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Examintion of Integrated Stem Education in Physics: Students' Attitude towards Stem

Secil ALNIAK
Marmara University

Feral OGAN BEKIROGLU
Marmara University

Abstract: In this study, effects of STEM Education on the attitudes of students towards STEM education was examined. In the first semester of the 2018-2019 academic year, the study was carried out with 65 students attending the 7th grade of a public school in Istanbul. The experimental group consisted of 31 students and the control group consisted of 34 students. STEM course was conducted between 28 November and 11 January. In this research, pre - test post - test experimental design with control group was used. STEM Attitude Scale was used as data collection tool. This scale was applied to both groups as a pre-test and then a post-test to measure and compare the effect of STEM activities. When the quantitative data were analyzed, it was seen that integrated STEM education had a positive effect on STEM attitudes of students.

Keywords: STEM education, Physics

Introduction

In recent years, the need for individuals who think, question, produce and have critical thinking skills, that is, 21st century skills that can do what machines cannot do, has increased in recent years. 21st century skills include high-level skills and learning dispositions that students need to develop in order to be successful in this age of easy access to information. These skills are deemed necessary by educators, business leaders, academics and government agencies in 21st century society and business.

Especially the applications of advanced technology and advanced science and the training of individuals who will work and produce in these fields are important in terms of country policies. Considering the countries producing in this field, one of the reasons why our country is in the background can be said to be the lack of high level labor force (Cil & Cepni, 2017). In order to eliminate this high level of labor force and to increase global competitiveness, generations capable of producing solutions to the problem and blending technology with their knowledge should be raised. All these needs have led to new reforms in education. STEM training is an approach developed for this need.

The term STEM education refers to teaching and learning in the fields of science, technology, engineering and mathematics (Gonzalez & Kuenzi, 2012). STEM education approach aims to make the students competent in all these disciplines. In order to produce solutions to the daily life problems of the students, they work together in an engineering design process and produce and implement different strategies.

Obama, who was the US president in 2010, also expressed his ideas about how future leadership will be shaped in parallel with how students are educated especially in STEM fields and pointed out the importance of STEM. Dincer (2014) reported that in 2041, our working-age population will increase to 65 million, and that in order to transform this potential into a potential to provide innovation, STEM education in general and overall education should be improved. Corlu, Capraro and Capraro (2014) published articles on the reflections of STEM training on field teacher training and examined the ongoing innovation initiatives in the field of education in Turkey and in the world. They emphasized that the fact that teachers have only knowledge in their own fields will be

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insufficient to raise the human potential needed for the development of our country. This shows that the traditional teaching approach is not sufficient and there is a need for an STEM approach that links the subject with more than one discipline.

Methodology

The aim of this study was to examine the effects of integrated STEM education on students' attitudes towards STEM and to contribute to the proper implementation of STEM education in our country. Pre-test post-test experimental design with control group was used. The study group consisted of two 7th grade students in a public school in Istanbul. The experimental group consisted of 31 students (19 boys, 12 girls) and the control group consisted of 34 students (19 boys, 15 girls). In the first semester of the 2018-2019 academic year, the study was carried out in two branches in the 7th grade in Anatolian district of Istanbul. STEM course was conducted between 14 November and 11 January. Each STEM course activity was 90 minutes (2 course hours) with four STEM activities. STEM attitude scale was applied to control and experimental groups before and after the STEM integration.

Results

The findings related to the participants' attitudes before and after the STEM education are presented with tables.

Table 1. Experimental group's dependent T-Test results

Group	N	x̄	sd	df	t	p	Cohen's d
Experimental (Pre-Test)	30	4.2798	0.43812	29	3.637	0.001	0.6641
Experimental (Post-Test)	30	4.4929	0.40421				

Table 1 shows the experimental group STEM attitude scale dependent t test results. In this application, the p value of t-test was found to be 0.001 for the related samples which tested whether there was a difference between the STEM attitude questionnaire scores applied before and after STEM training in physics subjects. As $p < 0.05$, a statistically significant difference was observed between the total scores of the pre-test and post-test measurements. Therefore, there was significant difference between the STEM attitude pre-test and post-test scores of the experimental group students in which STEM education was applied.

Table 1. Groups' independent T-Test results before the application

Group	N	x̄	ss	sd	t	p
Experimental	31	4,2753	0,43146	63	0,696	0,485
Control	34	4,2080	0,33818			

When Table 2 was examined, it was found that the p value of the t-test was 0.485 for the independent groups that determined whether there was a difference between the STEM attitude test pre-test mean scores of the experimental and control groups before the application. Since $p > 0.05$, the hypothesis that there was no difference between the averages of the groups was accepted. Accordingly, no statistically significant difference was found between the averages of the groups.

Table 3.Groups' independent T-Test results after the application

Group	N	x̄	ss	sd	t	p
Experimental	30	4,4929	0,40421	62	4,08	0,000
Control	34	4,0910	0,38146			

According to Table 3, it was found that the p value of t test is 0.000 for independent samples which determine whether there was a difference between the STEM attitude test pre-test mean scores of the experimental and control groups before the application. Since $p < 0{,}05$, the hypothesis that there was a difference between the means of the groups was accepted. Accordingly, a statistically significant difference was found between the averages of the groups.

Table 2 .Control group's dependent T-Test results

Group	N	x̄	sd	df	t	p	Cohen's d
Control (Pre-Test)	34	4.2080	0.33818	33	-1.529	0.136	0.2622
Control (Post-Test)	34	4.1891	0.38801				

As it is seen in Table 4, the p value of the dependent sample t test which determines whether there was a difference between the pre-test and post-test scores of the STEM Attitude Questionnaire applied to the control group was found to be 0,136. As p> 0.05. No statistically significant difference was observed between the total scores of the pre-test and post-test measurements.

Table 3. Dependent T-Test results of STEM attitude scale for experimental group

Group		N	x̄	sd	df	t	p	Cohen's d
Experimental	Relationship between Mathematics and Science Learning STEM Post Test	30	4,4722	,44653	29	2,355	,025	0,4299
	Relationship between Mathematics and Science Learning STEM Pre Test	30	4,2833	,46352				
Experimental	Engineering Learning Post Test	30	4,5333	,51118	29	4,778	,000	0,872
	Engineering Learning Pre Test	30	4,1778	,61888				
Experimental	Personal and Social Implications Post Test	30	4,3458	,50609	29	1,773	,087	0,323
	Personal and Social Implications Pre Test	30	4,2042	,62239				
Experimental	Technology Learning Post Test	30	4,4250	,48312	29	1,309	,201	0,2389
	Technology Learning Pre Test	30	4,3167	,54903				

In Table 5, t-test results of STEM attitude scale sub-factors are given. It is seen that there was a statistically significant difference between the pre-test and post-test scores of the experimental group in relation to

Mathematics and Science Learning and STEM (t = 2,355; p <0.05). There was a statistically significant difference between pre-test and post-test mean scores of Engineering Learning and STEM (t = 4,778; p <0.05). A significant difference was found between STEM's Personal and Social Implications and the pre-test and post-test mean scores in favor of the post-test (t = 1,773; p> 0.05).

There was no statistically significant difference between pre-test and post-test mean scores of Technology Learning and Use (t = 1,309; p> 0.05). The highest increase was related to Engineering Learning and STEM, and the least increase was seen in Learning and Use of Technology factors.

Table 4.Dependent T-Test results of STEM attitude scale for control group

Group		N	x̄	sd	df	t	p	Cohen's d
Control	Relationship between Mathematics and Science Learning STEM Post Test	34	4,0784	,48762	33	-1,391	,174	-0,238
	Relationship between Mathematics and Science Learning STEM Pre Test	34	4,1176	,40728				
Control	Engineering Learning Post Test	34	4,1225	,50803	33	-,387	,701	-0,066
	Engineering Learning Pre Test	34	4,1324	,43958				
Control	Personal and Social Implications Post Test	34	4,1618	,56620	33	-1,719	,095	-0.016
	Personal and Social Implications Pre Test	34	4,1949	,51234				
Control	Technology Learning Post Test	34	4,2206	,47180	33	,442	,661	-0,796
	Technology Learning Pre Test	34	4,2059	,45838				

Regarding Table 6, there was no statistically significant difference between the pre-test and post-test mean scores of the control group Relationship between Mathematics and Science Learning and STEM (t = -1.391; p> 0.05). There was no statistically significant difference between pre-test and post-test mean scores of Engineering Learning and STEM (t = -0.387; p> 0.05). There was no statistically significant difference between the pre-test and post-test mean scores of 'Personal and Social Implications' in favor of the post-test (t = -1.719; p> 0.05). There was no statistically significant difference between pre-test and post-test mean scores of Technology Learning and Use (t = 0.442; p> 0.05). When the mean of sub-factors of STEM attitude scale applied in the control group was examined, it was seen that there was no increase in favor of the post-tests.

Conclusion

It was found that there was a significant difference in favor of the post-test between the pre-test and post-test scores of the group before and after STEM training. Accordingly, STEM education positively affects students' STEM attitudes. Findings obtained from voice recordings also support that STEM attitudes of students were positively affected. The most increasing sub-factor of the scale is engineering education and this shows that STEM activities have a positive effect on engineering learning. Other sub-factors positively influenced by STEM activities are mathematics and science learning and their relationship with STEM, STEM personal and social implications, and technology learning and use. Furthermore, it is seen that STEM activities show the least positive increase in technology learning and use of. As expected, there is no change in STEM attitudes of students who do not receive STEM education.

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Author Information

Seçil Alniak	Feral Ogan Bekiroglu
Marmara University,	Marmara University,
Goztepe İstanbul, Turkey	Goztepe İstanbul, Turkey
Contact E-mail:*secilalniak@hotmail.com*	