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THE EFFECT OF INTEGRATED STEM EDUCATION ON TEACHERS AND THE OPINIONS OF TEACHERS[1]

BÜTÜNLEŞİK STEM EĞİTİMİNİN ÖĞRETMENLER ÜZERİNDEKİ ETKİSİ VE ÖĞRETMENLERİN GÖRÜŞLERİ

Doç.Dr. Sema ALTUN YALÇIN
Erzincan Üniversitesi, Eğitim Fakültesi, Erzincan/Türkiye

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ABSTRACT

The article aims to enable teachers to learn the STEM program and have knowledge and experience that can be integrated into the curriculum. Totally 43 participants who were the teachers of science and mathematics were included in the study. The teachers were supported with theoretical knowledge and the necessary skills related to the practice were provided for them one by one for 6 months. In accordance with the training provided, it was tried to check how much the teachers could actualise the knowledge and applications. With this purpose, the teachers were directed to prepare course schedules and experts checked these. In addition, many situations such as: how much they could apply the integrated STEM education, which problems they encountered during the implementation phase and how they tried to solve these problems encountered, were recorded by entering the courses of the teachers; that is, through micro teaching.

At the end of the project, it was provided to develop the knowledge and skills of teachers related to the STEM. In addition, it was found out that they could apply the STEM program and use the interdisciplinary interaction in their professional lives. It was noticed that they developed a positive attitude towards using STEM in their lessons.

Keywords: STEM, Science Teacher, Mathematic Teacher, İnterdisciplinary, Micro Teaching

ÖZET

Çalışma da öğretmenlerin STEM programını öğrenmeleri ve müfredatla bütünleştirebilecek bilgi ve deneyime sahip olabilmeleri amaçlanmıştır. Çalışmaya; Fen Bilgisi Öğretmeni ve İlköğretim Matematik Öğretmeni olan toplam 43 kişi katılmıştır. Öğretmenlere teorik bilgi verilerek ve uygulamaya dönük beceri kazanmaları için gerekli uygulamalar 6 ay boyunca birebir sağlanmaya çalışılmıştır. Verilen eğitim doğrultusunda, öğretmenlerin bilgi ve uygulamaları ne kadar gerçekleştirebildikleri de kontrol altında tutulmaya çalışılmıştır. Bu amaçla; öğretmenlerin ders programı hazırlamaları sağlanarak ve bunlar uzmanlar tarafından kontrol edilmiştir. Ayrıca, öğretmenlerin derslerine gidilerek bütünleşik STEM eğitimini ne kadar uygulayabildikleri, uygulama aşamasında hangi problemlerle karşılaştıkları, karşılaşılan problemleri nasıl çözmeye çalıştıkları gibi pek çok durum öğretmenlerin dersleri kayıt altına alınarak yani birebir mikro öğretim yoluyla gerçekleştirilmiştir.

Projenin sonunda, öğretmenlerin STEM hakkındaki, bilgi ve becerilerinin gelişmesi sağlanmıştır. Ayrıca meslek yaşantılarında STEM programını uygulayabildikleri böylece disiplinler arası etkileşimi kullanabildikleri ortaya çıkmıştır. STEM uygulamalarını derslerinde kullanmaya karşı olumlu tutum geliştirdikleri saptanmıştır. Bununla birlikte,

[1] "Bu makale Erzincan Binali Yıldırım Üniversitesi Bilimsel Araştırma Projeleri Koordinatörlüğü tarafından desteklenen Bütünleşik STEM Projesi isimli projeden elde edilmiştir."

öğretmenlerin FeTeMM öğretimi yönelimlerinde ve yapılandırmacı öğrenme ortamı oluşturma becerileri üzerinde istatistiksel olarak anlamlı bir fark bulunmuştur.

Anahtar Kelimeler: STEM, Fen Bilgisi Öğretmeni, Matematik Öğretmeni, Disiplinlerarası, Mikro Öğretim

1. INTRODUCTION

STEM (FeTeMM) is an educational approach that emerged as a result of competition among the leading countries of the world in the early 19th century although it as first put forward by Judith Rahmaley in 2001 (Sanders, 2009). STEM Education is formed of the initials of the words; Science, Technology, Engineering and Mathematics; but it cannot be defined commonly by people who work in this field (Thomas, 2014; Akgündüz et al. 2015). While the word "Science" is taken "Science" FeTeMM is used in Turkish equivalent. Adıgüzel et al. (2012) characterized it as "Science" and they have adapted it to Turkish as BTMM. This opinion is also supported by Yıldırım and Altun (2014) and big mistakes and deficiencies may emerge due to being taken as the word "Science" instead of "Fen/Science" and have also been emphasized that using it as "Science" would be much more accurate and appropriate. In spite of differences of opinions on the word "Science", there is a consensus about being at the center of STEM Education of four disciplines including the disciplines of Technology, Engineering and Mathematics and a need to being established a link associated with each other.

STEM Education is a paradigm raised for training human resources in accordance with changing Science, Technology and Engineering understanding (Kılıç & Ertekin, 2017). STEM Education is important in order to take part in the economic market, compete with developed countries and become a strong country (Dugger, 2010). STEM Education has a great importance because of contributing to the development of high-level thinking skills of students (Becker & Park 2011; Ercan & Bozkurt, 2013; Marulcu, 2010; Wagner, 2008), having an effect in terms of being literate of Science, Mathematics and Technology ; contributing on the effect of choice of profession in an intended way meaning toward STEM fields (Çevik, 2018; Ünlü & Dökme, 2016) and increasing their interest and curiosity on these fields (Buxton, 2001; Becker & Park, 2011) and enhancing the success in PISA / TIMSS examinations (Dugger, 2010). It is aimed to be trained the students who will be scientists and engineers of the future as literate of Science and Technology with STEM Education (Morrison, 2006). STEM emerged as an educational policy because the students in the United States and, in particular, the students from indigenous people of America preferred Social areas, not Science, Mathematics and Engineering. Vast amount of funds was transferred to education field for r the purpose of annihilating the harm this situation may bring to the country and changing the interests and preferences of the students (Ostler, 2012). In our country, having difficulties in terms of students' tendencies and current situations is put forward by national and international exams. The data obtained from the examinations conducted by PISA, TIMSS and OSYM show that the students have generally low successes in Mathematics and Science and they do not focus on these areas about the choice of profession. It is clear that there are also problems in terms of transferring information to daily life, high level thinking skills and scientific competences, falling behind many countries in these areas and even being below average (Çepni, 2018). STEM Education has a great importance on Turkey's future and achieving the targets of Turkey. However, in order to realize it, it is needed to be put on a good philosophical basis and be organized well (Yıldırım, 2018). In other words, STEM Education should be given by experts who know well the knowledge of STEM pedagogical field (STEM PAB) (Marino et al. 2010; Yildirim, 2017), should be based on strong foundations meaning a theory determined properly (Garet, Porter, Desimone, Birman, & Yoon, 2001), should be planned, designed and implemented in a good way (Kabaran & Uşun, 2017).

In 2017, the Ministry of National Education added STEM Education to the curriculum, and as a result, MoNE obliged to be reviewed the current situation, identify any deficiencies, take necessary measures to eliminate them and make plans. In our country, the Ministry of National Education, Directorate General for Innovation, prepared a report and Education Technologies (Yeğitek), Istanbul Aydın

University, Tüsiad for the determination of the current situation and the solution of the existing problems and some research were carried out for this purpose. In addition, in the study implemented by Çolakoğlu and Günay Gökben (2017); it was tried to reveal the existing situation of faculty members towards STEM Education in Education Faculties that are one of the leading institutions that constitute the basis for STEM Education. As a result of the study, although the awareness and interest levels of the faculty members about STEM Education were high, it was determined that there was not enough implementation and preparation at the institutional level in the field of this education.

Additionally, Akgündüz et al. (2018) found that academicians do not have sufficient knowledge about STEM curriculum and have problems in identifying current problems. Çolakoğlu and Günay-Gökben (2017) examined the capacity and tendencies of the faculties of education that will train the future teachers on giving STEM Education and stated that any graduate education program related to STEM was not opened in the faculty of education, there are a few courses opened related to STEM at the level of undergraduate program in only 16 (26%) faculties of education. In addition, other studies emphasized that teachers who work in the schools affiliated to the Ministry of National Education only have their own knowledge of the field and do not have sufficient knowledge and equipment on the integration of the disciplines needed by STEM Education (Akgündüz et al. 2015; Tezel & Yaman 2017; Uğraş, 2017), and the numbers of training that can fill this gap are not at the sufficient level (Eroğlu & Bektaş, 2016), the cooperation between university and National Education cooperation is insufficient (Akgündüz, 2018) and there are capacity and competence problems for STEM Education on the integration into the curriculum. At the same time, the inappropriateness of the National Education Curriculum and the curriculum to the STEM Education, the physical structures of the classes and the number of students in the classroom, the limited time, the noise during the activity meaning class management, lack of interest of the students and no development of the measurement and evaluation tools suitable for STEM Education can be stated among other deficiencies (Eroğlu & Bektaş 2016; Özdemir 2016; Yeğitek 2016; Yıldırım & Selvi 2016). Another problem stated by Baran, Canbazoğlu-Bilici, and Mesutoğlu, (2015) is that the majority of STEM trainings carried out are activity-based. It was determined by Elmalı and the Balkan Kıyıcı (2017) that as a result of analysis of STEM-based studies carried out in Turkey, the topic tendencies of the article, thesis and other scientific studies are the examination of the effects of these studies from various dimensions by developing activities based on FeTeMM approach. In the report, Akgündüz et al. (2018) supported the same result that is the training and studies are generally not integrated and focused on the realization of after-school or out-of-school activities. Studies on how STEM Education and especially how to integrate it into the curriculum or how to be integrated are really rare, and there is a need on how STEM Education will be integrated into the curriculum and especially the need for the results of STEM Education applications adapted to the curriculum.

Although our country encountered STEM Education for the first time in 2012 through STEM Education with Panel in National Science and Mathematics Education Congress (UFBMEK) held for the 10th time in Niğde (Adıgüzel et al. 2012), Integrated STEM Education understanding emerged for the first time within Research and Development Center (BAUSTEM) at Bahçeşehir University in 2016. Integrated STEM means use of methods related to both a specific area (discipline) and a specific field education with the selection of depending on the interests of teachers and students in teaching other fields. The use of engineering design process or engineering education in project-based learning in Mathematics / Science courses can be given as an example. Another example is the usage of mathematical reasoning or mathematical modelling in Science courses (Aşık et al. 2017). Our teachers are required to take integrated teacher trainings in order to be able to perform their education successfully (Adıgüzel et al., 2012). In order to ensure that STEM Education is properly understood and maintained appropriately in the schools, it should not be enough to provide in-service training on the subject, and the trainings of future teachers should be taken into consideration and undergraduate level courses should be placed in higher education curriculum (Akaygun & Aslan-Tutak, 2016; Akgündüz et al., 2015). In these courses, it is more beneficial that teacher candidates from different

branches come together and receive training and besides this, training through integrated teacher education programs allows teacher candidates to more fully understand FeTeMM (Çorlu et al. 2014). Akgündüz et al. (2015) emphasized that education faculties need to be revised the undergraduate programs by adopting the interdisciplinary approaches and that the collaboration between faculties is very important for an effective STEM Education, providing students to take training from Engineering, Science and Literature, Technology Faculties has also an importance.

For the last 30 years, the constructivist approach, which influenced the educational world and educational environments philosophically and theoretically, constitutes the basis of STEM Education (Çepni, 2017). Implementation of STEM Education is based on learning methods based on a constructivist approach such as project-based learning (Çorlu & Çallı, 2017), 5E learning model (Yıldırım, 2018), problem-based learning and full learning (Çepni, 2017). 5E learning model has a great importance on STEM Education on the realization of especially engineering process skills, providing learning by doing and establishing the relationship between the information they have learned and daily life. The student focuses on the subject, searches information, discovers knowledge, makes meaningful learning by associating information in his mind and transfers it to new situations (Yıldırım, 2018). The project-based learning model in which high-level thinking skills such as problem solving and decision-making are actively used, design-based, and design and having a complex structure producing a product as a result of the process is fully coincided with STEM Education. Project-based learning as in STEM Education, associates with the topic specified and the problem faced in real life. In order to solve these problems, researches are made by bringing together the disciplines, solutions are tried to be produced and a product is revealed (Çorlu & Çallı, 2017). The problem-based learning model has a problem situation just like project-based learning model and is based on design-based learning (Barak & Raz, 2000). In the problem-based learning model, students focus on the problem, produce ideas on how to solve this problem, establish hypotheses, obtain new information be searching, re-examine the problem as a result of their research and present solutions (Çepni, 2017).In constructivist approach that includes many teaching methods, the individual creates the knowledge as a result of experience and living by using mind and logic filter and establishing a meaningful link with the existing information. In a democratic environment, the individual is in a learning environment where s/he interacts more with his/her environment in the direction of his/her interests, based on their active participation, based on the development of high-level thinking skills, including activities to gain experience, social interaction and communication are cared for (Loyens & Gijbels, 2008).”In the constructivist-learning environment, it is important why and how the learner will learn rather than what s/he will learn“. In a constructivist approach, teachers are responsible for providing students with an appropriate learning environment for more in-depth and permanent learning, enabling them to use their mental skills in an effective way, identifying and addressing student needs taking into account individual differences, and providing necessary learning materials (Erdem & Demirel, 2002). In the constructivist approach, each student should take an active role in the learning process and be responsible for their own learning (Aygören, 2009). On the purpose of providing this, the teacher should utilize different teaching methods in the classroom and should use modern teaching methods such as problem-based teaching method, project-based teaching method and cooperative learning in teaching environments (Saban, 2009). Teachers think that the best teaching-learning method that can be applied in the classroom is constructivist approach (Tuzcu & Yakar, 2009) and it increases the quality of education (Adanur, 2011). However, there are some problems during the implementation and the studies show the reason for this situation that teachers do not have enough knowledge about constructivist approach (Ağlagül, 2009; Özdemir & Kıroğlu; 2011), although they have sufficient knowledge, they have not practiced at a sufficient level (Yıldırım Ekinci & Köksal 2011).Although teachers have a positive attitude towards the constructivist approach (Adanur, 2011), they generally teach the lessons according to the traditional education approach (lecture, question-answer). However, they think they apply the constructivist approach (Ocak, 2012; Ünal & Akpınar 2006). The reason why teachers apply traditional teaching methods is; they think

they are more qualified at this topic (Gelbal & Kelecioğlu; 2007) and easy application of the narrative method, ensuring that the students' pre-knowledge deficiencies are eliminated in an easier and shorter way, being economic and similar reasons (Aktepe & Aktepe, 2009). Repudiating of teachers about the philosophy, purpose and vision of the approach that will be implemented, being prejudiced and reluctant to implement and willing to continue to be use practices they are accustomed is one of the negative factors (Rençber, 2008).After all, the seniority of teachers (Adanur, 2011; Dündar, Kabapınar & Deniz, 2011; Ocak, 2012; Unal & Akpinar, 2006), gender (Inel, Evrekli & Turkmen, 2010; Lakin Dündar, Kabapinar & Deniz; 2011). the crowded population in the classroom, the intensity of the content of the subjects, the physical condition of the class and the inadequacy of the infrastructure (Adanur, 2011), the negative perceptions of parents about the constructivist approach such as "there is no information in the textbooks and the views of the teacher in the course do not give information" causes the inability to apply this method in the lessons.

Some necessary trainings and practices were actualised within the scope of the study in order to train teachers in the integrated STEM Education that is one of the newly applied education programs, become qualified teachers in this context and apply this education program in their lessons appropriate to the program of national education. Thus, teachers, participating actively in the learning and teaching process in the STEM Education practices that is based on the constructivist approach, were in the position of both teacher and learner in this process. In the study, necessary practices were given to 43 teachers including science and secondary school mathematics teachers related to theoretical knowledge and practice. By giving information to the teachers about the integrated STEM Education, they were ensured to apply this information in their professional lives. Considering this thought, the effect of integrated STEM Education applications on teachers' skills in creating the constructivist learning environments and STEM orientations were investigated in the study.

With this purpose, by making a literature review for the trainings to be given to the teachers, it was aimed to create a suitable, effective and efficient process. The lesson plans prepared by the teachers were taken as the basis in order for the integrated STEM Education by Çorlu & Çallı (2017) and to combine this training with the curriculum. In addition, a pilot study was conducted with a different sample group for these applications by taking one-to-one guidance by the researchers for the teachers about the education they gave, the content, process, steps and criteria of these trainings. In the process, teachers were given long-term theoretical and practical training, which were overlapped with each other, and their practices were provided in classrooms. The ways, which teachers use the curriculum in their courses, were also supervised by micro teaching technique. At the end of this process, in line with the interviews and video recordings with teachers, it was determined that teachers could perform the integrated STEM Education in classrooms appropriately. Bozkurt Altan, Yamak and Buluş Kırıkkaya (2016) claimed that when they were given theoretical knowledge only, they could have problems when teachers applied STEM Education in teaching environments. Çorlu, (2012) refers that in order for STEM Education reach the goal, it is significant for teachers to get necessary and appropriate training; if there are deficiencies in this context, STEM Education may become complicated, complex and delicate, and STEM Education will not gain the goals. Teachers have the crucial role in effective application of the teaching programs and they should get training continuously related to the newly prepared teaching programs. Trainings provided should be well-prepared and comprehensive (Güneş & Baki 2011). Because no matter how good the developed programs are, the teachers, who will apply and implement it, should have knowledge of the philosophy, purpose, steps and scope of the program and the methods and techniques in the program (Coşkun 2005).

2. METHOD

Gürsu et al. (2017) designed the integrated STEM Education application process as, 1) face to face workshops, 2) integrated teaching courses, 3) writing science-based life problems and inter-group meetings, 4) on-line education of STEM lesson plan preparation, 5) lesson plan writing and feedback provided by field instructor academicians, 6) self-evaluation and reflection reports. In this present study, based on the integrated STEM Education and designing the process a different according to the desired of teachers, theoretical courses were conducted and all the applications were completed after the theoretical courses. In the study, 1) theoretical and practical courses related to the STEM training and its components were provided to the teachers. 2) In addition, writing a lesson plan to enable the integration of STEM Education into teaching environments: a) adding the gains of science branches (science, technology, mathematics and engineering), which are the other components of STEM Education, b) teaching the creation of lesson plan by integrating the subject with the teaching methods that form the basis of STEM Education. 3) Writing a lesson plan according to the determined topic, 4) examining lesson plans by experts and providing feedback. 5) Applying the lesson plans they created in teaching environments, and video recording. 6) How the video recordings can be applied together with the teachers and they can apply the integrated STEM Education, what problems they encounter during the implementation phase and how the problems can be solved were realised with the help of the micro- teaching.

Theoretical courses were actualised with all the teachers throughout 6 months and practices carried out for approximately 1 year by dividing the teachers into 5 groups. Each teacher prepared his/her individual lesson plans and applied in their classes, but watching the video recordings were realised with the groups. In addition, In order to adapt STEM Education to the curriculum, the experts in the course of writing the lesson plan reviewed the course plans and feedback was given to the teachers in order to correct the missing places. In this way, they could get feedback on the lesson plans they had prepared and interact with the experts and had the opportunity to ask questions.

Considering the study by Eroğlu and Bektaş (2016) that referred planning a long-term two-way interaction, in which teachers' classroom practice was observed, and planned an ongoing study of communication between experts and practitioners, set out with the thought a different qualitative study in which richer and in-depth data that would be obtained could be useful in terms of literature. Thus, the data in the study were collected with the protocols and questionnaires and in-class applications of teachers were followed by micro teaching method.

Before the questionnaires and interviews were applied to collect preliminary data from the teachers, brief information about STEM Education was given. Because, teachers stated that they had no information about STEM Education, what it meant, what it intended, and they wanted these topics to be explained. They claimed when they had prior knowledge about the content of STEM Education, their answers to questions would be more realistic and would help them to clarify their situation more clearly. In terms of how much our teachers intended to apply the STEM in their courses and in terms of their professional qualifications, the FeTeMM Education Orientation Scale was used. The scale was developed by Lin & Williams (2015) to determine the tendencies of pre-service science teachers in science, technology, engineering and mathematics teaching and was adapted into Turkish by Hacıömeroğlu & Bulut (2016). There are 31 items in the scale. In addition, in order to measure the achievement of teachers through STEM applications, " Constructivist Learning Environment Management Skills Scale" will be used. The scale was developed by Yıldırım (2014) and had 33 items. With the protocols, the views of teachers' on the Integrated STEM, their experiences and expectations were tried to be determined. Protocols with 8 teachers were actualised to determine the teachers' viewpoints related to the STEM Education on the topic of the suitability of STEM Education with our country's education system.

3. FINDINGS

In this section of the research, there are the analyses of the data obtained from teachers before and after the applied activities by means of appropriate statistical techniques and their presentation in tables. In addition, at the beginning and end of the study, the FeTeMM Education Orientation Scale and the Constructivist Learning Environment Management Skills Scale were applied and collected data were analysed. Within the lights of these data, it was tried to find out whether the Integrated STEM Education given to the teachers had any effect on their Tendencies of FeTeMM Teaching Orientation and Constructivist Learning Environment Management Skills Scale

Table I.
T-test results related to the scores of FeTeMM scale

MEASUREMENT	N	$\bar{X}$	Sd	t	df	p
Pre-test	21	111.85	8.65	-9.59	20	0.00
Post-test	22	141.86	11.57			

It was observed that data gathered from the FeTeMM scale were distributed normally. The results, gathered with the t-test applied to determine whether there was a meaningful difference between the questionnaire results before and after the STEM Education in the class in which the effect of STEM Education on the FeTeMM skills of science teachers was investigated, are presented in Table I. As it is seen in Table I, statistically meaningful difference was found between the pre-tests and post-tests ($p<0.05$).

Table II.
Dependent sample t-test results on scores for the Constructivist Learning Environment Management Skills Scale

MEASUREMENT	N	$\bar{X}$	Sd	t	df	p
Pre-test	21	114,76	8.7	-8.53	20	0,00
Post-test	21	143,90	13.47			

It was determined that the data obtained from the Constructivist Learning Environment Management Skills Scale was provided normality. The results of t-test, which was applied to determine whether there was a meaningful difference between the questionnaires before and after the STEM Education given in the class in which the effect of STEM Education on the tendencies of science teachers in managing the constructivist-learning environment was investigated, were presented in Table II. As it is seen in Table 2, statistically meaningful difference was found between the pre-tests and post-tests ($p<0.05$).

The teachers could not answer the open-ended questions asked to measure the knowledge of the teachers related to the STEM before the training. Because, they claimed that they had not had any knowledge related to the STEM and had not heard such a teaching method. According to the claims of the teachers, they were given a brief information about the STEM Education. Then the open-ended questions were asked them again. They expressed that they had not applied that teaching method before in their classes, but would apply it easily after they learned. They also claimed that they could not reply the questions in the protocol before the application of it in their classes. After the training process, the teachers claimed that they could easily apply all the Integrated STEM Education in their classes.

1. All of the eight teachers, who were asked the question, " (if there) Can you talk about the STEM-based activities you applied in your class shortly?", replied that they did STEM-based activities and they stated the activities such as the catapult, the most weight-bearing boat, the fastest falling ball activity, the water rocket to the top, and the effect of the plane wing structure on the flying pattern.

While they were applying these activities in their classes, they defined the gains they gave attention to, practice steps and practice objectives correctly.

2. As their responses to the 2nd question "why the STEM education is important?" was analysed, the codes: daily life (7), problem solving (6), integration (6), practice (5), gains (2) and production (6) emerged. They stated that they used the skills and experiences the students had gained from their school life to solve the problems they faced in their daily lives. They expressed that during the course of our daily lives, we were confronted with problems requiring different solutions, and we needed to produce scientific and different solutions to these different problems; thus, students could develop science, mathematics, engineering and technology skills together with STEM Education. In addition, they stated that they were able to produce more realistic and correct solutions to the problems encountered in STEM Education. They emphasized that scientific theory and practical applications of laws could be provided with STEM education in schools; thus, scientific truths could be used to solve a problem by stripping from theory armour." *For example, learners and students learn the relationship between force arm and force gain at school; however, this knowledge does not make sense when it is not used in solving a problem in real life. Students cannot solve the problems they face in real life by just using this theoretical knowledge. ".* They stressed that students were able to benefit from mathematics, engineering and technology in solving the problem with STEM Education; thus, they gained the ability to use the gains of these sciences together. In this period at which information is valuable, they stated that the upbringing of innovative individuals could be achieved by STEM, and that STEM education could create new products by turning the individual differences of the students into an opportunity.

3. At the responses related to the 3rd question as "what kind of curricula and educational materials are needed for STEM training applications?" were analysed, the codes as student- centred (8), flexible (6), activity based (2), more time (2), less gains (2), ready materials (5), simple materials (8) were emerged. The teachers stressed that they needed a partially more independent program for STEM education, and the program to be implemented should be student-centred and to cover problem-solving skills. The science lesson program created in 2013 can be considered suitable for STEM education, with this program, the lessons have been reduced and the teachers provided more opportunities to do such activities. Similarly, they emphasized the need for a program that STEM education in science applications could be given with it easily; for the implementation of this program, students can encounter problems, which are real or can be considered to be real as much as possible, produce solutions to problems, test the solutions produced, and work with groups if necessary.

They stated that ready materials and kits could be used within economical frame in STEM education; in addition, STEM activities could be prepared with simple materials that could be reached anywhere. Ö4 coded teacher expressed his/her thoughts as: *"In other words, STEM education can be performed with different materials in cases in which the engineering products are insufficient or incomplete. For example structures suitable electric motors can be used as the solution, as well as the water moving gear if a mechanism is needed to meet the oxygen demand of the fish living in the aquarium."* Ö5 coded teacher expressed, *"You have to produce solutions according to the quality of the material you have. This is how I interpret the technology in STEM. We take advantage of the technologies we have in looking for solutions to the problems we face in real life."*

4. As the answers to the question, "What do you think about the potential of education policies in the context of our country to support STEM education?" were analysed, it was determined that all the teachers had thought that our country had the potential to support the STEM Education. They claimed that the education policies in our country were generally affected by the education policies of developed countries. "*The fact that the education programs prepared for the science education are constantly changing / updating shows that we have a dynamic and not fully settled educational policy, however, our comparison with the developed countries such as PISA and TIMSS continuously shows*

us that we have important expectations in the field of education". In this context, they emphasized that the education policies of our country could be defended as innovative and ambitious policies.

They referred that the education policies implemented in our country support STEM education and they aim to educate individuals who are approaching the problems from a holistic perspective and can use the knowledge they learned in their daily life in our country as in the whole world. They stressed that the efforts of many universities and the Ministry of National Education for the promotion of STEM education supported this situation.

5. As the answers for the question, "what are the most appropriate teaching strategies, methods and techniques for STEM Education?" were analysed, the codes as project-based teaching (7), teaching through invention (6), extracurricular activities (7), cooperative learning (8) problem-based teaching came into existence.

Project-based teaching: It can be used with the environments where students can experiment on the projects they can perform their tasks.

Problem solving based teaching: After the problems encountered by the students are listed, students may be in search of solutions to their problems in groups. Students seeking to find solutions to their problems will contribute to STEM education. Because students will be in search for answers to their problems by forcing the limits of their accumulation.

Extracurricular activities: students can work with free activities. For example, they can work on and produce a solution for the problem as 'causes and reduction of pollution in the most used picnic areas' with extracurricular solutions such as determining the amount of wastes, recycling the wastes.

5E teaching: It can be used as a basis for the activities by enabling the information to be deeply connected with daily life.

Cooperative teaching: Working in groups will enable students to produce products that are more efficient.

Teaching through invention: can be applied in testing of suggested solutions. It can be used in determining of whether the used tools work properly or not and determining the most appropriate measurements.

6. As the answers to the question, "What are the possible problems that occur or may occur in the implementation of STEM Education?" were analysed, the codes as viewpoint (5), lack of information (5), economical deficiencies (5), resistance that some students show (2) emerged**.**

Viewpoint: the most significant obstacle in front of the STEM education is that the schools are exam-centred. As students focus on the exam success, they can miss the outer world and spend the energy to find the right choice in the question. Products can be used as a result of STEM activities to change this perspective. As a result, STEM products serve a real section of life.

Lack of information: Especially deficient knowledge of teachers may cause problem. The teachers should master both the STEM education and other discipline.

Economical deficiencies: the kits used in STEM education are extremely expensive, and it is not possible to obtain these kits by everyone. Without improper materials, products may also be missing and failures. Deficient products can reduce motivation.

Resistance that some students show: Especially some of the students in primary and secondary school level have biases towards the fields of science and mathematics. This can cause resistance to the use of science and mathematics in the application process.

7. As the answers to the question, "What are the limitations in the theory and practice of STEM education?" were analysed, the codes as time (7), material (7), suitability to the subject (5), practice (3), deficiency (3) emerged. The teachers stated that they could have problems during applying this teaching method as they were given theoretical information about the application of a teaching method. They stated that STEM training could be incomprehensible, complex, and vulnerable when not correctly provided, and that STEM education would not achieve its goal in such cases. They stressed that STEM education might not be appropriate to each student; similarly, STEM education might not be the most effective approach (perhaps because of material deficiency) in solution of each problem. They also stressed that as sufficient number of examples for STEM trainings did not include Turkish sources, there was misunderstanding of STEM approach by teachers and especially the activities carried with students should have been conducted with the ones who had sufficient experience and knowledge.

8. As the answers to the question, "What should be the objectives of STEM Education?" were analysed, the codes as different viewpoint to the problems (7), questioning (6), designing (6), not memorising (5), generating solutions (5), innovative viewpoint (4) and synthesising codes emerged. Teachers stated that STEM Education should be designed in such a way that students can develop a different perspective on problems; that is, STEM education should be used to train individuals who can use many disciplines together and seek solutions in this context. Teachers, in educating questioning and designing individuals, with STEM education, emphasized that an environment, in which students will question the events they encounter, search for solutions, make designs and try the products they create, should be provided. In addition, with other codes, they claimed that they should have targets that can raise individuals who produce inquiries not memorize, produce solutions, gain an innovative perspective, acquire the logic of STEM, and synthesize different disciplines within a plan. Teachers stated that students should be able to produce practical solutions for the problems they encounter, produce innovative solutions, find practical solutions by finding underlying problems using different tools and information, use the information they acquired during their school life for different purposes, understand the value of information.

4. RESULTS AND CONCLUSIONS

At the end of the study, it was found that STEM Education had a positive effect on teachers' FeTeMM Skills and developing the Constructivist Learning Environment Creation Skills. Developing the views and attitudes of teachers, who are the direct applicants of STEM Education, positively on this educational approach, is significant both in terms of improving the quality of the course in which the STEM Education they integrated and developing teachers in terms of new approaches (Eroğlu & Bektaş, 2016). Students' positive attitude towards the teaching method-approach and activities to provide meaningful and permanent learning and providing development in themselves are significant in terms of a qualified education and developing individuals. Teachers who are open to innovations are also likely to train their students as individuals who are investigating, questioning, studying, expressing themselves and having scientific curiosity (Siew, Amir & Chong, 2015). Garet, Porter, Desimone, Birman, & Yoon, (2001) teachers who have these qualifications, have a positive influence on students' attitudes as well as their attitudes. In addition, Capraro et al., (2016) the innovative practices of a teacher who does not have the theoretical background and practical experience in the fullest sense harm the student's learning process.

In the study, teachers were not able to respond to open-ended questions asked to measure their knowledge about STEM Education before they started to provide Integrated STEM Education. Because, they stated that they had no knowledge of STEM and had not heard of such education before. In Turkey report on STEM Education written by Akgündüz et al. (2015), it was seen that most of the teachers were not aware of this education method, and this demonstrated similarity with the result of present research. Other studies in the literature support this case (Bakır & Kutlu, 2018). In the study, a brief information about STEM education was given to the teachers according to their requests. Then

the open-ended questions were asked them again. As a result of the analysis of the collected data, teachers claimed that they had never applied to this method in their classrooms before, but they would use as they learned. In this study, a training process, which was long-term, with teachers in different branches, in healthy communication and interaction with experts, theoretical and practical equilibrium and equal weight, including the lesson plan to be able to integrate into their lessons and the activities of implementing it; for example, field knowledge, pedagogical field, was followed in order to integrate STEM Education with the knowledge of teachers. At the end of the study, as a result of the protocols with the teachers, it was determined that all of the teachers thought that they could easily implement Integrated STEM Education in their courses.

This situation is thought to be originated from the Integrated STEM Education given to the teachers and the content of this education. The literature studies support this case. Elmalı & Balkan Kıyıcı (2017) some contents of the educations are theoretical based, others are activity based and this case is expressed to be one of the basic reasons that cause problems during the application of STEM Education used by teachers. In order to carry out the comprehensibility and application of the subject in a healthy manner, it is necessary to prepare modules containing practical examples. According to Marino, Black, Hayes & Beecher (2010), it should be noted in this module is that its designing enabling to teachers' relevant field knowledge, pedagogical content knowledge and technological pedagogical content knowledge. According to Roberts & Cantu, (2012), one of the problems with STEM Education is that it is not clear how this education approach will be realised in the classroom and that the possibility of guiding teachers is limited. In the study by Yoon, et al., (2007), as a result of the studies carried out with different cultures, it was stated that the professional development programs that the teachers participated should contain at least 80 hours for the students to have a positive effect on their learning.

In the study, it was determined that all the teachers thought our country had the potential to support the STEM Education. They claimed that education policies in our country generally affected with the policies of other countries. In this context, they stressed that the education policies in our country were the innovative and disputed education policies. Nevertheless, the teachers emphasized the need for a more independent program for STEM Education; the program to be implemented should be student-centred and should include problem-solving skills. They also stated that the science program created in 2013 could be regarded as appropriate to the STEM Education; with this program, the gains of the courses were reduced and more opportunities were provided for teachers to do such activities. Similarly, they stressed that STEM education in science applications courses could be given easily; in order to apply the program, it should be a program enabling students learning environments in which they encounter the problem cases that are can be regarded as real, produce solutions for the problems, can test their solutions and work in groups as they needed. They emphasized that many universities and the Ministry of National Education were ready to support the studies to ensure the STEM education become widespread. In parallel with this result gathered from the study, The Ministry of National Education prepared the Strategic Plan for 2015-2019 and took decisions to include STEM Education in the curriculum. A start for STEM education was constituted by including engineering applications to the new teaching program for only 5th classes in the 2017-2018 educational year (MEB, 2018). Although the Ministry of National Education took decisions on strengthening STEM education and integration into teaching environments, no action plan has been prepared yet (Çiftçi & Çınar, 2017) and STEM Education does not state in STEM teaching programs adequately (Bakırcı & Karışan, 2018; Hacıoğlu, Yamak & Kavak, 2016; Tekerek & Karakaya, 2018).

At the end of the study, the teacher stressed that the STEM Education might not be appropriate to each student; similarly, STEM Education might not be the most effective approach in solving each problem (perhaps because of material deficiency). In addition, they stated that in applying the STEM Education, they gave the most effective teaching methods, approaches and techniques as project-based teaching, problem-based teaching, extracurricular activities, cooperative teaching, 5E and teaching through invention. This result demonstrates similarity with the results of the study by Çorlu

(2014). In addition, the teachers claimed the problems that occurred or might occur as viewpoint, lack of knowledge among teachers, economical deficiencies and resistance of some students in applying the STEM Education. They emphasized that it was important that STEM approach was misunderstood by the teachers because of the lack of sufficient number of examples in Turkish publications for STEM trainings and it is important to make the first activities organized with students with those who had sufficient experience and knowledge. In the study conducted by Bakır & Kutlu (2018), similarly, it was determined that some problems were encountered in STEM Education.The lack of equipment due to economic reasons in schools and teachers do not have sufficient theoretical knowledge and application experience in STEM Education is emphasized. In order to close this gap, some trainings are offered by private institutions, universities and national education (Bozkurt Altan, Yamak & Buluş Kırıkkaya, 2016). However, in addition that there are very few faculty members working in this field, very few faculties have been opened at the undergraduate and graduate level. (Akgündüz et al, 2015; Akgündüz, 2018). This insufficient value given to STEM education is not only limited with in-service training institutions, but also teachers do not show required importance and sufficient consciousness is not constituted (Yıldırım & Selvi, 2016). In order to eliminate this situation, STEM centers should be established, activities should be organized to raise awareness on this issue, and participation in STEM themed congresses and workshops should be ensured (Uğraş, 2017). The integration of STEM education into the national education curriculum, i.e. the curriculum, leads teachers to think of them as one of the major obstacles to STEM Education and this situation may cause them to wander away from the STEM Education (Akgündüz, 2018).

The most important obstacle in front of STEM education originates from that the schools are examination-centred. As students focus on exam success, they can miss the world around them and spend all their energy trying to find the right choice in the question. Products emerging as a result of STEM activities can be used to change this viewpoint. As a result, STEM products support a real section of life. Teachers emphasized that STEM trainings should create an environment where students can question the events they face, search for solutions, design and experiment with the products they create (Meyrick, 2007). In addition, they claimed that they should have targets that can raise individuals who produce inquiries not memorize, produce solutions, gain an innovative perspective, acquire the logic of STEM, and synthesize different disciplines within a plan (Eroğlu & Bektaş, 2016). Teachers stated that students should be able to produce practical solutions for the problems they encounter, produce innovative solutions, find practical solutions by finding underlying problems using different tools and information, use the information they acquired during their school life for different purposes, understand the value of information (Gülhan & Şahin 2016).

It was found that the teachers had the thought that STEM Education was significant for our education system and was one of the aims of education, which students use in their daily life with the skills, and experiences they gained through their school life. It was determined that they thought that during the course of our daily lives, we were confronted with problems requiring different solutions, and we needed to produce scientific and different solutions to these different problems; thus, students could develop science, mathematics, engineering and technology skills together with STEM Education. In addition, it was found that they believed that more realistic and accurate solutions would be provided to the problems encountered in STEM education and scientific theory and practical applications of laws could be provided with STEM education in schools; thus, scientific truths could be used to solve a problem by stripping from theory armour.

They stated that the upbringing of innovative individuals could be provided by STEM in this period in which the information is valuable and that the STEM education would create new products by turning the individual differences of the students into an opportunity. In STEM education, they stated that ready materials and kits could be used within the framework of economic boundaries and STEM activities could be prepared with simple materials found everywhere.

Aronin and Floyd (2013) define STEM Education as the knowledge, media and technology skills, learning and regeneration skills, life and professional skills defined as 21st century skills of the individual, and qualifications such as; creativity and regeneration, critical thinking and problem-solving and communication and cooperation, information literacy, media literacy, information and communication technologies literacy, flexibility and cohesion, entrepreneurship and self-direction, and these skills can be gained by the students with STEM Education (Wang, 2012; Erdoğan & Çiftçi, 2017; Uğraş, 2017; Altan et al., 2016, Çorlu, 2014; Chesloff, 2013; DeJarnette, 2012; Gonzalez and Kuenzi, 2012; Siew et al., 2015; Çolakoğlu & Günay Gökben, 2017). In our country, there is a misconception that teachers can do STEM education with expensive materials (such as lego-style materials) in the studies conducted with teachers (Bekir, 2018). Therefore, teachers perceive STEM education as a costly education approach (Brown et al.,2011; Gebbie et al., 2012). With this study, it was determined that the teachers were purified from the thought.

The study was carried with science and secondary school mathematics teachers and consisted of the processes and stages as teaching the Integrated STEM Education, aiming at organizing the curriculum, course gains and STEM objectives, targets and event contents together to the teachers in order to ensure the integration of STEM Education into the courses and implementing in the classrooms. In addition to STEM Education being perceived as extracurricular activity or trying to be applied in activity-based in Science Applications Course, an understanding of how this training approach could be integrated in line with the course objectives and how this integration should be done, i.e. the content of the training to be given to teachers and the impacts of these practices were tried to be provided. Teachers, who prepare a new course plan by combining the objectives of the course with the acquisitions of other sciences within STEM, evaluated the effect of this lesson plans on their students in their classrooms and their suitability in terms of school, student, material and our education system. The fact that the training given to the teachers is long-term and the follow-up of the process can be exhausting and difficult, the application of this education can be perceived as difficult. However, it is thought that this education can be carried out with a good plan, team and equipment. Because it is thought that teachers, who are the direct applicator of the courses and the first coordinator of the class, are thought to be able to implement this approach, by better learning this innovative educational approach, in an educational environment where well-planned, theoretical and practical balances can be communicated to the people who can easily guide and follow-up the feedback service to the them.

REFERENCES

Adanur, Z. (2011). *Applicability of constructivist approach in joint primary classes from the views of primary school teachers: A sample of Trabzon* (Unpublished master's thesis). Karadeniz Teknik University, Trabzon.

Adıgüzel, T., Ayar, M. C., Çorlu, M. S., & Özel, S. (2012). *Fen, teknoloji, mühendislik ve matematik (FeTeMM) eğitimi: Disiplinlerarası çalışmalar ve etkilişimler [STEM Education in the Turkish context: Interdisciplinary investigations and interactions]*. X. Ulusal Fen Bilimleri ve Matematik Eğitimi Kongresi [National Science and Mathematics Education Congress], Niğde, Turkey.

Ağlagül, D. (2009). The evoluation of the class teachers? skills to organize constructivist learning environment in the fifth grade of social studies (Unpublished master's thesis). Çukurova University, Adana.

Akaygun, S., & Aslan-Tutak, F. (2016). STEM Images Revealing Stem Conceptions Of Pre-Service Chemistry And Mathematics Teachers. International Journal of Education in Mathematics, Science and Technology, 4(1), 56-71.

Akgündüz, D., Aydeniz, M., Çakmakçı, G., Çavaş, B., Çorlu, M., Öner, T., & Özdemir, S. (2015). STEM eğitimi Türkiye raporu:"Günümüz modası mı yoksa gereksinim mi?"[Turkey STEM education report: "Is it or is today's fashion needs]. İstanbul: İstanbul Aydın University STEM Center.

Akgündüz, D. (2018). STEM Eğitiminin Öğretim Programına entegrasyonu: Çalıştay Raporu [Integration of STEM Education into the Curriculum: Workshop Report], C&B publisher.

Aşık, G., Doğança Küçük, Z., Helvacı, B. & Corlu, M. S. (2017). Integrated Teaching Project: A Sustainable Approach To Teacher Education. *Turkish Journal of Education, 6*(4), 200-215. DOI: 10.19128/turje.332731

Aygören, F. (2009). Yapılandırmacı öğrenme ortamlarının sınıf öğretmenlerinin ve okul yöneticilerinin görüşlerine göre değerlendirilmesi (Çine örneği) [Evaluating the constructivist learning environments by the views of the primary school teachers and school administrators (Sample of Çine)) (Unpublished master's thesis). Adnan Menderes University,Aydın.

Baran, E., Canbazoğlu-Bilici, S., & Mesutoğlu, C. (2015). Science, Technology, Engineering, And Mathematics (Stem) Public Service Announcement (Psa) Development Activity. *Journal of Inquiry Based Activities, 5*(2), 60-69.

Barak, M., & Raz, E. (2000). Hot-Air Balloons: Project-Centered Study As A Bridge Between Science And Technology Education. *Science Education, 84*(1), 27-42.

Becker, K., & Park, K. (2011). Effects Of Integrative Approaches Among Science, Technology, Engineering, And Mathematics (STEM) Subjects On Students' Learning: A Preliminary Meta-Analysis. *Journal of STEM Education: Innovations & Research, 12*(5), 23-37.

Buxton, C. A. (2001). Modeling Science Teaching On Science Practice? Painting A More Accurate Picture Through An Ethnographic Lab Study. *Journal Of Research In Science Teaching, 38*, 387-407.

Çevik, M. (2018). Impacts Of The Project Based (PBL) Science, Technology, Engineering And Mathematics (STEM) Education On Academic Achievement And Career Interests Of Vocational High School Students. Pegem Journal of Education & Instruction, 8(2), 281-306, http://dx.doi.org/10.14527/pegegog.2018.012

Çepni, S. (2018). Kuramdan uygulamaya stem eğitimi [Stem training from theory to practice]. Pegem Atıf İndeksi.

Çiftçi, M. & Çınar, S. (2017, April). Fen bilgisi öğretmenlerinin stem eğitiminin fen bilimleri dersine entegrasyonu hakkındaki görüşleri [Science education science teachers science science course integration]. Paper presented at the 7th International Congress of Research in Education, 27-29, Çanakkale.

Çolakoğlu, M. H., & Gökben, A. G. (2017). STEM Studies In Turkish Faculties Of Education. *Journal of Research in Informal Environments, 2*(2), 46-69.

Corlu, M. S., Capraro, R. M., & Capraro, M. M. (2014). Introducing STEM Education: Implications For Educating Our Teachers In The Age Of Innovation. *Ed*ucation and Science, 39(171), 74-85.

Çorlu, M. S., & Çallı, E. (2017). *STEM kuram ve uygulamalarıyla fen, teknoloji, mühendislik ve matematik eğitimi [Science, technology, engineering and mathematics education with STEM theories and applications]*. İstanbul: Pusula.

Dugger, W. E. (2010, December). Evolution of STEM in the United States. Paper presented at the 6th Biennial International Conference on Technology Education Research, Australia. retrieved from http://www. iteea. org/Resources/PressRoom/AustraliaPaper. pdf.

Elmalı, Ş., & Kıyıcı, F. B. (2017). Review of STEM Studies Published in Turkey. *Sakarya University Journal of Education, 7*(3), 684-696. Doi: 10.19126/suje.322791.

Ercan, S., & Bozkurt, E. (2013, October). Expectations from engineering applications in science education: decision-making skill. Paper presented at the IOSTE Eurasian Regional Symposium & Brojerage event Horizon 2020, Antalya, TURKEY

Erdem, E., & Demirel, Ö. (2002). Constructivist Approach In Programme Development. *Journal of Hacettepe University Faculty of Education, 23*, 81-87.

Eroglu, S., & Bektas, O. (2016). Ideas Of Science Teachers Took STEM Education About STEM Based Activities. *Journal of Qualitative Research in Education, 4* (3), 43-67.

Garet, M. S., Porter, A. C., Desimone, L., Birman, B. F., & Yoon, K. S. (2001). What Makes Professional Development Effective? Results From A National Sample Of Teachers. *American Educational Research Journal, 38*, 915–945
Kabaran, G. G. & Uşun, S. (2017). Eğitim fakültesi öğrencilerinin fakülte ve öğretim elemanı kavramlarına ilişkin metaforları. Eğitim Kuram ve Uygulama Araştırmaları Dergisi. 3(2), 35-49

Kılıç, B., & Ertekin, Ö. (2017). MEB için fen teknoloji mühendislik matematik-fetemm modeli (stem) ile eğitim. TÜBİTAK Bilişim ve Bilgi Güvenliği İleri Teknolojiler Araştırma Merkezi Temel Bilimler Araştırma Enstitüsü. Retrieved form http://tbae.bilgem.tubitak.gov.tr/

Loyens, S. M., & Gijbels, D. (2008). Understanding The Effects Of Constructivist Learning Environments: Introducing A Multi-Directional Approach. *Instructional Science, 36*(5-6), 351-357.

Marino, M. T., Black, A. C., Hayes, M. T., & Beecher, C. C. (2010). An Analysis Of Factors That Affect Struggling Readers' Achievement During A Technology-Enhanced STEM Astronomy Curriculum. *Journal of Special Education Technology, 25*(3), 35-47.

Marulcu, İ. & Sungur, K. (2012). Analyzing Of Science Teacher Candidates' Engineering And Engineering Perceptions In Addition To Perspective Of Engineering Design As A Method. *Afyon Kocatepe University Science Magazine, 12*, 13-23.

Morrison, J. S. (2006). Attributes of STEM Education: The Students, The Academy, The Classroom. *TIES STEM Education Monograph Series.*

Ostler, E. (2012). 21st Century STEM Education: A Tactical Model For Long-Range Success. *International Journal of Applied Science and Technology, 2*(1), 28-33.

Özdemir, S. (2016). STEM Eğitimi Için Görüşler. Ankara

Özdemir, Y., & Kıroğlu, K. (2011). The Knowledge Level Of Elementary School Teachers About The Constructivist Learning Theory. Ahmet Kelesoglu Education Faculty (AKEF) Journal, 32.

Saban, A. (2009). Prospective Teachers' Mental Images About The Concept Of Student. *The Journal of Turkish Educational Sciences, 7*(2), 281-326.

Sanders, M. (2009). STEM, STEM Education, STEMmania. *The Technology Teacher, 68*(4), 20–26.

Tezel, Ö., & Yaman, H.(2017). A Revıew Of Studıes On STEM Education In Turkey. *Journal of Research in Education and Teaching, 6*(1), 135-145.

Thomas, T. A. (2014). Elementary teachers' receptivity to integrated science, technology, engineering, and mathematics (STEM) education in the elementary grades. (unpublished doctoral's thesis). University of Nenada, Reno.

Tuzcu, D., & Yakar, Z. (2009). *Fen ve teknoloji öğretmenlerinin* fen öğretimine yönelik inançları ve sınıf uygulamaları arasındaki ilişkiler üzerine nitel bir çalışma. Paper presented I. International Congress of Educational Research, Çanakkale, Turkey.

Uğraş, M. (2017). Okul Öncesi Öğretmenlerinin Stem Uygulamalarina Yönelik Görüşleri [Stem Of Preschool Teachers

Opinions]. *Journal Of New Trends in Educational Science, 1*(1), 39-54

Ünlü, Z. K., & Dökme, İ. (2016). Gifted Children' Images about STEM's E. *Trakya University Journal of Education Faculty, 7*(1), 196-204.

Wagner, T. (2008). Rigor Redefined. *Educational Leadership, 66*(2), 20-24.

Milli Eğitim Bakanlığı Yenilik ve Eğitim Teknolojileri Genel Müdürlüğü (MEB YEĞİTEK GM) (2016). STEM Eğitimi Raporu. Retrieved 12 June 2019 from http://yegitek.meb.gov.tr/www/meb-yegitek-genel-mudurlugu-stem-fen-teknolojimuhendislik-matematik-egitim-raporu-hazirladi/icerik/719.

Yıldırım, B. (2017). Fen eğitiminde STEM. Turkey: Pegem Atıf İndeksi.

Yıldırım, B. (2018). An Examination Of The Effects Of Stem Applications Prepared In Accordance With Context Based Learning. *Journal of Kazım Karabekir Education Faculty,* (36), 1-20.

Yıldırım, B., & Altun, Y. (2014). STEM eğitimi üzerine derleme çalışması: Fen bilimleri alanında örnek ders uygulanmaları. Paper presented In International Congress of Education Research, Ankara, Turkey.

Yıldırım, B., & Sevi, M. (2016). Examination of the effects of STEM Education integrated as a part of science, technology, society and environment courses. Journal of Human Sciences, 13(3), 3684-3695.

Yıldırım, B., & Türk, C. (2018). Pre-Service Primary School Teachers' Views about STEM Education: An Applied Study, *Trakya University Journal of Education Faculty, 8*(2), 195-213.