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International Online Journal of Educational Sciences

ISSN: 1309-2707

The Effects of STEM Activities on STEM Attitudes, Scientific Creativity and Motivation Beliefs of the Students and Their Views on STEM Education

Research Article

Mustafa UGRAS[1]

[1]*Firat University, Faculty of Education, Elazig, Turkey*, ORCID: 0000-0001-6921-0178

To cite this article: Ugras, M. (2018). The Effect of STEM Activities on STEM Attitudes, Scientific Creavity and Motivation Beliefs of the Students and Their Views on STEM Education, *International Online Journal of Educational Sciences*, 10(5), 165-182.

ARTICLE INFO

Article History:
Received: 19.092018
Available online:
30.11.2018

ABSTRACT

The present study aimed to determine the effects of STEM activities on the STEM attitudes, scientific creativity and motivational beliefs of seventh grade students and the views of the students on STEM education. In this context, the mixed research method was used. In the quantitative section of the study, pre-test/post-test single-group research model was used and case study method was used in the qualitative section. "STEM Attitude Scale," "Scientific Creativity Scale," and "Motivation and Learning Strategies Scale," and an interview form and student diaries were used as data collection instruments, where the latter two instruments were used to determine students' views on STEM educational approach. Twenty-five seventh grade students attending a school in Elazığ province urban center participated in the study. An 8-week program was conducted with STEM activities for the students participating in the study. Shapiro-Wilk test was applied to calculate the normality of the data obtained in the study and it was determined that the study data exhibited normal distribution. After paired sample t-test, it was determined that there was a significant difference between STEM attitudes, scientific creativity and motivation beliefs of the students. The student views on STEM education demonstrated that they considered STEM education as instructive, entertaining, creative and motivating. Furthermore, the students stated that STEM education improved their creativity and motivation towards the courses and contributed to their career choices.

Keywords:
STEM attitude, scientific creativity, motivation belief, STEM activities, student views.

[1] Corresponding author's address: Firat University, Faculty of Education, Elazig, Turkey,
Telephone:
e-mail: mugras@firat.edu.tr
DOI: https://doi.org/10.15345/iojes.2018.05.012

Introduction

In order to cope with the rapid developments in the information and technology age, individuals need to adapt to innovations. In order for individuals to adapt to innovations, it is of great importance to possess creativity, critical thinking, research, questioning, problem solving and collaboration skills, which are included among the 21st century skills (Morrison, 2006; Wai, Lubinski and Benbow, 2010). STEM (Science, Technology, Engineering, Mathematics) education, which was initiated by various reforms in the United States, was accepted as an educational approach that would contribute to the development of skills that 21st century individuals should acquire and support the economic growth (National Research Council (NRC), 2014; Royal Society Science Policy Center, 2014). 21st century skills would develop in individuals with STEM education and accordingly, individuals could adapt to the developments and innovations in the 21st century.

There are different definitions about STEM education in the literature. Bybee (2010) stated that STEM education was an approach that instructs science and mathematics disciplines by integrating technology and engineering starting from pre-school to 12th grade. Lantz (2009) defined STEM as an interdisciplinary learning approach that associates real life events with science, technology, engineering and mathematics disciplines.

The basic aim of STEM education approach is to prepare the individuals for life and to provide them to live competent life (Moore, Stohlmann, Wang, Tank & Roehrig, 2014). This could be realized by establishing a relationship between disciplines for a holistic learning (Smith & Karr-Kidwell, 2000).

The definitions of STEM and the aims of this educational approach include emphases such as providing solutions to real-world problems, producing products to facilitate these solutions, and to use scientific knowledge of scientific, technological, engineering and mathematical disciplines. Thus, creativity, mentioned among the 21st century skills, is an important skill for STEM education. The views that creativity is a general skill were replaced by views that creativity is a field-specific skill (Baer, 1991; Feldman, 1994; Runco, 1989). Studies demonstrated that creativity is a skill demonstrated in various fields (Plucker, 1998). However, there is not sufficient evidence that children, who are creative in a certain field, demonstrated plural thinking skills in every field (Gardner, 1993). Thus, the kind of creativity required for scientific discovery in society is scientific creativity, which has a slightly narrower scope when compared to general creativity. Scientific creativity means to produce original ideas or products in the field of science (Sak & Ayas, 2013). Scientific creativity requires the discovery of the knowledge inherent in nature and technology, assimilation of this knowledge, enjoying and defending observations and experiments, and free and critical thinking (Orhon, 2011). In STEM education, using the scientific, technological, engineering and mathematical knowledge and producing useful and original products provide ideas about the success of the implemented education.

In order for students to succeed in STEM education, their attitudes towards the disciplines of science, technology, engineering and mathematics are important. Students' attitudes towards science generally decrease as their education progresses (Osborne, 2003; Simpson and Oliver, 1990). Therefore, it is of great importance to develop positive student attitudes towards these disciplines starting from the first stages. Studies reported that students' educational environment could positively influence their motivational beliefs and attitudes towards science (Fortus & Vedder-Weiss, 2014; Vedder-Weiss & Fortus, 2010). Improvement of student attitudes and motivation is only possible through curricula developed for their active participation in the education process (Schnittka, Evans, Won, & Drape, 2015; Cutucache, Luhr, Nelson, Grandgenett, & Tapprich, 2016; Chittum, Brett, Sehmuz & Ásta, 2017). It is suggested that students' attitudes and motivations would increase with STEM education that allows active participation of the students.

There are limited number of studies in the literature on STEM education where the students actively participated. For example, Gülhan and Şahin (2016) investigated the effect of Science-Technology-Engineering-Mathematics integration on the perception and attitudes of 5th grade students towards these

fields. The STEM activities they developed were applied to the students respectively for 12 weeks and it was determined that the STEM perceptions and STEM attitudes of the students developed as a result of the education. Prof. Dr. Şahin, Ayar and Adıgüzel (2014), in a study they conducted to investigate the characteristics of after-school science, technology, engineering and mathematics activities, the student experiences and achievements associated with these experiences and the effects of the activities on the students, they concluded that after-school activities were effective on the development of 21st century skills of the students. In their study conducted by Yamak, Bulut, and Dundar (2014), the impact of STEM activities on scientific process skills and attitudes of fifth grade students towards science. It was concluded that the STEM activities improved students' scientific process skills and attitudes towards science. Chittum et. al, (2017) investigated the effect of after-school STEM program on students' motivations and reported that the student motivation developed after the program.

Mayasari, Kadarohman, Rusdiana & Kaniawati (2016) researched the effect of integrating creative products STEM knowledge on student creativity. The findings demonstrated that addition of STEM knowledge that supports creativity to the activities improved the creativity of the students further, in addition to their skills to solve daily problems related to STEM. Vennix, den Brok, and Taconis (2018) found that the STEM attitudes and motivations of the students, who participated STEM-assisted education programs, increased.

In contemporary society, economic development varies and develops with technological innovations and advances. Langdon, McKittrick, Beede, Khan & Dom, (2011) indicated that STEM professions could improve the economic growth, global competitiveness, innovation and life standards of a country. It was suggested that preference of the said professions would be possible with the increase in STEM literacy and development of the positive attitudes of students towards STEM fields (Sahin, Ayar & Adıgüzel, 2014; Sullivan, 2008). Thus, the number of studies that aim to improve the number of STEM literate individuals should be increased. It was suggested that these studies should be conducted starting from the first educational stages. Because, it was considered that the levels before the eighth grade were very important for the students to acquire positive attitudes and motivation towards these disciplines for the sustainability of the STEM fields (Maltese & Tai, 2010; PCAST, 2012). Related literature review demonstrated that only a few studies were conducted on the effects of STEM activities on certain variables. The present study aimed to determine the effects of an education program that included design-based activities, which aimed to instruct STEM topics and concepts, on STEM attitudes, scientific creativity, which is an important concept in STEM education, the motivation beliefs that creates interest for STEM disciplines and education of seventh grade students that participated in the study, and to determine the student views on STEM education. It was considered that the study findings would contribute to the literature.

The Aim of the Study:

The aim of the present study was to observe the effects of STEM activities on STEM attitudes, scientific creativity and motivation beliefs of seventh grade students and to determine the student views on STEM education.

Research Problem

Is there a significant difference between pre-test and post-test attitude, scientific creativity and motivation scores of the students who participated in STEM activities?

The research problem was analyzed using the sub-problems listed below:

1. Is there a significant difference between the STEM attitude pre-test and post-test scores of seventh grade students who participated in STEM activities?

2. Is there a significant difference between the scientific creativity pre-test and post-test scores of seventh grade students who participated in STEM activities?

3. Is there a significant difference between the motivation belief pre-test and post-test scores of seventh grade students who participated in STEM activities?

4. What were the views of the students on STEM education?

Method

In the study, a mixed research design that combined qualitative and quantitative methods was used (Creswell, 2009). The mixed research design was selected to investigate the determined research problem in depth (Creswell, 2009). The study was conducted in two successive stages. Quantitative data were collected and analyzed in the first stage and qualitative data were collected and analyzed in the second. In the first stage, the pre-test-post-test single-group experimental design was used to collect quantitative data. The experimental design is used in studies that aim to test the causality between the study variables (Cohen and Manion, 1997; Gay and Airasian, 2000). The experimental design is used to assess changes or developments, determine pre-existing differences and the success or failure of an implemented program based on the differences and developments between the results (Shea, Arnold & Mann, 2004). As Creswell (2012) reported, in studies where a new educational approach is developed and applied, it is natural to prefer the single-group pre-test-posttest experimental design. Furthermore, this type of experimental design is adequate for use in educational programs that involves large segments of society (Gliner, Morgan and Leech, 2015). Thus, in the present study, pretest-posttest single group experimental design was used. In the second phase of the study, the case study method, one of the qualitative research methods, was used. In a case study, one or more cases are investigated in depth, the factors that affect the case are researched with a holistic approach, and how the factors that affect the case affects it and how the case is affected by these factors are emphasized (Yıldırım & Şimşek, 2013).

The Study Group

Twenty-five (15 females, 10 males) seventh grade students attending a public school in Elazığ province volunteered to participate in the present study. The participants were assigned codes such as "S1, S2, S3 … S25" for ethical purposes. In order to determine the participating students, convenience sampling method was utilized for practical and economic reasons (Monette, Sullivan and Dejong, 1990).

Application Process

In the present study, an educational program was developed to determine the effect of STEM education on STEM attitudes, scientific creativity, and motivational beliefs of seventh grade students and student views on STEM education approach. In this program, design-based STEM activities presented in Table 1 were applied to students for 8 weeks, 3 hours a week. The program was developed based on STEM concepts and achievements mentioned in the seventh grade curriculum published by the Ministry of National Education in Turkey.

Table 1. STEM Education Program

Week	Topic
Week 1	Connect the people with bridges
Week 2	Use renewable energy for a clean earth and future generations
Week 3	Build strong homes where people would not die as a result of earthquakes
Week 4	Enjoyable hours in fast trains
Week 5	Let us produce certain objects to facilitate our Daily lives
Week 6	Who will spin the peg-top the fastest?
Week 7	Let us build a fast boat to arrive to the opposite shore rapidly

Data Collection Instrument

In the present study, "STEM Attitude Scale," "Scientific Creativity Scale," and "Motivation and Learning Strategies Scale" were used to determine the effects of STEM activities on STEM attitudes, scientific creativity, and motivational beliefs of students. Furthermore, in order to determine the views of the students on STEM education approach, an interview form was developed by the researcher and finalized based on the views of a field expert, and data were collected using this form. In addition, the students were asked to write a diary about the daily activities they conducted at the end of the days when STEM activities were conducted. The students were not limited about their diary entries. They were informed that they may include information about the activities, their own and peers' performances, personal feelings and thoughts.

The interview technique was used to determine the student views on STEM education after the training program was completed. An interview was defined as the conversation process by the researcher and the participant, focusing on the questions based on the study area (Act: Merriam, 2013; DeMarrais, 2004). The main objective of the interview is to learn the views of the participants on a topic (Patton, 2002). In the present study, semi-structured interview method was used. Semi-structured interviews allow the participants to reflect the world based on their perceptions and using their own words (Merriam, 2013).

For the internal validity of the qualitative dimension of the study, data was diversified with the use of interviews and student diaries. In the interview form developed by the researcher, an expert was consulted. Then, three students were asked to read and evaluate the interview form for comprehensibility. Based on the expert opinion and the student assessments, the interview form was reorganized to comply with the views on the suitability and comprehensibility of the questions. During the study, the recorded student responses were reconfirmed. The interviews lasted approximately 15-20 minutes. The student responses are quoted in the findings section. For the external validity of the study, research method, study group, data collection instruments, data collection and analysis, and the findings were clearly described. Furthermore, the data were analyzed by another field expert to ensure researcher diversity. Interviews were recorded to ensure the internal reliability of the study and to prevent data loss. Furthermore, the findings were presented directly without interpretation by the researchers. Finally, the study findings were discussed in comparison with previous study findings in the conclusion section to ensure the external reliability of the study.

STEM Attitude Scale

The STEM Attitude Scale was developed by Faber, Unfried, Wiebe, Corn, Townsend & Collins (2013) and adapted into Turkish language by Yıldırım and Selvi (2015). The 5-point Likert-type scale includes 37 items. The Cronbach alpha coefficient for the whole scale was calculated as 0.94. Furthermore, the factor analysis findings are as follows: CFI = 0.90, NFI = 0.95, GFI = 0.86, AGFI, 0.84, IFI = 0.96, SRMR = 0.53 and RMSEA = 0.063.

Scientific Creativity (SC) Scale

The "Scientific Creativity Scale" was developed by Hu and Adey, (2002) and adapted into Turkish language by Deniş-Çeliker and Balım (2012) and the items that were not adequate for Turkish culture were changed to finalize a scale that included 6 items. The Cronbach alpha internal consistency coefficient of the scale was 0.86 and the test-retest correlation was calculated as 0.91.

Motivation and Learning Strategies Scale

"Motivation and Learning Strategies Scale" (MLSS) was developed by Pintrich, Smith, Garcia, and Mckeachie (1991) for university students under the title of "The Motivated Strategies for Learning

Questionnaire" (MSLQ). Karadeniz, Büyüköztürk, Akgün, Çakmak and Demirel (2008) adapted the MSLQ to Turkish language and for 12-18-year-old students. The 7-point Likert-type scale includes two sections: motivation and learning strategies. There are 25 items in the motivation section and 46 items in the learning strategies section of the scale. In the study by Karadeniz et al. (2008), it was determined that the Cronbach alpha coefficient for the motivation sub-dimension of the scale ranged between .67 and .86, and the Cronbach alpha coefficient for the learning strategies sub-dimension ranged between .63 and .88. Pintrich et al. (1991) reported that the motivation and learning strategies sections could be used as a stand-alone scale based on the study objectives. In the present study, only the motivation sub-dimension of the adapted MSLQ scale was utilized.

Data Analysis

Data were collected before and after the application. In order to calculate the normal distribution of the data, Shapiro-Wilk test, recommended for use with a sample size below 30, was used (Ak, 2008). The findings are presented in Table 2. The fact that p value was over 0.05 was considered as the evidence of normal distribution of the data as observed in Table 2. Due to the normal distribution of the data, the parametric paired sample t-test was used. In cases of significant correlations between the variables, the effect sizes were examined and how the variables were affected was interpreted.

Table 2. Normality Test Findings

	Shapiro-Wilk		
	Statistic	**df**	***p***
STEM Attitude	.923	25	.060
SC	.951	25	.270
Motivation Belief	.927	25	.072

The data collected with the interviews conducted with the participating students and the student diaries were described with the content analysis method. Content analysis is used to identify and quantify the presence of certain words, concepts, themes, idioms, characters or sentences within one or more manuscripts (Kızıltepe, 2017). In content analysis, reliability is calculated by observing the agreement between the descriptions made by the researchers. In the present study, the interview transcripts were analyzed separately by the researcher and a faculty member in the educational field who was also experienced in qualitative research. In order to determine the reliability of the content analysis, the agreement rate formula [agreement / (agreement + disagreement) x 100] was used (Miles and Huberman, 1994). The inter-coder agreement was calculated as .92. At least 70% agreement between the coders is required to establish reliability (Miles and Huberman, 1994). Due to the fact that the coefficient of agreement between the coders was over 70%, the coding conducted in the study was considered reliable. After this stage, the data were organized and categorized. Categorized data are presented in frequencies and percentages.

Findings

The paired sample t test findings, applied to determine the attitudes of seventh grade students towards STEM, are presented in Table 3.

Table 3. STEM Attitudes of Seventh Grade Students Based on Paired Sample t-Test Findings

	N	***X***	**Ss.**	***t***	***p***
Pretest	25	3,1	,50694	-11,745	,00
Posttest	25	3,64	,42783		

*p<0,05

Table 3 demonstrates that there was a statistically significant difference between the pre-test and post-test scores (p <.05). Thus, it was determined that STEM activities improved STEM attitudes of seventh grade students. In paired sample t-test, the effect size is calculated by the ratio of t value to the square root of the sample size (Green & Salkind, 2005). The test result effect size was calculated as (d) 2.35 (Green & Salkin, 2005). The fact that the effect size was over 1 indicated that the difference between the groups was quite high (Green & Salkin, 2005).

The paired sample t test analysis findings on pre-test and post-test scores of the seventh-grade students applied to determine their scientific creativity levels are presented in Table 4.

Table 4. The Findings of the Paired Sample t-Test Conducted on Scientific Creativity Scores of Seventh Grade Students

	N	***X***	**Ss.**	***t***	***p***
Pretest	25	37.5200	11.28	-17.753	.00
Posttest	25	46.2000	11.62		

*p<0,05

Analysis of the Table 4 demonstrated that there was a significant difference between pre-test and post-test scores (p <.05). Thus, it was concluded that STEM activities improved the scientific creativity of seventh grade students. In paired sample t-test, the effect size is calculated by the ratio of t value to the square root of the sample size (Green & Salkind, 2005). The effect size (d) was calculated as 3.55. The fact that the effect size was over 1 indicated that the difference between the groups was quite high (Green & Salkin, 2005).

The paired sample t test analysis findings on pre-test and post-test scores of the seventh-grade students applied to determine their motivation beliefs are presented in Table 5.

Table 5. The Findings of the Paired Sample t-Test Conducted on Motivation Belief Scores of Seventh Grade Students

	N	***X***	**Ss.**	***t***	***p***
Pretest	25	4.32	.69842	-7.879	.00
Posttest	25	4.83	.42536		

*p<0,05

Table 7 demonstrated that there was a significant difference between the pre-test and post-test scores (p <.05). Thus, it was concluded that STEM activities improved the motivation beliefs of seventh grade students. In paired sample t-test, the effect size is calculated by the ratio of t value to the square root of the sample size (Green & Salkind, 2005). The effect size (d) was calculated as 1.58. The fact that this value was over 1 indicated that the difference between the groups was quite high (Green & Salkin, 2005).

The results of the content analysis conducted on the interview data to determine the views of seventh grade students on STEM education are presented in the tables below.

The results of the content analysis conducted on the student responses to the question "What do you think about STEM education?" are presented in Table 6.

Table 6. The student responses to the question "What do you think about STEM education?"

Codes	***f***	**%**
Instructive	10	40
Entertaining	9	36
Develops creativity	5	20
Motivating	1	4

Analysis of Table 7 demonstrated that most students considered STEM education as instructive (40%) and entertaining (36%). The remaining students stated that STEM education was creative (20%) and motivating (4%).

The participating student responses to the question "What do you think about STEM education?" are presented below:

"For the first time I have learned these topics so easily and in an entertaining manner. It used to be often boring and difficult, since the topics were previously instructed directly (S7)."
"I was motivated by the fact that I was directly involved in the implementation process and did new things. The course was so attractive that I was never detached from the instruction (S12)."
"When the teacher conducted sample activities, provides information about the topics related to the activity and produced products using this information. Therefore, I understood how I could use the information I learned in the class (S15)."
"I never liked these topics, I find them hard and boring, but I realized after the process that these boring subjects could be instructed in an entertaining way as well (S2)."
"That was the first time I experienced such an education. Normally, I have dexterity, so I was more attracted, the products we produced in collaboration with friends were very creative (S24)."

Table 7. The student responses to the question "Do you think these activities contributed to your personal achievements?"

Codes	***f***	**%**
Creativity	9	3
Using information	6	2
Motivation	4	1
Career choice	3	1
Efficient use of time	2	8
Patience	1	4

Sample participating student responses to the question " Do you think these activities contributed to your personal achievements?" are presented below:

"…I was organized to conduct the activities at a specific time…(S2)"
"…I realized that I could do various objects with the material around me… (S23)"
"…Previously, I wanted to be a lawyer, but now, I want to be an engineer…(S24)"
"…I did not realize how to use my knowledge so far unfortunately, I would try to acquire the knowledge to be successful in the exams, but now, I will work on how to and where to use it… (S8)"
"…I was not very successful during the activities, but by trying it over again I finally managed to do it… (S6)"

Analysis of student diaries demonstrated that the participating students had difficulties initially, however they were very enthusiastic in participating in the process during following weeks. It was determined that most students considered science topics boring, however they had fun and improved their learning significantly during the activities. It was determined that they never associated the learned knowledge with daily life before, and they developed an awareness that they could use this information by thinking about the information in different ways. Furthermore, most stated that they wanted to work in STEM professions and one should be patient during the process and never give up for success.

Recommendations

Certain recommendations are presented below based on the present study findings:

1. STEM education should be initiated in early ages.

2. Teachers and pre-service teachers should be trained to acquire an accurate interdisciplinary perspective on STEM education and applications.

3. The teachers should emphasize STEM activities, considered to be effective on STEM attitudes, scientific creativity and motivation beliefs of the students, both in-school and after-school activities.

Conclusion and Discussion

The aim of the present study was to determine the effects of STEM activities developed for the seventh grade level on STEM attitudes, scientific creativity, motivation beliefs of the seventh grade students and identify their views on STEM educational approach.

It was determined that there was a significant difference between the pre-test and post-test scores of the students conducted to determine the change in their attitudes towards STEM ($p <, 05$). Based on these findings, it was concluded that STEM activities improved the STEM attitudes of the students. The findings were consistent with other results reported in the literature (e.g., Gülhan & Şahin, 2016; Naizer, Hawthorne and Henley, 2014). In a study, Güzey, Harwell and Moore (2014) found a significant difference in favor of the students attending STEM-based schools when they compared STEM-based schools and non-STEM-based schools in STEM fields. Rehmat (2015) also reported that problem-based STEM activities increased STEM attitudes of fourth grade students. According to the above-mentioned studies, it could be suggested that STEM activities increase the STEM attitudes of the students.

The study findings demonstrated that the STEM activities improved scientific creativity of the students. Similar findings were reported in the literature (Erdogan et al., 2013; Knezek et al., 2013; Sahin et al., 2014; Siew, Amir and Chong, 2015). Morrison (2006) reported that students who attended STEM education are creative individuals who design creative projects and produce solutions based on contemporary needs. Lawanto et al. (2013) emphasized that students developed critical and creative thinking skills with design experience in engineering discipline. Cho and Lee (2013) reported that the creativity of sixth grade students improved with the use of syllabi developed based on STEM approach.

After the implementation of the activities, a significant difference was observed between the motivation beliefs of the students. In a study conducted by Chittum et al. (2017) with ninth grade students using a design-based after-school STEM program, it was determined that the motivation beliefs of the students who participated in the program improved and their motivation resistance was higher when compared to other students. The educational environment of the students could provide motivation and sustain the motivation for a long time (Fortus & Vedder-Weiss, 2014; Vedder-Weiss & Fortus, 2010). In STEM education, it was suggested that there was a direct correlation between the students' motivation beliefs and the active participation of the students in the process.

It was determined that the students considered the STEM education instructive, entertaining, creative and motivating. Previous studies in the literature reported consistent results (e.g., Gökbayrak and Karışan, 2017; Karahan, Cambazoğlu-Bilici and Ünal, 2015). In their studies, Marulcu and Sungur (2012) and Sungur-Rose and Marulcu (2014) reported that design-based engineering courses developed students' psychomotor, creativity and social thinking skills, and created a learning environment where the students could socialize. A study by Lewis (2009) reported that design-based activities improved students' creativity.

The participants stated that their creativity improved, they were more motivated in the classroom, wanted to work in STEM-related fields in the future and the program developed an awareness about better management of time and patience as a result of the STEM activities. Furthermore, similar results were obtained in the analysis of the diaries kept after the activities. In the Ohio STEM Learning Network (2012), it was emphasized that STEM education improved students' creative thinking skills that they require in the global economy. Lawanto et al. (2013) emphasized that students developed their critical and creative thinking skills

with the design experiences in engineering discipline. Previous studies in the literature reported similar results (e.g., Şahin et al., 2014; Yamak et al., 2014; Karahan, Bilici and Unal, 2015; Gülhan and Şahin, 2016). In a study, Park and Yoo (2013) investigated the effect of STEAM education on learning motivations, interests and scientific process skills of the students, and concluded that the student motivation increased as a result. In a study conducted by Baran, Bilici and Mesutoglu (2015), it was determined that activities made the students think about STEM fields in their future career choices, improved their collaboration and communication skills, and the flexibility and entertaining properties of the activities motivated the students. In addition, analysis of the STEM spots designed in the same study demonstrated that the attitudes of the students towards science, engineering, technology and mathematics and their scientific knowledge improved. In a study by Seong-Hwan, (2013), it was reported that STEAM activities increased the interest of students in STEM fields.

GENİŞLETİLMİŞ ÖZET

STEM Etkinliklerinin Öğrencilerin STEM' e İlişkin Tutumları, Bilimsel Yaratıcılıkları, Motivasyon İnançları Üzerindeki Etkileri ve STEM Eğitimine İlişkin Görüşleri

Giriş

Günümüz toplumlarında ekonomik kalkınma, teknolojik yenilik ve gelişmeler ile doğru orantılı olarak değişmekte ve gelişmektedir. Langdon, McKittrick, Beede, Khan & Dom, (2011) tarafından STEM alanındaki mesleklerin, bir ülkenin ekonomik büyüme, küresel rekabet, inovasyon ve yaşam standartlarının artmasını sağlayabilecek meslekler olabileceği belirtilmektedir. Bu meslekleri bireylerin tercih etmesi STEM okuryazarlığının artması ve öğrencilerin STEM alanlarındaki olumlu tutumlarının gelişmesi ile mümkün olacağı düşünülmektedir (Sahin, Ayar & Adıgüzel, 2014; Sullivan, 2008). Bu kapsamda STEM okuryazarlığına sahip birey sayısını arttırmaya yönelik çalışmaların sayıca artması gerekmektedir. Bu çalışmaların eğitim öğretimin ilk kademelerinden başlanarak yapılmasında fayda olduğu düşünülmektedir. Çünkü STEM alanlarındaki sürekliliği sağlamada sekizinci sınıftan önceki kademelerin bu disiplinlere yönelik tutum ve motivasyon sağlamak açısından büyük önem taşıdığına yönelik görüşler bulunmaktadır (Maltese & Tai, 2010; PCAST, 2012). Bu bilgiler ışığında alan yazın incelendiğinde, STEM etkinliklerinin belirli değişkenler üzerindeki etkilerini inceleyen çalışmaların sınırlı olduğu belirlenmiştir. Bu çalışmada STEM konularını ve kavramlarını öğretmeye yönelik tasarım temelli etkinliklerin olduğu bir eğitim programının araştırmaya katılan yedinci sınıf öğrencilerinin, STEM' e karşı tutumlarına, STEM eğitimi için önemli bir kavram olan bilimsel yaratıcılığa, disiplinlere yönelik ilgi oluşmasını sağlayan motivasyon inançlarına etkilerinin ve STEM eğitimine ilişkin öğrenci görüşlerinin belirlenmesi amaçlanmıştır. Elde edilen sonuçların literatüre katkı sağlayacağı düşünülmektedir.

Çalışmanın Amacı:

Bu çalışmanın amacı, STEM etkinliklerinin; yedinci sınıf öğrencilerinin STEM tutumlarına, bilimsel yaratıcılıklarına ve motivasyon inançlarına olan etkilerini görmek ve STEM eğitimine ilişkin görüşlerini belirlemektir.

Yöntem

Araştırmada, nitel ve nicel yöntemlerin birlikte kullanıldığı karma araştırma deseni kullanılmıştır (Creswell, 2009). Karma araştırma deseni belirlenen araştırma probleminin ayrıntılı incelenmesi (Creswell, 2009) amacıyla tercih edilmiştir. Araştırma birbirini izleyen iki aşamada yürütülmüştür. Araştırmanın birinci aşamasında nicel veriler ikinci aşamasında ise nitel veriler toplanıp çözümlenmiştir. Araştırmanın birinci aşamasında nicel veriler elde edilirken, deneysel desenlerden ön test-son test tek gruplu deneysel deseni uygulanmıştır. Araştırmanın ikinci aşamasında nitel araştırma yöntemlerinden biri olan durum çalışmasından yararlanılmıştır. Durum çalışmasında, bir veya birden çok durum derinlemesine incelenir, duruma etki eden faktörler bütüncül bir yaklaşım ile araştırılır, etki eden faktörlerin ilgili durumu nasıl etkilediği ve bunlardan nasıl etkilendiği üzerinde durulur (Yıldırım ve Şimşek, 2013).

Sonuç ve Tartışma

Bu araştırma, yedinci sınıf öğrencilerinin seviyelerine göre hazırlanmış STEM etkinliklerinin yedinci sınıf öğrencilerinin STEM tutumlarına, bilimsel yaratıcılıklarına, motivasyon inançlarına etkilerinin ve STEM eğitimine ilişkin görüşlerinin belirlenmesi amacıyla yapılmıştır.

Öğrencilerin, STEM' e karşı tutumlarında değişimin belirlenmesine yönelik uygulanan ön test-son test sonuçları arasında anlamlı bir farklılık olduğu belirlenmiştir ($p<.05$). Bu sonuca göre, STEM etkinliklerinin araştırmaya katılan öğrencilerin STEM' e karşı tutumlarını olumlu yönde geliştirdiği sonucuna ulaşılmıştır.

Literatürde bu sonuçlara paralel çalışma sonuçları bulunmaktadır (Ör: Gülhan & Şahin, 2016; Naizer, Hawthorne ve Henley, 2014). Güzey, Harwell ve Moore (2014) yaptıkları çalışmada STEM odaklı okullar ile STEM odaklı olmayan okulların STEM alanlarına karşı tutumlarını karşılaştırdıklarında STEM odaklı okullarda öğrenim gören öğrenciler lehine anlamlı bir fark tespit etmişlerdir. Rehmat (2015) da yaptığı çalışmada probleme dayalı STEM etkinliklerinin dördüncü sınıf öğrencilerinin STEM' e karşı tutumlarını artırdığını belirtmiştir. Tüm bu çalışma sonuçlarına göre STEM etkinliklerinin öğrencilerin STEM tutumlarını arttırdığı söylenebilir.

Araştırmada STEM etkinliklerinin öğrencilerin bilimsel yaratıcılıklarını olumlu yönde geliştirdiği sonucuna ulaşılmıştır. Literatürde bu sonuçlara paralel çalışma sonuçları bulunmaktadır (Erdoğan vd., 2013; Knezek vd., 2013; Şahin vd., 2014; Siew, Amir ve Chong, 2015). Morrison (2006) STEM eğitimi ile yetişmiş bir öğrencinin dünyanın ihtiyaçlarına göre yaratıcı projeler tasarlayan ve çözümler üreten yaratıcı bireyler olduğunu belirtmektedir. Lawanto vd. (2013) mühendislik disiplinindeki tasarım deneyimi ile öğrencilerin eleştirel ve yaratıcı düşünme becerilerini geliştirdikleri vurgulamaktadır. Cho ve Lee (2013) yaptıkları çalışmada altıncı sınıf öğrencilerinin STEM eğitimi temelinde geliştirilen ders planları ile yaratıcılıklarının geliştiğini vurgulamışlardır.

Araştırmaya katılan öğrencilerin etkinliklerin uygulanmasından sonra motivasyon inançlarında anlamlı bir farklılık olduğu belirlenmiştir. Chittum v.d., (2017) tarafından dokuzuncu sınıf öğrencileri ile tasarım temelli okul dışı STEM programı uygulayarak yapılan çalışmada, programa katılan öğrencilerin motivasyon inançlarının geliştiği ve diğer öğrencilere göre motivasyon dirençlerinin yüksek olduğu belirlenmiştir. Öğrencilerin içinde bulundukları eğitim öğretim ortamları onlara motivasyon sağlamakta ve bu motivasyonlarının uzun süreli devam etmesine sebep olmaktadır (Fortus & Vedder-Weiss, 2014; Vedder-Weiss & Fortus, 2010). STEM eğitiminde öğrencilerin motivasyon inançlarının artması ile öğrencilerin sürece aktif bir şekilde katılarak fikirler ve bu fikirler doğrultusunda ürünler oluşturması arasında doğru orantılı bir ilişki olduğu düşünülmektedir.

Öğrencilerin STEM eğitimi ile ilgili olarak; öğretici, eğlendirici, yaratıcılığı geliştiren ve motive edici olduğuna yönelik görüşleri belirlenmiştir. Literatürde bu sonuçlara paralel çalışma sonuçları bulunmaktadır (Ör:Gökbayrak ve Karışan, 2017; Karahan, Cambazoğlu-Bilici ve Ünal, 2015). Marulcu ve Sungur (2012) ve Sungur-Gül ve Marulcu (2014) yaptıkları çalışmada; mühendislik tasarım temelli derslerin öğrencilerin psikomotor, yaratıcılık ve sosyal düşünme becerilerini geliştirdiği ayrıca onların sosyalleşmelerini sağladığı bir öğrenme ortamı yarattığı, buna bağlı olarak da ders içeriklerini daha iyi anladıkları sonucuna ulaşılmıştır. Lewis (2009) tarafından yapılan çalışma sonucunda tasarım temelli etkinliklerin öğrencilerin yaratıcılıklarını geliştirdiği tespit edilmiştir.

Katılımcılar STEM etkinlikleri sonucunda yaratıcılıklarının geliştiği, derslerine daha motive oldukları, artık ileride STEM ile ilgili alanlarda çalışmak istedikleri, bilgilerin ve zamanın iyi kullanılması ile sabırlı olunmasına yönelik bir farkındalık oluşturduğuna yönelik görüşleri belirlenmiştir. Ayrıca etkinlikten sonra tutulan günlüklerin analizinde de bunlara benzer sonuçlara ulaşılmıştır. Ohio STEM Learning Network'da (2012), STEM eğitiminin öğrencilerin küresel ekonomide ihtiyaç duydukları yaratıcı düşünme becerilerini geliştirdiğini vurgulanmıştır. Lawanto vd. (2013) ise, mühendislik disiplinindeki tasarım deneyimi ile öğrencilerin eleştirel ve yaratıcı düşünme becerilerinin geliştirdiğini vurgulamaktadır. Literatürde bu sonuçlara paralel çalışmalar bulunmaktadır (Ör: Şahin vd., 2014; Yamak vd., 2014; Karahan, Bilici ve Ünal, 2015; Gülhan ve Şahin, 2016). Park ve Yoo (2013) yaptıkları çalışmada STEAM eğitiminin öğrencilerin öğrenme motivasyonlarına, ilgilerine ve bilimsel süreç becerilerine etkisi incelemiş, sonuç olarak öğrencilerin motivasyonlarının arttığı sonucuna ulaşmıştır. Baran, Bilici ve Mesutoğlu (2015) tarafından yapılan çalışmada, yapılan etkinliklerin öğrencilerin gelecekteki kariyer tercihlerinde STEM alanlarını düşünmelerini sağladığı, işbirliği ve iletişim becerilerini geliştirdiği, etkinliklerdeki esneklik ve eğlencenin öğrencileri motive ettiği

belirlenmiştir. Ayrıca aynı çalışmada tasarlanan STEM spotları incelendiğinde öğrencilerin fen, mühendislik, teknoloji ve matematik alanlarına yönelik tutum ve bilgilerinin olumlu yönde değiştiği tespit edilmiştir. Seong-Hwan, (2013) yaptığı çalışmada STEAM etkinliklerinin öğrencilerin STEM alanlarına ilgilerini arttırdığı belirtmiştir.

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