design tasks were given to the students and the design activities and design materials were prepared by the researcher within two hours of each group. At this stage students were given the task of "pot design". For this “Ayşe, who has to go out of town for the meeting, is making preparations. She loves flowers and has flowers in her house. If the flowers become dehydrated for a week, they will wither, so she needs to find a solution to the situation” a situation like this was given, and students were asked to design a flower pot for Ayşe. They performed the design tasks by implementing the steps of "asking", "producing suggestions", "making plans", "creating models" and "developing models" respectively and making the presentation of the models (products). In the evaluation step, evaluation was made with the design evaluation scale prepared by the researcher and feedback was given.

For the "classifying animals" activity in the unit, a picture of animals in the class was shown and they were asked to classify the animals according to their similarities and differences. In our activity "What is this technology", students were shown a visual image of some animals and some technological angles. Students were asked to examine the pictures and asked which animal features in the pictures inspired these technological tools. They are required to match and explain these pictures. As a design task, they were asked to make a design entitled "My little farm". "Mr. Yusuf, who loves farm life very much, has the dream of retiring and building a farm. Mr. Yusuf, who is approaching his retirement, has begun preparations to establish his dream farmhouse. Yusuf thought how he could build a farm and decided to talk to an agricultural engineer to realize his dream. Mr. Yusuf, talks to agricultural engineer Mr. Oğuz, "I want to build a farm, what I have to do to build my farm in my dream, I would like to get information from you on this issue". "I want to know what I need to do to build a farm, what kind of path I need to follow. Can you help me on this matter?" Agricultural engineer Mr. Oğuz: "Mr. Yusuf, first, we have to answer these questions. Where do you want to build your farm, what kind of farm you want to build, what you want to grow, how big your farm should be. You should plan for it. You must determine the cost, criteria, constraints and priorities. It is anticipated that all living beings on the farm will be included in the living class. It is expected that these living beings will be correctly classified. You are expected to design the living spaces of animals correctly. You are expected to calculate how much space our farm was established on. You are expected to calculate how much space our farm uses when creating living habitats. The cost of your farm model should not exceed 30TL" problem situation is given and it is required to carry out their design. The "environment" activity has been given to the unit in relation to human and environment related achievement. The students made the presentation of the project papers related to the environmental problems given at the beginning of the unit and explained the solutions to the environmental problems.

Implementation of the Method at the Current Program

In the study, the method proposed by the current program was implemented in a class of the school which forms the sample with the control purpose. The course has been observed without any intervention. The students were seated in a row so that they could see each other's back. The subjects of "Travelling and Knowing the World of Life" determined and planned by the Ministry of National Education were presented to the class in accordance with the current program by the teacher during the planned period.

The processing of a lesson has been realized as follows: To increase the readiness of the students and to increase their interest in the lesson, questions were asked about the students' thinking and brainstorming method was applied. A variety of activities have been carried out in the form of demonstrations from the course book which will attract the attention of the students. Various videos, visuals, animations were shown from EBA and VITAMIN related to the subject. Interactive board was actively used during the subject narrative. In the subject teacher gave various examples and students were asked to give a few more examples. After the lecture was over, a few questions were asked to the students about the subject and many students in the class had time to give their answers and created a discussion environment with the whole class. At the end of the course, the students were given some tests as homework and the next lesson started by solving the questions that students could not solve. After the question-solving process was over, the new topic was introduced.

FINDINGS

Data Analysis

The normality test of the assumptions of the parametric tests was done to decide which tests to use during the analysis phase of the data. The results of the Kolmogorov-Smirnov Test have been examined since the number of samples used in this study is over 30 (Kalaycı, 2016). When Kolmogorov-Smirnov test results were examined, CDGTBT was statistically determined to have a normal distribution of collected data for FYMO scales ($p > 0.05$), and parametric tests were applied to the data gathered from the scale and tests.

Table 5. CDGTBT, FYMO, Kolmogorov-Smirnov Test Results

	Statistics	**SD**	**p**
Experiment Group first CDGTBT	.143	33	.083
Control Grubu first CDGTBT	.154	31	.059
Experiment Group last CDGTBT	.149	33	.062
Control Grubu last CDGTBT	.082	31	.200
Experiment Group first FYMÖ	.127	33	.192
Control Grubu first FYMÖ	.145	31	.096
Experiment Group last FYMO	.126	33	.199
Control Grubu last FYMO	.154	31	.059

Independent groups of pretest scores of the CDGTBT groups before the start of the study were given in Table 6 of the t-test analysis.

Table 6. Independent groups of pretest scores of CDGTBT Results of t-test analysis

Groups	N	X	SS	SD	t	p
Experiment	33	37.07	17.641	62	1.468	0.792
Control	31	30.40	18.706			

The maximum score for CDGTBT is 100.

There is no statistically significant difference between the pre-tests of the experimental and control groups ($t = 1.468$, $p > 0.05$) when looking at the data in Table 4.2. According to these findings, it can be said that the students in the experiment and control group are at the same level of basic knowledge in the "Exploring and Knowing the World of Living Creatures" unit before starting work.

To determine which method was more effective in terms of academic achievement after the study was completed, the scores obtained from the final tests of CDGTBT were analyzed by t-test for descriptive statistics and independent groups to determine whether there was a difference in academic achievement among the groups and the results of the analysis of the final tests of CDGTBT were given in Table 7.

Table 7. Independent groups of posttest scores of CDGTBT Results of t-test analysis

Groups	N	X	SS	SD	t	p
Experiment	33	63.178	18.863	62	2.962	0.004
Control	31	47.907	22.324			

The maximum score for CDGTBT is 100.

The results of the CDGTBT post-test analysis in Table 4.3 show that there is a statistically significant difference between the averages of the post-test scores obtained ($t = 2.962$; $p < 0.05$). According to these findings, it can be said that the students in the experimental group in which the STEM applications were made were more successful in the academic sense than the students in the control group in which the teaching method prescribed by the current program was applied ($X_{Experiment}$=

63.178; $X_{Control}$=47.907). With STEM applications, we can say that students learn better. It has been found that STEM applications increase the academic achievement of students.

The independent t-test findings of the pre-test scores of the motivation scale toward science learning before starting to practice are given in Table 8.

Table 8. Independent groups of pre-test scores of Motivation Scale toward Science Learning t-test analysis result

	Groups	N	X	SS	SD	t	p
Research	Experiment Control	33 31	25.21 25.94	3.090 3.119	62	-0.932	0.355
Performance	Experiment Control	33 31	21.24 21.19	3.279 3.497	62	0.058	0.954
Cooperation	Experiment Control	33 31	17.27 16.87	2.528 2.405	62	0.065	0.518
Communication	Experiment Control	33 31	22.52 21.13	2.502 3.106	62	1.972	0.053
Participation	Experiment Control	33 31	13.39 13.19	1.694 1.973	62	0.437	0.664
Total	Experiment Control	33 31	99.30 98.32	8.267 8.852	62	0.458	0.810

The maximum score that can be obtained is 115.

When we look at the findings in Table 8, it is seen that there is no statistically significant difference between pre-tests of experiment and control group ($t = 0.458$. $p > 0.05$). There is also no statistically significant difference in research, performance, cooperation, communication, participation sub factors. According to these findings, it can be said that the students in experiment and control group have similar characteristics in terms of their motivation to learn science before they start to work.

After the study was completed, to determine which method was more effective in terms of motivation toward science learning, the scores obtained from the final tests of the motivation scale for science were compared through t-test from descriptive statistics and independent groups to see if there was any variation among the groups and the analysis results of the final tests are presented in Table 9.

Table 9. Independent groups of the final test scores of the Motivation Scale toward Science Learning t-test analysis result

	Groups	N	X	SS	SD	t	p
Research	Experiment Control	33 31	25.03 22.19	3.988 3.016	59.355	3.222	0.002
Performance	Experiment Control	33 31	21.18 19.71	4.391 4.540	62	1.319	0.192
Cooperation	Experiment Control	33 31	18.03 16.32	2.640 2.600	62	2.605	0.011
Communication	Experiment Control	33 31	21.61 22.58	3.102 2.405	62	-1.398	0.167
Participation	Experiment Control	33 31	13.42 13.16	2.398 2.192	62	0.457	0.649
Total	Experiment Control	33 31	99.27 99.19	11.867 7.803	62	0.31	0.317

The maximum score that can be obtained is 115.

There was no statistically significant difference between the mean scores of the post-test scores obtained from the results of motivational scale post-test analysis for science learning in Table 9 ($t = 0.31$, $p > 0.05$). When the sub-factors of the motivation scale were examined, a positive increase was found in favor of the experimental group statistically in the factors measuring the research and cooperation; there was no statistically significant difference in performance, communication and participation subcategories. There was an increase in favor of control group students in terms of communication. However, because they are conducting group activities, there are students in the experimental group who cannot communicate with their group friends, who cannot participate in the group activities, and it is thought that the difference is caused by these students. According to these results; STEM activities have had a positive effect on the research and cooperation of the motivation of the students toward science learning. It can be said that two different teaching activities in terms of performance, communication and participation have similar effects. It can be said that the two different teaching practices applied have a similar effect on students' motivation toward science learning in terms of performance, communication and participation, and that STEM applications have a positive effect on cooperation. It is thought that these positive effects of STEM applications are caused by the fact that in practice students must work in groups to form a cooperative spirit and conduct research at a considerable level in order to realize the activities. The lack of differences between the groups in terms of performance, communication and participation may be due to the adaptation problems experienced by the students due to the lesson processing by a method that is not familiar to the students.

CONCLUSION AND RECOMMENDATIONS

At the end of the study, the following results were obtained: In the 5th grade science class, it was learned that STEM applications and the students in the classrooms where the current program was applied did not have a statistically significant difference between the preliminary tests of the experimental group and the control group when the scores they received from the achievement test of the "Exploring and Knowing the World of Living Creatures" ($t = 1.468$, $p>0.05$). According to these findings, it can be said that the students in the experiment and control group are at the same level of basic knowledge in the "Exploring and Knowing the World of Living Creatures" unit before beginning. A statistically significant difference was found between the averages of the post-test scores obtained from CDGTBT end-test analysis results ($t = 2.962$; $p <0.05$). According to these findings, it can be said that the students in the experimental group in which STEM applications are applied are more successful in the academic sense than the students in the control group in which the teaching method prescribed by the current program is applied ($X_{Experiment}= 63.178$; $X_{Control}=47.907$). These findings are in parallel with the studies on STEM applications in the literature. There are many studies supporting this study showing that STEM applications have improved academic achievement; Ceylan (2014), Yıldırım and Altun (2015), Cotabish, Dailey, Robinson, and Hunghes, (2013), Yıldırım and Selvi (2017).

STEM applications and the scores of the students in the classrooms in which the current program's system is applied have been examined by the motivation scale test toward science learning in the 5th grade science class of the middle school " Exploring and Knowing the World of Living Creatures" unit. In the pre-tests of the experimental and control groups, no statistically significant difference was found between the groups in any of the subcategories of research, performance, cooperation, communication and participation ($t = 0.458$; $p> 0.05$). According to these findings, it can be said that the students in experiment and control group have similar characteristics in terms of their motivation to learn science before they begin. When the analysis of the results of motivational scale final-test total scores for science learning were considered, it was found that there was no statistically significant difference between the average of the final test scores obtained ($t = 0.317$; $p> 0.05$). When the sub-factors of the motivation scale were examined, a positive increase was found in favor of the experimental group statistically in the factors measuring the research and cooperation; there was no statistically significant difference in performance, communication and participation subcategories.

The evolving and changing world directs the educators to change as well as the educational programs. Positive changes have been made in this direction with the curriculum of the Science Education (3, 4, 5, 6, 7 and 8th grades) Primary Education Institutions (Primary Schools and Secondary Schools) of Ministry of National Education in 2013. Engineering applications have been added to the Ministry of National Education's 2017 draft curriculum. This approach of the Ministry of National Education shows that STEM education contributes to the realization of the curriculum vision. From here we can reach the judgment that we can close the gap in our teaching program with STEM applications. As in many developed countries to be able to raise individuals with 21st century skills, STEM practices should be added to our education policies in our country.

STEM applications can be added to teacher training programs as a course. STEM applications can be applied as in-service training to teachers working within the Ministry of National Education.

Individuals were trained to improve their research skills in science, technology, mathematics and engineering, to develop their critical thinking skills, to improve creativity skills, to improve their collaborative study skills, to be able to associate their current knowledge with real life, to improve their innovation skills, to improve their questioning learning skills, to improve their questioning skills, and the increase their motivation. Students regard STEM as such applications that they can find solutions to the problems they encounter in daily life and have fun without seeing them as a necessity. With the STEM applications, it can be observed an increase in the students' motivation and academic achievements. From this point, teachers should include more STEM practice in science teaching.

There are certain situations in which researchers should pay attention in the STEM applications. Integration of STEM education into courses is actually a challenging process, but the most challenging part is to prepare a lesson plan in line with the STEM training. Integration of the STEM training into courses can be easily achieved if appropriate lesson plans and activities are prepared. The STEM applications can be integrated into many curricular topics. The researchers should plan what they will teach in the context of the STEM training while preparing a lesson plan and prepare the materials; otherwise it cannot be taught exactly in the way that it is desired to be taught and time wastes can be experienced. Researchers can apply the STEM training in their courses effectively and efficiently if they pay attention to these issues.

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