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THE EFFECT OF 5E MODEL STEM EDUCATION ON THE SCIENCE ACADEMIC ACHIEVEMENT OF SECONDARY SCHOOL 6TH GRADE STUDENTS

Sevim Çetin[1], Renan Şeker[2]

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ABSTRACT

This research was carried out in order to reveal the effect of the 6th grade students' "Systems in Our Body" unit "Support and Movement" on the academic achievement of 6th grade students of the science course, which is explained with 5E model STEM applications. The sample of the research consists of 6th grade students studying in a state secondary school in 2018-2019. Semi-experimental design was used as the research design. The application, which lasted 5 weeks, was evaluated with pretest, posttest and retention test. The "Systems in Our Body Achievement Test" with a reliability coefficient (KR-20) = 0.89, developed by the researcher, was used as a data collection tool. Statistical analyses of the data were made with the help of SPSS package program with independent and dependent sample t-test. According to the results of the t-test analysis, it was observed that the academic achievement of the science course taught with the 5E model STEM education applications was significantly ($p<0.05$) high. There was a significant ($p<0.05$) difference between the retention test and the posttest of the group in which STEM education and science lesson were taught, compared to the group in which science lesson was taught with traditional teaching method. According to the findings obtained at the end of the research, it was concluded that the science course taught with the 5E model STEM education is effective both on academic success and on remembering the learned information, in other words, on the permanence of the information.

Keywords: STEM Education with 5E Model, Science Education, Systems in Our Body.

[1]Doctoral Student, Gazi University, Institute of Educational Sciences, sevimmccetin@gmail.com, 0000-0002-1277-7963)

[2]Assistant Professor, Necmettin Erbakan University, Faculty of Education: rseker@erbakan.edu.tr, 0000-0003-0953-1177

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INTRODUCTION

Generations come to the world with a great curiosity and desire to explore, and from the moment they are born, they try to satisfy their curiosity with their five senses. The experiences they have in daily life give children the opportunity to realize the environment they live in, get to know them and make sense of the outside world. They always keep their desire to explore alive by mixing each new information with the previous one and arranging their new information. Events such as the swimming patterns of fish in the natural environment or watching a spider weave a web provide opportunities for children to study science (Martin et al., 1998). Cepni (2007) science; He defines it as "the understanding of the universe after the individual has organized and systematized the knowledge with scientific methods". In our age, when science is mentioned, mostly science comes to mind (Çepni, 2008). Science education is a field of education that is astonishing and attractive in the environment in which the individual lives (Gürdal, 1992). Individuals who are needed in education are those who can access information, produce information and use this information. In order to put future generations on solid foundations, it is necessary for each individual to be matured with science education equipment. Considering within this framework, the importance of science courses and science curricula increases (Arslan , 2005). Since students establish a connection between daily life and science lessons, it is one of the lessons that they have difficulty in creating prejudices and transferring knowledge (Durmaz, 2004). The fact that science teaching is purified from traditional methods and plain expressions and directed towards inquiry-based science education will make students' interest in science meaningful (Rocard et al, 2007). In our age, as new discoveries are made, the production of knowledge increases. With increasing production, it is getting harder to dominate the information that increases. With the development and growth of technology, even the most up-to-date methods used now will become out of date over time. Staying up-to-date will be possible by not falling behind the times, approaching problems scientifically, questioning and researching (Başkurt, 2009). STEM education; It is an education model formed by the combination of science, technology, engineering and mathematics disciplines (Çorlu, 2014). It has been seen that STEM education, which has an important place in science education, increases the motivation and interest of students towards the lesson (Yamak et al, 2014). When we look at the success results as a country in Trends in International Mathematics and Science Study (TIMMS), which is one of the international exams, our science course success and science literacy averages fell behind other countries that participated in the exams (https://timss.meb.gov.tr). In the light of these results, studies can be conducted to investigate the effect of STEM education approach on increasing success in science education in our country. In the world, there are trials on what can be done to increase success in science and mathematics courses. Among these trials, it is important to determine the effects of STEM education that has just emerged in the world and to put it into practice in our country's schools.

Purpose of the research

The aim of the study is to examine the effect of 5E Model STEM education applications on the academic achievement of 6th grade students in science course. Purposeful answers were sought for the following questions:

1. Is there a significant difference between the Systems in Our Body Achievement Test (VSUBT) post-test of the experimental group students in the study and the post-test scores of the control group students?
2. Is there a difference between the retention test scores of the experimental group students and the VSUBT retention test scores of the control group students in the study?
3. Is there a significant difference between the pre-test and post-test scores of the experimental group students in the study?
4. Is there a significant difference between the pre-test and retention test scores of the experimental group students in the study?
5. Is there a significant difference between the post-test and retention test scores of the experimental group students in the study?
6. Is there a significant difference between the pre-test and post-test scores of the control group students in the study?
7. Is there a significant difference between the pre-test and retention tests of the control group students in the study?
8. Is there a significant difference between the post-test and retention test scores of the control group students in the study?

METHOD

The design of the study is a quasi-experimental design with pre-test, posttest and retention test, and control group. In the study, the groups were pre-tested before the application, and as a result, an unbiased assignment was made between the classes that were similar to each other as an experiment and a control group. In the experimental group, the science course was taught with 5E model STEM education applications, and in the control group, the traditional method was taught within the framework of the current science curriculum.

Participants

The sample of the study consists of 40 students studying in the 6th grade. The study was conducted in a state secondary school in Selçuk district of Konya province in the 2018-2019 academic year. The pretest mean scores of the experimental and control groups were not included in the research by the researcher, so that some students who changed the equivalence in the classes were not included in the study in order to make a healthy comparison. equalized and the number of students in the groups was equalized as 20. The students who were not included in the study were not informed of this situation and they received the same education as the students included in the study. To see if there was a difference between the groups, t-test analysis was performed for unrelated (independent) samples according to the pretest scores (Table 1). As a result of the analysis, it was determined that there was no difference between the groups in terms of academic achievement according to the pretest score averages (p=.968).

Table 1. Independent Sample t-test results of the Pretest Scores of the Experimental and Control Groups

Group	N	Mean	Ss	Sd	t	p
Control Group	20	12,900	4,102	38	0,041	0,968*
Experimental Group	20	12,950	3,691			

*p>0,05

Care was taken to ensure the equivalence of the experimental and control groups in terms of academic achievement as well as in terms of secondary variables. For this purpose, information about the academic achievement of the groups included in the research was obtained from the science teacher and school administration. All processes of the research were carried out under similar conditions for both groups, and the socioeconomic level, gender, attention was paid to the similarity of characteristics such as class size, the number of participants was kept high in case of possible loss of participants, and care was taken to ensure that the data collection process was carried out impartially in both groups.

Data Collection Tool Development Process

In the study, the "Systems in Our Body Unit Achievement Test" developed by the researcher was used to measure the academic success of the students in the Science course "Support and Movement". The "Systems in Our Body Unit Achievement Test" used within the scope of the research was prepared by considering the 2018 science curriculum achievements of the Ministry of Education. In order to develop this test, first of all, a test consisting of 45 items was prepared by making use of the MEB Achievement Tests and State Scholarship Exams. This test was piloted on 256 students who had taken this course in previous years. The data obtained from this application were analysed with the TAP statistics program. At the end of the analysis, 15 items that would definitely not be included in the test and that could be corrected and included in the test were excluded from the test. In its final form, the academic achievement test consisting of 30 items (KR-20) = 0.89, item discrimination of 0.55 and item difficulty of 0.61 was administered to the students in the trial and control groups as pre-test, posttest and retention test.

Application of this Research

In the experimental and control groups, the teaching of the science course took 5 weeks as per the program. It was done before starting the classes in both groups. In the experimental group, introductory activities and practices were made in accordance with the 5E model STEM education on the subject for 5 weeks. In the control group, the lessons were taught with the classical method during the same period. After the lecture was completed, the posttest and the retention test were administered to both groups 6 weeks after the post-test.

Analysis of Data

Before the analysis of the data, it was checked whether the data had a normal distribution, and it was decided which of the parametric or non-parametric statistical techniques would be used according to the result. Since the number of samples was less than 30, normality test was applied with SPSS package program to test the suitability of the data for normal distribution. For this work, besides the skewness and kurtosis values of the data, the Shapiro-Wilk test was used because the number of samples was less than 30 (Yazıcıoğlu, 2004; Köklü et al., 2006). As a result of the test, as the skewness and kurtosis values of the data were between +1.5 and –1.5, and the p values in the Shapiro-Wilk test were greater than 0.05 (Table 2), it was assumed that the data showed a normal distribution, and parametric tests were used in the statistical analysis of the data. Analyses were made using the SPSS package program, with independent sample t-test for intergroup comparisons and dependent sample t-test for in-group comparisons.

Table 2. Shapiro-Wilk test results of Experimental and Control Groups

Group	Statistic	df	Sig.
Control Pretest	,948	20	,333
Control Posttest	,951	20	,377
Control Retention Test	,934	20	,188
Trial Pretest	,934	20	,182
Trial Posttest	,927	20	,137
Trial Retention Test	,956	20	,470

In addition, the effect size, which is another criterion that shows whether the difference between the groups is significant or not. To be defined simply, the effect size is the size of the difference that a newly used method makes compared to the old one and is calculated in different ways. It is the calculation most commonly developed by Cohen. According to Cohen, a d value less than 0.2 is defined as a weak effect, a medium effect of 0.5, and a strong effect if it is greater than 0.8.

FINDINGS

In this part of the study, the findings are given with the data collected quantitatively in parallel with the sub-problems of the research. Findings of the first sub-problem:

Is there a significant difference between the posttest scores of the experimental group students and the posttest scores of the control group students in the study?

H_0 hypothesis: There is no significant difference between the posttest and academic achievement scores of the control group, in which the science lesson was employed with the traditional teaching method, and the posttest scores of the experimental group, in which the modern teaching method 5E Model STEM education applications and the science lesson were recruited.

In order to test the H_0 hypothesis, data analysis with independent sample t-test and Cohen's d effect size calculation were performed. Analysis results are presented in Table 3.

Table 3. Independent sample t-test and Cohen's d effect size calculation results of posttest mean scores of the experimental and control groups

Group	N	Mean	Ss	Sd	t	p	Effect size
Control Group	20	18,900	6,129	38	-3,600	0,001*	1,14
Experimental Group	20	24,850	4,156				

*p<0,05

When Table 3 is examined, it will be seen that the posttest arithmetic mean is 18.900 in the control group, 24.850 in the experimental group, and the difference between them is significant in favor of the experimental group (t= -3.600; p<0.05). According to the Cohen's d effect size calculation, it is seen that this difference is in the large effect category (cohen's d=1.14>0.8). According to the results, it can be said that the contribution of the 5E model STEM education applications to the academic success of the students is good.

Findings of the second sub-problem:

Is there a difference between the VSUBT retention test scores of the experimental group students and the VSUBT retention test scores of the control group students in the study?

H_0 hypothesis: There is no significant difference between the academic achievement scores of the retention test belonging to the control group in which the science lesson was employed with the traditional teaching method, and the retention test belonging to the contemporary teaching method 5E Model STEM education applications and the science lesson of the experimental group. In order to test the H_0 hypothesis, data analysis with independent sample t-test and Cohen's d effect size calculation were performed. Analysis results are presented in Table 4.

Table 4. Independent sample t-test and Cohen's d effect size calculation results of retention test mean scores of the experimental and control groups

Group	N	Mean	Ss	Sd	t	p	Effect size
Control Group	20	13,750	3,697	38	-6,349	0,000*	2,00
Experimental Group	20	21,800	4,299				

*p<0,05

When Table 4 is examined, it will be seen that the arithmetic mean of the retention test is 13.75 in the control group, 21.80 in the experimental group, and the difference between them is significant in favor of the experimental group (t= -6,349;). According to the Cohen's d effect size calculation, it is seen that this difference is in the large effect category (cohen's d=2.00>0.8). According to the results, it can be said that the 5E Model STEM education applications are good in terms of students' remembering information and retention.

Findings of the third sub-problem:

Is there a significant difference between the pre-test and post-test scores of the experimental group students in the study?

H_0 hypothesis: There is no significant difference between the contemporary teaching method 5E Model STEM education applications and the academic achievement scores of the pretest and posttest scores of the experimental group employed in the science course. In order to test the H0 hypothesis, data analysis with independent sample t-test and Cohen's d effect size calculation were performed. Analysis results are presented in Table 5.

Table 5. The results of dependent sample t-test and Cohen's d effect size calculation of the pre- and post-test mean scores of the experimental group

Test	N	Mean	Ss	Sd	t	p	Effect Size
Pretest	20	12,950	3,691	19	-9,587	0,000*	3,03
Posttest	20	24,850	4,145				

*p<0,05

When Table 5 is examined, it is seen that the Pretest mean score in the experimental group is 12,950, and the retention test mean score is 24,850, and the difference between them is significant in favor of the retention test (t= -9.587; p<0.05). According to the Cohen's d effect size calculation, it is seen that this difference is in the large effect category (cohen's d=3.03>0.8). According to these results, it can be said that the contribution of the 5E model STEM education applications to the academic success of the students is good.

Findings of the fourth sub-problem:

Is there a significant difference between the VSUBT pretest and retention test scores of the experimental group students in the study?

H_0 hypothesis: There is no significant difference between the contemporary teaching method 5E Model STEM education applications and the academic achievement scores of the pretest and retention test scores of the experimental group employed in the science course. In order to test the H0 hypothesis, analysis with dependent sample t-test and Cohen's d effect size calculation were made. The results are presented in Table 6.

Table 6. The results of the dependent sample t-test and Cohen's d effect size calculation of the mean scores of the pretest and retention test of the experimental group

Test	N	Mean	Ss	Sd	t	*p*	Effect Size
Pretest	20	12,950	3,691	19	-6,984	0,000*	2,20
Retention test	20	21,800	4,299				

*p<0.05

When Table 6 is examined, it is seen that the mean score of the Pretest in the experimental group is 12,950, and the mean score of the retention test is 21,800, and the difference between them is significant in favor of the retention test (t= -6,984; p<0.05). According to the Cohen's d effect size calculation, it is seen that this difference is in the large effect category (cohen's d=2.20>0.8). According to these results, it can be said that the contribution of 5E model STEM education applications to the students' level of remembering what they have learned is in a good way.

Findings for the fifth sub-problem:

Is there a significant difference between the VSUBT post-test and retention test scores of the experimental group students in the study?

H_0 hypothesis: There is no significant difference between the modern teaching method 5E Model STEM education applications and the academic achievement scores of the post-test and retention test scores of the experimental group recruited for the science course. In order to test the H_0 hypothesis, analysis with dependent sample t-test and Cohen's d effect size calculation were made. The results are presented in Table 7.

Table 7. Results of dependent sample t-test and Cohen's d effect size calculation of posttest and retention test mean scores of the experimental group

Test	N	Mean	Ss	Sd	t	p	Effect Size
Posttest	20	24,850	4,145	19	2,284	0,028*	0,72
Retention test	20	21,800	4,299				

*p<0.05

When Table 7 is examined, it is seen that the posttest mean score in the experimental group is 24,850 and the retention test mean score is 21,800, and the difference between them is significant in favor of the posttest (t= 2.284; p<0.05). According to the Cohen's d effect size calculation, it is seen that this difference (cohen's d=0.72>0.2, <0.8) is in the medium effect category.

Findings of the Sixth Sub-problem:

Is there a significant difference between the VSUBT pretest and posttest scores of the control group students in the study?

H_0 hypothesis: There is no significant difference between the pretest and posttest scores of the control group, in which the traditional teaching method and the science lesson were employed. In order to test the H0 hypothesis, analysis with dependent sample t-test and Cohen's d effect size calculation were made. The results are presented in Table 8.

Table 8. Results of dependent sample t-test and Cohen's d effect size calculation of pretest and posttest mean scores of the control group

Test	N	Mean	Ss	Sd	t	p	Effect Size
Pretest	20	12,900	4,102	19	-3,638	0,001*	1,15
Posttest	20	18,900	6,129				

*p<0.05

When Table 8 is examined, it is seen that the pretest mean score is 12,900 and the posttest mean score is 18,900 in the control group, and the difference between them is significant in favor of the posttest (t= -3.638; p<0.05). According to the Cohen's d effect size calculation, it is seen that this difference is in the large effect category (cohen's d=1.15>0.8).

According to these results, it is seen that traditional education practices contribute to the academic success of students.

Findings for the seventh sub-problem:

Is there a significant difference between the VSUBT pre-test and retention tests of the control group students in the study?

H_0 hypothesis: there is no significant difference between the pretest and retention test scores of the control group in which the traditional teaching method and science lesson were employed. In order to test the H0 hypothesis, analysis with dependent sample t-test and Cohen's d effect size calculation were made. The results are presented in Table 9.

Table 9. Results of dependent sample t-test and Cohen's d effect size calculation of pretest and retention test mean scores of the control group

Group	N	X̄	Ss	Sd	t	p	Effect Size
Pretest	20	12,900	4,102	19	-0,688	0,527*	0,21
Retention test	20	13,750	3,697				

*p>0.05

When Table 9 is examined, it is seen that the pretest mean score of the control group was 12.900, and the mean score of the retention test was 13.750, and there was no statistical difference between them (t= 0.688; p>0.05). According to the Cohen's d effect size calculation, it can be said that this difference is important in the low-level effect category (cohen's d=0.21>0.2).

Findings for the eighth sub-problem:

Is there a significant difference between the VSUBT posttest and retention test scores of the control group students in the study?

H_0 hypothesis: There is no significant difference between the posttest and retention test scores of the control group in which the traditional teaching method and science lesson were employed. In order to test the H0 hypothesis, analysis with dependent sample t-test and Cohen's d effect size calculation were made. The results are presented in Table 10.

Tablo 10. Results of dependent sample t-test and Cohen's d effect size calculation of posttest and retention test mean scores of the control group

Group	N	Mean	Ss	Sd	t	p	Effect Size
Posttest	20	18,900	6,129	38	3,218	0,003*	1,01
Retention test	20	13,750	3,697				

*p<0.05

When Table 10 is examined, it is seen that the posttest mean score in the control group is 18,900, and the retention test mean score is 13,750, and the difference between them is significant in favor of the posttest (t=3,218; p<0.05). According to the Cohen's d effect size calculation, it can be said that this difference is in the large effect category (cohen's d=1.01>0.8). According to these results, there is a significant difference between the posttest and retention test mean scores against the retention test.

CONCLUSION AND RECOMMENDATIONS

This study was carried out to examine the effect of 5E Model STEM education applications on the academic achievement of 6th grade students. In this section, the results obtained from the findings obtained within the framework of the research are evaluated by comparing them with the results of the literature related to the subject, and the suggestions developed according to the results are given. As a result of the comparison between the groups in the study, the posttest and retention test average scores of the experimental group, who were taught with the contemporary teaching method, 5E Model STEM education applications, were significantly higher than the control group taught with the classical method ($p<0.05$). (Tables 3 and 4). According to this finding, it was concluded that the STEM applications made have a positive effect on the science lesson performance of the students. When the in-group comparisons of the experimental group given in Tables 5, 6 and 7 are examined, it is seen that the mean scores of the pre-test, posttest and retention test are significantly different from each other ($p<0.05$).

According to these results, it can be said that the permanence of the high learning level provided by the STEM application decreases in the future, but the information is not completely forgotten. On the other hand, when the in-group comparisons of the control group given in Tables 8, 9 and 10 are examined, the difference between the mean scores of the pretest and posttest, posttest and retention test is significant ($p<0.05$). the difference was insignificant ($p>0.05$). According to this result, it can be said that the permanence of the learning level obtained with the traditional method disappears in the following periods and what is learned is forgotten. Yıldırım and Altun (2015) worked with 3rd grade science teacher candidates and examined the effect of STEM education and related practices on success. From this point of view, within the scope of the "Science Laboratory Applications" course, activities were implemented in line with the objectives set for the subject of "Energy Conversions and Renewable Energy", and it was aimed to provide the students participating in the study with the ability to solve real-life problems as well as using the processes of engineering design. Within the scope of my research, it has been shown that the experimental group taught with STEM education in the science laboratory significantly increased the success ($p<0.05$) compared to the control group, where the course was taught according to the traditional method.

In a study conducted by Ceylan and Özdilek (2015), the effect of STEM education activities on students' success was examined. The study was conducted with 8th grade students and a quasi-experimental design was used. Science lessons were taught with STEM activities on acid and base prepared according to the 5E model. It has been revealed that activities prepared according to STEM on acid and base have a positive effect on students' success. This result supports the findings of our study. Yamak, Bulut, and Dündar (2014) worked with 20 people formed by 5th grade students in their studies. The activities were held during the summer term and they investigated the effects of three STEM activities on students' attitudes towards science lesson and scientific process skills. Studies have concluded that STEM activities have a positive effect on students' attitudes towards science and science process skills. These results show parallel results with our study.

Ceylan (2014) investigated the effect of STEM education on academic success, creativity and problem solving skills in his study with secondary school students. Students were also asked about their views on STEM education with open-ended questions.

As a result of the research, the average academic achievement score of the group taught with STEM education was found to be significantly higher ($p<0.05$), similar to the results of our study, compared to the group in which the course was taught with the traditional teaching method. It was concluded that the students' views on STEM education, which were determined by open-ended questions, were positive. Pekbay (2017) investigated the effect of STEM activities on more than one variable (problem solving skills, interest in STEM fields, etc.) on secondary school students. At the end of the research. It has been determined that the activities contribute to the students' solving the problems of daily life and increase the students' interest in STEM in a positive way. In a study similar to our study by Yasak (2017); In the Force and Motion unit, it was examined whether explaining the subject of pressure with STEM applications had an effect on students' academic success in science and their attitudes towards science.

As a result of the research, the test score averages of the group in which STEM applications were made were higher than the control group. According to the interviews with the students and the scale analysis, it was reported that the models created during the activity had an effect on increasing the attitudes of the students towards the lesson. In his thesis study, Nağaç (2018) examined the effect of STEM education on academic achievement and problem-solving skills in secondary school students. The lesson was taught with STEM activities in his work in which he employed the matter and heat unit. He determined that the different STEM applications he made did not have a statistically significant effect on the academic success and problem solving skills of the students. However, he stated that the lesson taught with STEM applications increased the students' interest in the lesson, they had fun and the lesson taught in this way would benefit the students. Again, Ergün and Balçın (2019) examined the effect of problem-based STEM applications on the academic achievement of 6th grade students. He used a one-group weak experimental design and 19 students formed his sample. As a result of the applications, it has been seen that STEM activities have an increasing effect on academic achievement.

According to the results obtained from the comparison between the groups at the end of the research; It was observed that the posttest and retention test average scores of the group in which 5E model STEM applications were applied were statistically significantly higher than the average scores of the group taught with the traditional teaching method. According to the in-group comparisons, it was revealed that the learning and remembering levels were high in the experimental group, in which the lessons were taught with the 5E Model STEM applications, and that the students did not completely forget the information they learned. It was determined that the learning level, which was quite high, although not as much as the experimental group, in the group taught with the traditional method, completely disappeared in the following periods, and the students completely forgot the information they learned. According to these results, it can be said that 5E model STEM applications can be used successfully in teaching science courses.

According to the findings of this study, the recommendations of the researchers are given below:

STEM education activities on subjects suitable for the MEB curriculum should be added to the textbooks and implemented.

Science teachers related to STEM education should be supported with in-service training.

STEM education should not only be limited to science courses, but also should be associated with other courses.

Units and topics should be expanded in accordance with the application of STEM education practices.

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