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The Effect of STEM Applications On Students' Science-Engineering Perceptions[1]

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Abstract
This study was conducted to find out the effects of STEM applications on students' perceptions of science and engineering. The study was conducted with 26 7th graders in a secondary school in Samsun. One group pre test, post test experimental design was used in the study. During the process of STEM applications within the scope of the unit of electric energy, a form consisting of 12 open ended questions was used, analyzed and evaluated. When the data obtained were analyzed, it was found that as a result of STEM education, students' perceptions of engineering changed positively, they were able to make more correct definitions of engineering and they were able to state the basic objectives of engineering. As a result of the applications, it was found that students were able to tell the elements of the engineering design process and the stages engineers follow while designing products and in addition they were able to express the importance of science for engineering while presenting the spiral relationship between the concepts of science-engineering-technology. Schools should allocate budget for STEM applications which will give students experiences about forming a sense of production, gaining skills related with hands, taking responsibilities and sharing and both students and teachers should be encouraged about STEM applications.

Key words:STEM; Science; Engineering

Introduction

Since turning the information which is the basis of science into daily life and technology production require using the information about science, mathematics and engineering together, new education programs began to be renovated in this direction. According to Bybee (2010) the need felt for the complicated skills necessitated by 21st century and the difficulties encountered, the need for a work force that has personal skills and the need for variety in occupations show the insufficiency of the education standards of 90s. The skills individuals should have in 21st century, an innovation age in which use of

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technology has increased fast and while the countries which produce information and technology have grown, the others have fallen behind, are listed as cooperation, creativity, communication, problem solving, analytical and algorithmic thinking (P21, 2015). These skills are in parallel with the skills of STEM education, which require the use of Science-Technology-Engineering-Mathematics (STEM) disciplines together for today's needs and aims to teach. Educators perceive and explain STEM in different ways. Besides helping students to understand how the tools they use in their daily lives work, STEM education should also develop students' use of technology (Bybee, 2010). Today, concepts such as problem solving, innovation and cooperation, which are in the center of the world's agenda and in the center of education policies, are embodied in STEM education.

Scientific literacy requires technology production and use, reaching sources of information and making sense of scientific information correctly. This situation shows the importance of making students gain skills of science and engineering, which is one of the universal education targets of our day. Having background information about technology is one of the prerequisites of science literacy, which is among the targets of science education (Akçay et al., 2010). In addition, being literate requires knowing the features of scientific knowledge and having an idea about the ways scientific knowledge is formed and being able to assess scientific information one comes across (NRC, 1996; Bell, 2008; Aslan et al., 2009). In "Primary education institutions science lesson teaching program' published by TTKB (2013), the following can be seen in the teaching of science";

> The vision of science teaching program is "educating all students as scientifically literate individuals". Science literate individuals who can research and question, give effective decisions, trust in themselves, make communicative research and do lifelong learning with an awareness of development have an understanding of the association between science and technology-society-environment and psychomotor skills (TTKB, 2013,p.I).

In STEM education, students are presented with experiences they will be active in through materials diversified with well-designed learning programs. Besides being creative, developing different solutions to new problems and presenting designs in cooperation, students are expected to present their ideas to their peers. Similarly, finding new ideas and exchanging information are prerequisites of engineering as well as science.

While presenting new ideas, engineers make use of products of science and mathematics. Diagrams, graphs, models and products are more important than reading and writing for scientists in presenting their ideas (NRC, 2012). Besides these, scanning through resources by using information and finding the most suitable information for our problem, knowing how to use information and presenting the best design solution are indispensible parts of engineering skills. The expressions so far show how important and necessary each of the disciplines of science, technology, mathematics and engineering are for the others. According to Tübitak (2004) for the target of 2023, the vision should include educating individuals equipped with future occupations within the science and technology context of the future and it should include all the levels of our education system in order to be able to have the future technology.

The objective of this study is to raise awareness about whether STEM applications change students' perceptions about science and engineering and about how the cooperation of these areas which use and produce information can affect productivity.

Method

The study was conducted with 26 7th graders in a secondary school in Samsun. During the process of 8-week long STEM applications developed within the scope of 7th grade unit of electric energy, a form consisting of 12 open ended questions Ercan (2014) was used to find out students' information and perceptions about engineering, the data were analyzed and evaluated. One group pre test, post test experimental design was used in the study. The data were assessed according to 5 level grading score key given in Table 1 and analyzed with Wilcoxon Signed Rank Test for Paired Samples.

Table 1. Graded scoring key for Engineering Discipline Information Form

The criteria used in the assessment	Point
All the expectations about the question answered	4
Most of the expectations answered ,however, there are mislearnings or lack of nowledge partly	3
Some of the expectations answered, there are mislearnings or lack of nowledge	2
There are too many mislearnings or lack of nowledge, very few expectations answered	1
None of the expectations answered	0

Results

Engineering information form was conducted as pre-test and post-test and assessed separately to find out students' perceptions and knowledge levels about engineering. Wilcoxon Signed Rank Test for Paired Samples results of pre-test and post-test scores for related samples (repeated measurements) are presented in Table 2.

Table 2. Wilcoxon Signed Rank Test for Paired Samples results of EIF Pre-test, Post-test scores

Post test-Pretest	n	Mean	Sum of	z	p
Rank	Rank				
Negative Ranks	0	.00	.00	4.46	.000
Positive Ranks	26	13.50	26.00		
Equal	0	-	-		

Pre-test and post-test forms conducted according to Wilcoxon Signed Rank Test for Paired Samples were assessed separately (table 3, table 4), the results obtained from both tests were assessed separately and the questions which showed differences were examined as stated below.

Table 3. Engineering Information Form Pre-test scores

Student / Question	1	2	3	4	5	6	7	8	9	10	11	12
1	1	1	2	3	0	0	0	1	0	3	2	3
2	1	4	0	0	4	0	2	3	0	3	0	2
3	1	2	1	0	0	1	0	2	0	0	3	2
4	1	3	0	0	0	2	1	2	3	4	0	0
5	1	4	0	0	1	3	0	3	0	4	2	0
6	1	4	4	2	1	2	2	2	1	2	0	2
7	0	0	1	0	0	0	0	0	0	1	2	0
8	0	3	4	2	1	2	1	1	0	0	0	2
9	3	3	4	0	0	0	2	0	0	1	0	0
10	0	2	0	0	0	1	2	0	0	0	0	0
11	2	2	3	1	2	2	3	1	1	1	2	1
12	0	2	0	0	0	2	1	1	0	2	1	0
13	1	0	0	2	0	0	0	0	0	0	0	0
14	3	1	0	2	1	1	1	0	1	0	0	0
15	3	4	4	0	0	1	2	1	0	0	0	2
16	2	3	0	0	0	2	3	2	1	2	2	0
17	1	4	4	2	0	1	2	3	3	1	2	0
18	1	3	1	0	1	2	1	0	0	0	2	2
19	2	3	2	3	0	2	2	2	3	2	1	2
20	0	1	0	0	0	0	0	0	0	0	0	2
21	3	2	3	3	0	2	4	2	3	1	0	0
22	3	2	2	0	0	0	0	3	0	1	0	0
23	1	1	2	2	0	2	2	4	1	2	2	0
24	3	2	2	0	1	2	3	4	1	3	0	0
25	3	4	2	0	0	0	0	0	1	3	0	2
26	3	0	2	0	0	0	0	2	0	0	0	2

While there were no students who met all the expectations to the first question of the information form 'What do you think engineer means?', there were 8 students who answered most of the expectations but had mislearnings or lack of nowledge partly (S 9, 14, 15, 21, 22, 24, 25, 26). There were 3 students who answered some of the expectations but had mislearnings or lack of nowledge (S11, 16, 19). There were 10 students who had too many mislearnings or lack of nowledge and who answered very few expectations (S 1, 2, 3, 4, 5, 6, 13, 17, 18, 23). There were 5 students who did not meet any of the expectations (S7, 8, 10, 12, 20).

There were 6 students who met all the expectations to the second question of the information form 'Which fields of engineering can you think of? Can you list them?' (S 2, 5, 6, 15, 17, 25). There were 6 students who answered most of the expectations but had mislearnings or lack of nowledge partly (S 4, 8, 9, 16, 18, 19). There were 6 students who answered some of the expectations but had mislearnings or lack of nowledge (S 4, 8, 9, 16, 18, 19). There were 4 students who had too many mislearnings or lack of nowledge and who answered very few expectations (S 1, 14, 21, 23). There were 3 students who did not meet any of the expectations (S 7, 13, 26).

There were 5 students who met all the expectations to the third question of the information form ''What do you think is the primary purpose in engineering?'(S 6, 8, 9, 15, 17). There were 2 students who answered most of the expectations but had mislearnings or lack of nowledge partly (S 11, 21).). There were 7 students who answered some of the expectations but had mislearnings or lack of nowledge (S 1, 19, 22, 23, 24, 25, 26). There were 3 students who had too many mislearnings or lack of nowledge and who answered very few expectations (S 3, 7, 18). There were 9 students who did not meet any of the expectations (S 2, 4, 5, 10, 12, 13, 14, 16, 20).

While there were no students who met all the expectations to the 4. question of the information form 'Have you ever experienced an event in which you acted like an engineer in daily life? Can you describe this event?' there were 3 students who answered most of the expectations but had mislearnings or lack of nowledge partly (S 1, 19, 21). There were 6 students who answered some of the expectations but had mislearnings or lack of nowledge (S 6, 8, 13, 14, 17, 23). There were 1 students who had too many mislearnings or lack of nowledge and who answered very few expectations (S 11). There were 16 students who did not meet any of the expectations (S 2, 3, 4, 5, 7, 9, 10, 12, 15, 16, 18, 20, 22, 24, 25, 26).

There were 1 students who met all the expectations to the 5. question of the information form 'Do you consider yourself as an engineer? Why?' (S 2). There were no students who answered most of the expectations but had mislearnings or lack of nowledge partly. There were 1 students who answered some of the expectations but had mislearnings or lack of nowledge (S 11). There were 6 students who had too many mislearnings or lack of nowledge and who answered very few expectations (S 5, 6, 8, 14, 18, 24). There were 18 students who did not meet any of the expectations (S 1, 3, 4, 7, 9, 10, 12, 13, 15, 16, 17, 19, 20, 21, 22, 23, 25, 26).

While there were no students who met all the expectations to the 6. question of the information form 'What does it mean that an engineering design process should be progressive, creative and repetitive?' there were 1 students who answered most of the expectations but had mislearnings or lack of nowledge partly (S 5). There were 11 students who answered some of the expectations but had mislearnings or lack of nowledge (S 4, 6, 8, 11, 12, 16, 18, 19, 21, 23, 24). There were 5 students who had too many mislearnings or lack of nowledge and who answered very few expectations (S3, 10, 14, 15, 17). There were 9 students who did not meet any of the expectations (S1, 2, 7, 9, 13, 20, 22, 25, 26).

There were 1 students who met all the expectations to the 7. question of the information form 'Which stages do you think engineers follow while designing a product? Can you list them?' (S 21). There were 3 students who answered most of the expectations but had mislearnings or lack of nowledge partly (S 11, 16, 24). There were 8 students who answered some of the expectations but had mislearnings or lack of nowledge (S 2, 6, 9, 10, 15, 17, 19, 23). There were 5 students who had too many mislearnings or lack of nowledge and who answered very few expectations (S 4, 8, 12, 14, 18). There were 9 students who did not meet any of the expectations (S 1, 3, 5, 7, 13, 20, 22, 25, 26).

There were 2 students who met all the expectations to the 8. question of the information form 'Engineers define 'criteria' and 'limitations' while planning their design. What do you think limitations and criteria mean? Can you explain? (S 23, 24). There were 4 students who answered most of the expectations but had mislearnings or lack of nowledge partly (S 2, 5, 17, 22). There were 7 students who answered some of the expectations but had mislearnings or lack of nowledge (S 3, 4, 6, 16, 19, 21, 26). There were 5 students who had too many mislearnings or lack of nowledge and who answered very few expectations (S 1, 8, 11, 12, 15). There were 8 students who did not meet any of the expectations (S 7, 9, 10, 13, 14, 18, 20, 25).

While there were no students who met all the expectations to the 9. question of the information form 'Do criteria and limitations always support each other during engineering design process? What kind of a path should be followed if they contradict with each other?' there were 4 students who answered most of the expectations but had mislearnings or lack of nowledge partly (S 4, 17, 19, 21). There were no students who answered some of the expectations but had mislearnings or lack of nowledge. There were 7 students who had too many mislearnings or lack of nowledge and who answered very few expectations (S 6, 11, 14, 16, 23, 24, 25). There were 15 students who did not meet any of the expectations (S 1, 2, 3, 5, 7, 8, 9, 10, 12, 13, 15, 18, 20, 22, 26).

There were 2 students who met all the expectations to the 10. question of the information form 'Do you think that engineering is necessary for science? Can you explain?' (S 4, 5). There were 4 students who answered most of the expectations but had mislearnings or lack of nowledge partly (S 1, 2, 24, 25). There were 6 students who answered some of the expectations but had mislearnings or lack of nowledge (S 6, 12, 16, 19, 21, 26). There were 6 students who had too many mislearnings or lack of nowledge and who answered very few expectations (S 7, 9, 11, 17, 21, 22). There were 9 students who did not meet any of the expectations (S 3, 8, 10, 13, 14, 15, 18, 20, 26).

While there were no students who met all the expectations to the 11. question of the information form 'Can you assess the association between technology and engineering and science and technology?' there were 1 students who answered most of the expectations but had mislearnings or lack of nowledge partly (S 3). There were 8 students who answered some of the expectations but had mislearnings or lack of nowledge (S 1,5, 7, 11, 16, 17, 18, 23). There were 2 students who had too many mislearnings or lack of nowledge and who answered very few expectations (S 12, 19). There were 15 students who did not meet any of the expectations (S 2, 4, 6, 8, 9, 10, 13, 14, 15, 20, 21, 22, 24, 25, 26).

While there were no students who met all the expectations to the 12. question of the information form 'Do you think that the engineering design process can have more than one ways for correct results? Can you explain?' there were 1 students who answered most of the expectations but had mislearnings or lack of nowledge partly (S 1). There were 14 students who answered some of the expectations but had mislearnings or lack of nowledge (S 4, 5, 7, 9, 10, 12, 13, 14, 16, 17, 21, 22, 23, 24). There were 1 students who had too many mislearnings or lack of nowledge and who answered very few expectations (S 11). There were 14 students who did not meet any of the expectations (S 4, 5, 7, 9, 10, 12, 13, 14, 16, 17, 21, 22, 23, 24).

Table 4. Engineering Information Form Post-test scores

Student / Question	1	2	3	4	5	6	7	8	9	10	11	12
1	2	2	2	2	4	3	3	3	3	3	2	2
2	3	3	4	4	4	4	2	2	2	3	4	4
3	4	2	3	2	1	1	3	2	3	2	2	4
4	4	2	4	2	3	2	4	2	3	4	4	3
5	4	4	4	4	4	4	3	3	3	1	0	4
6	4	4	4	4	4	4	3	3	3	4	0	2
7	3	3	4	4	4	3	2	3	2	4	2	3
8	1	4	3	4	4	4	3	4	1	4	4	4
9	3	4	4	4	4	4	3	4	4	4	2	4
10	1	3	4	0	4	2	2	3	3	2	0	0
11	3	4	4	4	4	4	4	3	2	2	3	3
12	4	4	4	4	4	4	3	3	3	3	4	3
13	1	4	0	2	4	2	1	2	1	3	2	2
14	4	3	2	4	3	2	3	2	3	2	2	3
15	3	4	4	4	4	4	2	3	2	1	0	4
16	4	4	4	4	0	4	2	4	3	1	2	2
17	4	4	2	4	4	4	3	4	2	2	2	4
18	2	4	2	0	3	3	1	2	1	4	2	4
19	4	4	4	4	0	3	1	4	4	3	2	4
20	2	3	2	3	3	3	3	2	2	3	2	4
21	4	3	4	4	2	3	4	4	3	2	2	3
22	4	4	4	4	4	4	3	4	3	3	2	4
23	4	2	2	4	3	2	2	4	3	4	1	3
24	4	3	4	4	4	4	3	3	0	4	4	4
25	4	4	4	4	4	4	3	4	4	2	4	4
26	3	3	3	2	2	4	2	3	3	1	0	2

There were 14 students who met all the expectations to the first question of the information form 'What do you think engineer means?' (S 3, 4, 5). There were 6 students who answered most of the expectations but had mislearnings or lack of nowledge partly (S 2, 7, 9). There were 3 students who answered some of the expectations but had mislearnings or lack of nowledge (S 1, 18, 20). There were 3 students who had too many mislearnings or lack of nowledge and who answered very few expectations (S 8, 10, 13). There were no students who did not meet any of the expectations.

There were 14 students who met all the expectations to the second question of the information form 'Which fields of engineering can you think of? Can you list them?' (S 5, 6, 8, 9, 11, 12, 13, 15, 16, 17, 18, 19, 22, 25). There were 8 students who answered most of the expectations but had mislearnings or lack of nowledge partly (S 2, 7, 10, 14, 20, 21, 24, 26). There were 4 students who answered some of the expectations but had mislearnings or lack of nowledge (S 1, 3, 4, 23). There were no students who had too many mislearnings or lack of nowledge and who answered very few expectations, who did not meet any of the expectations.

There were 16 students who met all the expectations to the third question of the information form 'What do you think is the primary purpose in engineering?'(S 2, 4, 5, 6, 7, 9, 10, 11, 12, 15, 16, 19, 21, 22, 24, 25). There were 3 students who answered most of the expectations but had mislearnings or lack of nowledge partly (S 3, 8, 26). There were 6 students who answered some of the expectations but had mislearnings or lack of nowledge (S 1, 14, 17, 18, 20, 23). There were no students who had too many mislearnings or lack of nowledge and who answered very few expectations. There were 1 students who did not meet any of the expectations (S 13).

There were 18 students who met all the expectations to the 4. question of the information form 'Have you ever experienced an event in which you acted like an engineer in daily life? Can you describe this event?' (S 2, 5, 6, 7, 8, 9, 11, 12, 14, 15, 16, 17, 19, 21, 22, 23, 24, 25). There were 1 students who answered most of the expectations but had mislearnings or lack of nowledge partly (S 20). There were 5 students who answered some of the expectations but had mislearnings or lack of nowledge. (S 1, 3, 4, 13, 26). There were no students who had too many mislearnings or lack of nowledge and who answered very few expectations. There were 2 students who did not meet any of the expectations (S 10, 18).

There were 16 students who met all the expectations to the 5. question of the information form 'Do you consider yourself as an engineer? Why?' (S 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 17, 22, 24, 25). There were 5 students who answered most of the expectations but had mislearnings or lack of nowledge partly(S 4, 14, 18, 20, 23). There were 2 students who answered some of the expectations but had mislearnings or lack of nowledge (S 21, 26). There were 1 students who had too many mislearnings or lack of nowledge and who answered very few expectations (S 3). There were 1 students who did not meet any of the expectations (S 16).

There were 14 students who met all the expectations to the 6. question of the information form 'What does it mean that an engineering design process should be progressive, creative and repetitive?' there were 1 students who answered most of the expectations but had mislearnings or lack of nowledge partly (S 2, 5, 6, 8, 9, 11, 12, 15, 16, 17, 22, 24, 25, 26). There were 5 students who answered some of the expectations but had mislearnings or lack of nowledge (S 4, 10, 13, 14, 23). There were 1 students who had too many mislearnings or lack of nowledge and who answered very few expectations (S 3). There were no students who did not meet any of the expectations.

There were 3 students who met all the expectations to the 7. question of the information form 'Which stages do you think engineers follow while designing a product? Can you list them?' (S 4, 11, 21). There were 13 students who answered most of the expectations but had mislearnings or lack of nowledge partly (S 1, 3, 5, 6, 8, 9, 12, 14,17, 20, 22, 24, 25). There were 7 students who answered some of the expectations but had mislearnings or lack of nowledge (S 2, 7, 10, 15, 16, 23, 26). There were 3 students who had too many mislearnings or lack of nowledge and who answered very few expectations (S 13, 18, 19). There were no students who did not meet any of the expectations.

There were 9 students who met all the expectations to the 8. question of the information form 'Engineers define 'criteria' and 'limitations' while planning their design. What do you think limitations and criteria mean? Can you explain? (S 8, 9, 16, 17, 19, 21, 22, 23, 25). There were 10 students who answered most of the expectations but had mislearnings or lack of nowledge partly (S 1, 5, 6, 7, 10, 11, 12, 15, 24, 26). There were 7 students who answered some of the expectations but had mislearnings or lack of nowledge (S 2, 3, 4, 13, 14, 18, 20). There were no students who had too many mislearnings or lack of nowledge and who answered very few expectations, who did not meet any of the expectations.

There were 3 students who met all the expectations to the 9. question of the information form 'Do criteria and limitations always support each other during engineering design process? What kind of a path should be followed if they contradict with each other?' (S9, 19, 25). There were 12 students who answered most of the expectations but had mislearnings or lack of nowledge partly (S 1, 3, 4, 5, 6, 10, 12, 16, 21, 22, 23, 26). There were 6 students who answered some of the expectations but had mislearnings or lack of nowledge(S 2, 7, 11, 15, 17, 20). There were 3 students who had too many mislearnings or lack of nowledge and who answered very few expectations (S 8, 13, 18). There were 1 students who did not meet any of the expectations (S 24).

There were 8 students who met all the expectations to the 10. question of the information form 'Do you think that engineering is necessary for science? Can you explain?' (S 4, 6, 7, 8, 9, 18, 23, 24). There were 7 students who answered most of the expectations but had mislearnings or lack of nowledge partly (S 1, 2, 12, 13, 19, 20, 22). There were 7 students who answered some of the expectations but had mislearnings or lack of nowledge (S 3, 10, 11, 14, 17, 21, 25). There were 4 students who had too many mislearnings or lack of nowledge and who answered very few expectations (S 5, 15, 16, 26).There were no students who did not meet any of the expectations.

There were 6 students who met all the expectations to the 11. question of the information form 'Can you assess the association between technology and engineering and science and technology?'(S 2, 4, 8, 12, 24, 25). There were 1 students who answered most of the expectations but had mislearnings or lack of nowledge partly (S 11). There were 13 students who answered some of the expectations but had mislearnings or lack of nowledge (S 1, 3, 7, 9, 13, 14, 16, 17, 18, 19, 20, 21, 22). There were 1 students who had too many mislearnings or lack of nowledge and who answered very few expectations (S 23). There were 5 students who did not meet any of the expectations (S 5, 6, 10, 15, 26).

There were 13 students who met all the expectations to the 12. question of the information form 'Do you think that the engineering design process can have more than one ways for correct results? Can you explain?'(S 2, 3, 5, 8, 9, 15, 17, 18, 19, 20, 22, 24, 25). There were 7 students who answered most of the expectations but had mislearnings or lack of nowledge partly (S 4, 7, 11, 12, 14, 21, 23). There were 5 students who answered some of the expectations but had mislearnings or lack of nowledge (S 1, 6, 13, 16, 26). There were no students who had too many mislearnings or lack of nowledge and who answered very few expectations. There were 1 students who did not meet any of the expectations (S 10).

Discussion

Engineering has become inevitable for technology production which makes people's lives easier and the whole of which is the product of sciences and thus in the last decade science, technology and engineering have begun to be taught together in all education programs. Since the transformation of this union depended on some calculations, mathematics had to be in this union inevitably. Based on these thoughts, STEM applications, a very important teaching approach, began to become widespread. In line with these views, our study tested the changes in 7th graders' perceptions of engineering before and after STEM applications.

According to the analysis results of Wilcoxon Signed Rank Test for Paired Samples, there is a significant difference between the pre-test and post-test scores of the engineering information test conducted before and after the applications, $z=4.46$, $p<.05$. When the average and total of difference scores were taken into consideration, the difference was found to be in favor of positive ranks, that is pre-test scores. According to these results, it can be said that STEM applications have a significant effect on developing students' levels of information about engineering positively. In parallel with our study, in their study they conducted with 5th graders, Gülhan and Şahin (2016) stated that students developed positive attitudes and perceptions about engineering as a result of STEM applications.

When the pre-test and post-test answers of the first question in the form 'What do you think engineer means?' were compared, it was found that while none of the students met all the expectations in the pre-test, the answers of more than half of the students (14 out of 26) differed to meet all the expectations in the post-test. When these results are taken into consideration, low perceptions of students about engineering although they are in contact with engineering products in every field of their lives and the fact that they cannot define engineering is an important problem which shows that they are educated in a parrot fashion and they cannot use information. In their study, Coştu, Ünal and Ayas (2007) emphasized the importance of association information with Daily life in science education and thus the importance of educating individuals who can use information. In addition, since teaching methods which enable interdisciplinary information transfer were not used until recently, the students were not expected to realize these and as a conclusion, students could not structure science with engineering, mathematics or with its social dimension. However, science should be addressed with technology and social development which occurs as a result of using technology. As a result of our applications, more than half of our students began to perceive science so and they began to make correct definitions (Table 4).

As in the first questions, the answers to the third question 'What do you think is the primary purpose in engineering?' were found to be insufficient in the pre-test and the answers that met the expectations were found to increase significantly after the applications. When these results are taken into consideration, it was concluded that students are inclined to STEM applications and that they can be used widely especially in science education. In his study about STEM applications in science education, S. Gencer (2015) stated that students' excitement and curiosity increased during the applications, which was in parallel with our results.

When the answers to the question 'Which fields of engineering can you think of? Can you list them?' were analyzed, it was found that while the number of students who met all expectations in the pre-test was 6, the number of students increased to 14 in the post-test. Similar to the questions examined above, students made definitions with their information in daily life and they had more perceptions about civil engineering than other fields. However, we see engineering in most of the technological products that make life easier. It seems difficult for a student who cannot think of this and who has not been educated thus to make definitions or to act like an engineer. Thus, it should be considered normal for no student to meet all of the expectations with their answers to the question 'Have you ever experienced an event in which you acted like an engineer in daily life? Can you describe this event?'. After STEM applications, students both realized their states about engineering in their daily lives and began to give examples from their own behaviors and their activities. This situation shows that students cannot realize that they have the necessary experiences for being an engineer in daily life. In their study, Yılmaz, Türkoğuz and Şahin (2014) stated that one of the most important goals of education is to prepare students to life and to enable them to explain the situations they meet in daily life.

Similarly, while the number of students who met all the expectations in question 'Do you consider yourself as an engineer? Why?' is 1 in the pre-test, this number increased to 16 in post-test. Especially the students who presented good products physically as a result of applications stated that they saw themselves as engineers. In a study conducted with 7th graders, Gencer (2015) emphasized the importance of design-based applications in developing students' carrier awareness. Moore and Richards (2012) also state that students' occupation choices can be led by STEM applications.

While none of the students met all the expectations to the question 'What does it mean that an engineering design process should be progressive, creative and repetitive?' in pre-test, 16 students met all the expectations in post-test. A great majority of students who made designs with their engineering experiences during the process were able to define the features of engineering design process. While there was only 1 student in pre-test who could meet all the expectations to the question 'Which stages do you think engineers follow while designing a product? Can you list them?', there were 16 students in post-test who could meet all the expectations or had mislearnings partly. Mislearnings in students' answers are the expression of some stages in a switched order. 5 stage engineering design process put forward by Wendell et al. (2010) was used during STEM applications. We can accept the mislearnings as normal since engineering design process is a new situation for students.

While there were 2 students in pre-test who could meet all the expectations to the question 'Engineers define 'criteria' and 'limitations' while planning their design. What do you think limitations and criteria mean? Can you explain?', there were 19 students in post-test who could meet all the expectations or had mislearnings partly. The concepts of criteria and limitation were the most difficult concepts for students to understand. The reason for this is thought to be the fact that students saw these concepts for the first time. Similarly, while there were no students in pre-test who met all the expectations to the question 'Do criteria and limitations always support each other during engineering design process? What kind of a path should be followed if they contradict with each other?', there were 15 students in post-test who could meet all the expectations or had mislearnings partly. While it was not seen possible for students who did not have engineering experiences to answer such a question correctly, a great number of students made explanations by setting out from their experiences in the process.

While there were 2 students in pre-test who could meet all the expectations to the question 'Do you think that engineering is necessary for science? Can you explain?', there were 8 students in post-test who could meet all the expectations. In their study, Richardson and Houston (2006) stated that students could make stronger associations with the positive increase about science with STEM. While there were no students in pre-test who met all the expectations to the question 'Can you assess the association between technology and engineering and science and technology?', there were 6 students in post-test who could answer all the questions correctly. We can say that students began to realize the integrated association between science-technology-engineering. NRC (2012) emphasizes the importance of students and teachers associating the concepts of science, technology and engineering. While there were no students in pre-test who met all the expectations to the question 'Do you think that the engineering design process can have more than one ways for correct results? Can you explain?', there were 13 students in post-test who could answer all the questions correctly and 7 students who gave incorrect answers. The fact that majority of students made correct explanations shows that they realized their friends in other groups presented solutions with different designs. Different solutions to the same problem correspond to 21st century skill creativity concept. Even students' realizing that they can develop different solutions is seen as a very important development.

Increase in students' knowledge about engineering and the positive increase in their thoughts about engineering are seen as prerequisites for countries' goal of a producing society. Especially the most successful or the smartest students choosing these occupations is seen as the key of becoming one of the strongest and most producing countries. The rates of choosing STEM occupations for the most successful thousand students in the university exam decreased gradually each year and stayed within fixed rated since 2012 (Akgündüz, 2016). This situation brings to mind the question of what can be done to make successful students develop an interest in STEM occupations. STEM education has the characteristics that can arouse this interest.

A student who starts secondary school in Turkey is expected to start university 8 years later and start the occupation 12 years later. We believe that for the students who are expected to choose STEM occupations at university, secondary school should be assessed as critical period to arouse interest and curiosity and these applications should be focused on. This situation will cause students to be more successful and more productive besides helping students with a specific potential to choose an occupation. We believe that with the application of information in daily life, students will be able to change their perceptions about science and engineering. STEM, which has been widely applied in the whole world especially within the last decade, should be made widespread and applied in all schools of our country. In line with this view, Bybee (2010), Corlu, M.S., Capraro, R.M., Capraro, M.M. (2014), Gülhan and Şahin (2016) emphasized the importance of making STEM education more widespread in their studies.

Referances

Akgunduz, D. (2016). A Research About The Placement Of The Top Thousand Students in STEM Fields in Turkey Between 2000 and 2014. Eurasia Journal of Mathematics, Science & Technology Education, 12(5), 1365-1377

Akçay, H., Yager R. E., Iskander M. S., Turgut, H., (2010). Change in student beliefs about attitudes toward science in grades 6-9. Asia-Pacific Forum on Science Learning and Teaching, 1(1),11, p 1.

Aslan O., Yalçın N., & Tasar, M.F., (2009). The Views of the Teachers of the Science And Technology on the Nature of Science. Ahi Evran University Journal of Kırşehir Education Faculty. 3(10), 1-8

Bell, R. L. (2008). Teaching the Nature of Science through Process Skills. Boston: Allyn and Bacon.

Bybee, R.W. (2010). What is STEM education? Science, 329, 996. doi: 10.1126/science.1194998

Corlu, M.S., Capraro, R.M., & Capraro, M.M. (2014). Introducing STEM Education: Implications for Educating Our aTeachers For the Age of Innovation. Education And Science. 171(39)

Coştu, B., Ünal, S., & Ayas, A., (2007). The Use of Daily-Life Events in Science Teaching. Ahi Evran University Journal of Kırşehir Education Faculty. (KEFAD). 8(1), 197-207

Daugherty, J. (2012). Infusing engineering concepts: Teaching engineering design. National Center for Engineering and Technology Education. Retrived From http://files.eric.ed.gov/fulltext/ED537384.pdf . (02.08.2016)

Ercan, S. (2014). Engineering Discipline Information Form. Published Doctoral Thesis. Marmara University.

Gülhan, F., & Şahin F. (2016). The Effects of Science Technology- Engineering Mathematics (STEM) İntegration on 5th Grade Students' Perceptions and Attidutes Towards These Areas. International Journal Of Human Sciences, 13(1) 602-620. doi:10.14687/ijhs.v13i1.3447

Moore T., & Richards L. G. (2012). P-12 Engineering Education Research And Practice. Introduction To A Special Issue of Advances in Engineering Education, 3(2), 1-9.

National Research Council (NRC). (1996). National Science Education Standards. Washington, DC: National Academy Pres.

National Research Council [NRC]. (2012). A Framework for k-12 science education: practices, crosscutting concepts, and core ideas. Washington DC: The National Academic Press. http:77nap.edu/13165. 90. (02.08.2016)

P21. (2015). Partnership For 21st Century Learning 2015. Retrieved From http://www.p21.org/storage/documents/P21_framework_0515.pdf

Primary Education İnstitutions Science Lesson Teaching Program, TTKB, 2013. Ankara. Retrived From http://ttkb.meb.gov.tr/www/guncellenen-ogretim-programlari/icerik/151 (03.08.2016)

Richardson, D., & Houston, C. W. (2006). A Study Of The Impact Of An Informal Science Education Program On Middle School Students' Science Knowledge, Science Attitude, STEM High School And College Course Selections, And Career Decisions. 115-118 Retrived From https://www.lib.utexas.edu/etd/d/2006/ricksm81757/ricksm81757.pdf

Savran Gencer, A. (2005). Scientific and Engineering Practices in Science Education: Twirly Activity, Journal of Research-Based Activities. (ATED). 5(1), 1-19.

The Scientific and Technological Research Council of Turkey [TÜBİTAK]. (2004). National Science and Technology Policy 2003-2023 Strategy Document, Retrieved from www.tubitak.gov.tr/tubitak_content.../Vizyon2023 Strateji Belgesi. (02.08.2016)

Yılmaz, E., Türkoğuz, & S., Şahin, M. (2014). Teachers' Views about Misconceptions of Solar System and Space Subjects and Its Effect on Daily Life. Dokuz Eylul University Buca Faculty of Education. 37