Effectiveness of STEM Education on Students' Science Course Success: A Meta-Analysis Study*

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Article History

Submitted: 08.10.2021

Accepted: 29.12.2021

Published Online: 31.12.2021

Keywords

STEM

Academic Achievement

Meta-Analysis

Effect Size

Science Education

Research Article

* “COPE-Dergi Editörleri İçin Davranış Kuralları ve En İyi Uygulama İlkeleri” beyanları: Bu çalışma için herhangi bir çıkar çatışması bildirilmemiştir. Bu çalışma için etik kurul onayı alınmıştır.

DOI:

<http://dx.doi.org/10.29228/JASSS.54118>

Abstract

The main aim of this study was to reveal the effect of science, technology, engineering and mathematics (STEM) education in the science course on the academic success of students compared to the traditional method using the meta-analysis method. The study included all master's theses, doctoral theses and articles that examined the effect of STEM education on the academic success of students compared to the traditional method between 2010-2020 and were published in our country in accordance with the determined criteria. As a result of the literature review, 28 studies that could be included in the meta-analysis were found. As a result of the study, the overall effect size value of STEM education on students' academic success compared to traditional methods was calculated as 1.010 (95% confidence interval). This value corresponds to a very high effect level according to the classification of Cohen et al. (2007 cited by Saraç, 2018). How the effect sizes of the studies included in the study differed according to the target group, sample size, learning domain and the application time moderators was examined. As a result of the moderator analyses, a significant difference was found in favor of the studies with 50 and more samples between the sample sizes of the studies examined. A significant difference was found in favor of the effect size of the "Physical Events" learning domain between the effect sizes of the learning domains. When the distribution of students' grade level and experimental application time in terms of effect sizes in the studies examined was examined, no statistically significant difference was found. This study is important in that it attempts to understand how effective STEM education practices are in science education in our country compared to traditional methods and current science curriculum. Furthermore, it will contribute to our literature in terms of examining the studies on STEM from a holistic perspective.

Reference Information / Atıf Bilgisi

Ademoğlu, E; Emre, F. B. and Akyürek, S. T. (2021). Effectiveness of STEM Education on Students' Science Course Success: A Meta-Analysis Study. *Jass Studies-The Journal of Academic Social Science Studies*, 14(88): 45-60.

FETEMM Eğitiminin Öğrencilerin Fen Bilimleri Dersi Başarısı Üzerine Etkililiği: Bir Meta Analiz Çalışması

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Makale Geçmişi

Geliş: 08.10.2021
Kabul: 29.12.2021
On-line Yayın: 31.12.2021

Anahtar Kelimeler

FETEMM
Akademik Başarı
Meta-Analiz
Etki Büyüklüğü
Fen Eğitimi

Araştırma Makalesi

* Statements of "COPE-Code of Conduct and Best Practices Guidelines for Journal Editors": No conflicts of interest were reported for this article. Ethics committee approval is required for this article.

DOI:

<http://dx.doi.org/10.29228/JASSS.54118>

Öz

Bu çalışmanın temel amacı, öğrencilerin fen bilimleri dersinde fen, teknoloji, mühendislik ve matematik (FETEMM) eğitiminin, geleneksel yöntemle göre öğrencilerin akademik başarısına etkisini meta analiz yöntemiyle ortaya koymaktır. Araştırma, 2010-2020 yılları arasında FETEMM eğitimlerinin geleneksel yöntemle göre öğrencilerin akademik başarısına etkisini inceleyen ve belirlenen kriterlere uygun, ülkemizde yayımlanmış tüm yüksek lisans tezleri, doktora tezleri ve makaleleri içermektedir. Literatür taraması sonucunda meta analize dâhil edilebilecek 28 çalışmaya ulaşılmıştır. Araştırma sonucunda, FETEMM eğitiminin geleneksel yöntemlere göre öğrencilerin akademik başarısı üzerindeki genel etki büyüklüğü değeri 1,010 (%95 güven aralığı) olarak hesaplanmıştır. Bu değer Cohen ve arkadaşları (2007 akt. Saraç, 2018)'nın sınıflandırmasına göre çok büyük etki düzeyine tekabül etmektedir. Araştırmaya dâhil edilen çalışmaların etki büyüklüklerinin; hedef grup, örneklem büyüklüğü, öğrenme alanı ve uygulama süresi moderatörlerine göre nasıl farklılaştığı incelenmiştir. Moderatör analizleri sonucunda, incelenen çalışmaların örneklem büyüklükleri arasında 50 ve üzeri örnekleme sahip olan çalışmaların lehine anlamlı bir farklılaşma tespit edilmiştir. Öğrenme alanlarının etki büyüklükleri arasında ise "Fiziksel Olaylar" öğrenme alanının etki büyüklüğünün lehine olacak şekilde anlamlı farklılaşma tespit edilmiştir. İncelenen çalışmalarda öğrencilerin sınıf düzeyi ve deneysel uygulama sürelerinin etki büyüklükleri açısından dağılımına baktığımızda istatistiksel olarak anlamlı bir fark bulunmamıştır. Bu çalışma, ülkemizde yapılan fen eğitiminde FETEMM eğitimi uygulamalarının, geleneksel yöntemlere ve mevcut fen bilimleri öğretim programına göre ne kadar etkili olduğunu anlamaya çalışma açısından önemlidir. Ayrıca FETEMM ile ilgili yapılan çalışmaları bütüncül bir bakış açısıyla inceleme açısından alan yazınımıza katkı sunacaktır.

INTRODUCTION

The reason why the countries of the world compete scientifically and technologically is that they want to be stronger economically. As a result of technological advancements and economic developments since the industrial revolution, the definition of qualified person of the 21st century competitive world has also changed. The need for individuals with high communication skills, who can work in multidisciplinary fields, who are prone to group or team work rather than individual works, and who have critical and creative thinking skills has also increased (Yıldırım, 2019). The developments in the world of science and technology have led to the opening of new business areas (Yıldırım, Şahin and Tabaru, 2017). Individuals who can work in these fields should have the 21st century skills. As a result of the reflection of developments in science and technology in the field of education, education systems all over the world have been reinterpreted according to the needs, which has led to the development of new approaches (Karakaya, Ünal, Çimen and Yılmaz, 2018). Emphasizing the facts and definitions in science education unfortunately cannot provide effective learning. Mastery learning is possible by stimulating students mentally and emotionally. Keeping students' innate sense of curiosity alive, and feeling the pleasure and excitement of discovering by the student facilitates the pursuit of knowledge. Because, as Plutarchus stated, "the mind is not a vase to be filled, but a fire to be lit" (Loxley, Dawes, Nicholls and Dore, 2016: 41)

With the increasing importance attached to science education, especially since the second half of the 20th century, it has become inevitable to review science curricula (Ozan and Uluçınar Sağır, 2019). The countries have revised their education systems and turned to different education models to raise individuals with the 21st century qualifications. One of these education models is the STEM education (Yıldırım et. al., 2017).

At this point, STEM is the newest approach to science education. Although there are many definitions of STEM education in the literature, it is generally defined as a new course consisting of the integration of science, technology, mathematics and engineering (Dugger, 2010).

The approaches used by teachers also determine the effectiveness of the teacher factor on course success. Although there are many parameters involved in the increase in students' school success, Sarier (2016) argued in his meta-analysis study that academic achievement within these parameters was directly associated with the students themselves, and their families and teachers. Although the concept of academic achievement or success in education can usually be measured by test scores, grades, or both of them, it is not just comprised of these numbers. Academic achievement enables students to grow up as individuals equipped for professional and social life and shapes their future (Sarier, 2016). It has been concluded that science lessons taught by STEM education have positive effects on students' academic achievement (Gazibeyoğlu, 2018; Nağaç, 2018; Çimentepe, 2019) and their attitudes towards science (Yamak, Bulut and Dündar, 2014).

Researchers have indicated that the solution of a problem cannot be possible with a single study, but scientific knowledge can be achieved by the harmony of the results of experimental studies conducted by various researchers (Çarkungöz and Ediz, 2009). The quantitative data obtained from these studies can be statistically collected by the meta-analysis method. Meta-analysis is briefly called as the analysis of analyses (Ayaz, 2015). In other words, it refers to obtaining a general result by statistically combining the results of different studies on the same subject (Dinçer, 2014).

Research Problem and Sub-Problems

With this study, it was aimed to combine the studies that met the inclusion criteria related to STEM education through meta-analysis and to reach an overall effect size. In line with this aim, answers to the following questions were sought.

The sub-problems determined based on this problem are as follows:

1. When the grade levels (5th grade, 6th grade, 7th grade and 8th grade) in which the studies included in the research were conducted are examined, is there a relationship between the effect sizes of STEM education according to the grade levels?

2. Science course learning areas include "Physical Events", "Matter and Nature", "Living Things and Life" and "Earth and the Universe". One of the studies included in the research applied STEM education by designing activities for all three of the subject areas of "Physical Events", "Matter and Nature", "Living Things and Life". Since this study covers the general learning domains, it was considered under the category of "General". When the learning domains in which the studies were conducted ("Physical Events", "Matter and Nature", "Living Things and Life", "Earth and the Universe" and "General") are examined, is there a relationship between the effect sizes of STEM education according to the learning domains?

3. When the studies included in the research are analyzed according to sample sizes, is there a relationship between the sample sizes of STEM education and the effect size?

When the studies included in the research are examined according to the application time, is there a relationship between the effect sizes of STEM education according to the application time of the studies?

METHOD

Research Model

In the study, meta-analysis method was used to determine the effectiveness of STEM education for science course on students' academic achievement.

Data Collection

The studies to be included in the study consisted of articles, master's and doctoral theses published in scientific journals that met the inclusion criteria related to "STEM Education Approach" in Turkey between 2010-2020.

Master's theses made in Turkey were reviewed in both Turkish and English from the website of council of higher education (YÖK) National Thesis Center between 02.12.2019 and 29.07.2020. In the review, the words "FETEMM", "Akademik başarı" in Turkish and "STEM", "STEAM", "STEM+", "academic achievement", "academic performance", "academic succes" in English were searched in the titles and keywords. YÖK thesis database, ULAKBİM database, Google Academic web pages and the electronic library of İnönü University were used to determine these studies. As a result of the literature review, 63 studies containing at least two of the relevant keywords (e.g., STEM and Academic Achievement, etc.) were found. 37 studies without data conforming to the coding protocol were eliminated. As a result of the reviews, 26 studies that met the inclusion criteria were included in the analysis. The data contained in 2 studies out of the 26 included studies include both t-test results for academic achievement multiple choice test scores and t-test scores for open-ended questions measuring academic achievement. Therefore, the effect sizes of both t-test results in this study were included in the meta-analysis. In conclusion, the total number of studies included in the meta-analysis reached 28.

Acceptance/Inclusion Criteria

The criteria used for the studies included in the research are as follows:

- The study must have been conducted between 2010 and 2020,
- The study must measure academic achievement,
- The study must have been conducted with secondary school 5th, 6th, 7th and 8th grade students,
- The study must have been published in a master's theses, doctoral theses and peer-reviewed scientific journals in Turkey or abroad, the full texts of which can be accessed,

- Lessons must have been taught by traditional teaching methods in the control group of the study and by STEM education in the experimental group,
- The study must include the groups' mean scores on academic achievement, sample sizes and standard deviations, t-score and p-scores.

Exclusion Criteria

- Studies that did not meet the inclusion criteria,
- Studies conducted with highly gifted students or students with special learning difficulties,
- Qualitative studies,

Apart from these criteria, studies that did not contain sufficient numerical data to calculate the effect size were also excluded from the meta-analysis.

Coding of Data

A Coding Form (Annex-1) was prepared in accordance with the aim of the study in order to determine the compliance of the studies with the inclusion criteria in the meta-analysis and to compare the studies with each other. The coding form is the grouping of individual studies within the framework of the research question or hypothesis determined by the researcher (Dinçer, 2014). Some of the features in the coding form are the name of the study, the name of the author, the year of publication, the type of publication, the person who prepared the scale, education level of the students who participated in the study, statistical data used in the study, and the effect size of the study.

Based on the data obtained in the study, the necessary calculations were made using the demo version of the Comprehensive Meta Analysis (CMA) program. Based on the effect size of the individual studies saved in the program, the overall effect size of all studies was calculated according to both the fixed effects model and the random effects model. Since it was found out that the distribution of the effect sizes of the studies was not homogeneous according to the results of the heterogeneity test, analyses were performed using the random effects model. The significance value (p) was determined as 0.05 in the study.

RESULTS

In this section of the study, the statistics obtained from the studies conducted to determine the effect of STEM education on academic achievement in science courses are given in tables.

Results on the Effect Size of the Study

Table 1: Results on Effect Sizes According to Fixed and Random Effects Models

Model	N	Standard error	Heterogeneity				Overall Effect Size	95% Confidence Interval	
			Q	df	p	I ²		Lower Limit	Upper Limit
Fixed Effects	28	0.054	208.884	27	0.000	87.074	1.003	0.896	1.110
Random Effects	28	0.153		27			1.010	0.709	1.310

Before calculating the effect size of the studies, we should first perform homogeneity test according to the fixed effects model in order to determine which effect model we will use. According to the fixed effects model of the studies included in the study, the homogeneity value was calculated as $Q=208.884$. Based on the χ^2 table, it was determined that the corresponding value for $df=27$ at a significance level of 95% was 40.113. The distribution of the effect sizes of the studies has a

heterogeneous structure and the analyses should be performed according to the random effects model. The calculation of the overall effect size as +1.010 according to the random effects model indicates that the effect of the applications is in favor of the experimental group. According to this result, while STEM education has a strong effect on the academic achievement of students in science courses according to Cohen, Manion and Morrison (2007 cited by Saraç, 2018), it has a very large effect on it according to the classification made by Thalheimer and Cook (2003 cited by Bakioğlu and Özcan, 2016).

Şekil.6: Figure 1. Forest plot of the distribution of effect sizes of the studies examining academic achievement according to Hedge's g

When the table given in Figure 1 was examined, the effect size values of the studies included in the meta-analysis were calculated as 2.668 (Aysu, 2019) as the highest and -0.253 (Neccar, 2019) as the lowest.

Results on the Publication Bias of the Study

In this study, Funnel Scatter Plot, Duval and Tweedie (2000) Trim and Fill Method, Orwin's Error Protection Number methods were used to determine the publication bias.

Figure 2. Funnel plot of Hedges g values corresponding to standard error

When the funnel plot was examined, it was found out that the individual studies were distributed close to symmetry, which indicated that there was no publication bias, however, other tests were performed to reach more precise results. In meta-analysis studies, the overall effect size is shown with a solid black diamond at the bottom (Borenstein, Hedges, Higgins and Rothstein, 2009). When the funnel plot was examined, it was observed that the symbol in the form of a solid diamond at the end corresponded to a value of approximately 1. The overall effect size value calculated according to the random effects model was +1.010, which was consistent with the results of our meta-analysis study.

Table 2: Duval and Tweedie Analysis Results of Effect Sizes

Excluded Study	Fixed Effects			Fixed Effects		
	Effect Size.	Lower Limit.	Upper Limit.	Effect Size.	Lower Limit.	Upper Limit.
0						
Observed values	1.00292	0.89614	1.10970	1.00980	0.70936	1.31024
Corrected values	1.00292	0.89614	1.10970	1.00980	0.70936	1.31024

According to the results of Duval and Tweedie Analysis, no virtual study was added or removed to correct the publication bias, which is another indicator of the absence of publication bias.

Table 3: Orwin Protected N Number for Effect Sizes

Element	Values
Standard Mean Difference in the Studies with Values Observed	1.00292
Standard Mean Difference for the "Insignificant" Value	0.01000
Standard Mean Difference Mean in Lost Studies	0.00000
Number of studies required to bring the Standard Mean Difference to less than 0.01	2781.00000

When Table 3 is examined, the error protection number obtained from this meta-analysis study is 2781. This number indicates that there should be 2781 more studies contrary to the results of this

study in the literature so that the results of our study, which consists of 28 studies, to be eliminated. In the literature, there are 26 studies with the features that can be included in the meta-analysis. Since it will not be possible to find 2781 more studies, we can say that there is no publication bias in the results of this study.

Results on the Subgroup Analyses of the Study

Table 4: Effect Size Differences by Learning Domains

Learning Domains	N	Standard error	Heterogeneity				Overall Effect Size	95% Confidence Interval	
			Q	df	p	I ²		Lower Limit	Upper Limit
Living Things and Life	3	0.170	0.857	2	0.000	0.000	0.890	0.557	1.224
Earth and the Universe	2	0.189	0.717	1	0.397	0.000	0.634	0.263	1.005
Physical Events	17	0.224	162.282	16	0.000	90.141	1.268	0.829	1.707
Matter and Nature	5	0.237	12.657	4	0.013	68.398	0.514	0.050	0.978
General	1	0.348	0.000	0	1.000	0.000	0.205	-0.478	0.888
Q _W **			176.514	23	0.000				
Q _B ***			9.742	4	0.045*				

* $p < 0.05$, ** Q_W = Intra-Group Heterogeneity Value, *** Q_B = Intergroup Heterogeneity Value

The studies included in the meta-analysis consisted of the learning domains of "Living Things and Life", "Earth and the Universe", "Physical Events" and "Matter and Nature". However, one of the studies was included in the analysis under the general category since it contained the studies on three different learning domains ("Living Things and Life", "Matter and Nature", "Physical Events"). When the effect sizes were compared according to the learning domains, it was observed that the highest effect size belonged to the learning domain of physical events ($ES=1.268$). It was observed that the smallest effect size value belonged to the general ($ES=0.205$) category. When we applied the intergroup homogeneity test, the equivalent of the degree of freedom in the χ^2 table at a significance level of 95% was found to be 7.815. The homogeneity value between learning domains was $Q_B = 9.472$. Since the intergroup homogeneity value was greater than the critical value, there was a heterogeneous distribution between the effect sizes of the groups. Since the p value was less than 0.05, there was a significant difference among the effect sizes of the learning domains of the studies included in the study in favor of the learning domain of "Physical Events".

Table 5: Effect Size Differences by Sample Size

Sample Size	N	Standard error	Heterogeneity				Overall Effect Size	95% Confidence Interval	
			Q	df	p	I ²		Lower Limit	Upper Limit
1≤N≤50	13	0.170	65.606	12	0.000	81.709	0.868	0.434	1.303
51≤N<	15	0.209	134.211	14	0.000	89.569	1.123	0.714	1.532
Q _W **			0.701	1	0.403				
Q _B ***			199.817	26	0.000*				

*p<0.05, **Q_W= Intra-Group Heterogeneity Value, ***Q_B= Intergroup Heterogeneity Value

When the overall effect sizes were compared according to the sample sizes, it was observed that the overall effect size of the groups with a sample number of greater than 50 (ES=1.123) was higher compared to the groups with a sample number of less than 50 (ES=0.868). When the intergroup homogeneity test was examined, the degree of freedom (df=26) was found to be 38.885 at a significance level of 95% from the χ^2 table. The intergroup homogeneity value created according to the sample number was Q_B =199.817. Since the Q_B value was higher than the critical value in the χ^2 table, the groups had a heterogeneous distribution among themselves. Since the p significance value was less than 0.05, a significant difference was found between the effect sizes of the sample sizes of the studies included in the study. Effect sizes differed in favor of groups with 50 or more samples.

Table 6: Effect Size Differences by Target Groups

Grade	N	Standard error	Heterogeneity				Overall Effect Size	95% Confidence Interval	
			Q	df	p	I ²		Lower Limit	Upper Limit
5 th Grade	3	0.156	1.837	2	0.399	0.000	0.62	0.319	0.933
6 th Grade	9	0.398	129.816	8	0.000	93.837	1.466	0.686	2.247
7 th Grade	10	0.173	30.302	9	0.000	70.299	0.922	0.584	1.261
8 th Grade	6	0.183	11.555	5	0.041	56.728	0.68	0.325	1.041
Q _W **			173.510	24	0.000				
Q _B ***			4.899	3	0.179				

*p<0.05, **Q_W= Intra-Group Heterogeneity Value, ***Q_B= Intergroup Heterogeneity Value

When we compared the overall effect sizes according to the target groups, it was determined that the highest effect size was obtained with the applications performed with the 6th grade students (ES=1.466). It was observed that the lowest effect size was obtained from the lessons taught with the 5th grade students (ES= 0.626). The intergroup homogeneity value was calculated as Q_B = 4.899. The value of the degree of freedom (df=3) was found to be 7.815 at a significance level of 95% from the χ^2 table. There was a homogeneous distribution between the overall effect sizes of the target groups since the intergroup homogeneity value Q_B was less than the critical value. Since the p significance value was greater than 0.05, the studies included in the analysis did not differ significantly in terms of effect sizes.

Table 7: Effect Size Differences by Application time

Applicaton time	N	Standard error	Heterogeneity				Overall Effect Size	95% Confidence Interval	
			Q	df	p	I ²		Lower Limit	Upper Limit
1-4 weeks	16	0.228	165.152	15	0.000	90.917	0.997	0.551	1.443
5-10 weeks	12	0.184	43.099	12	0.000	74.477	1.014	0.653	1.374
Q_W**			208.250	26	0.000				
Q_B***			0.003	1	0.955				

* $p < 0.05$, ** Q_W = Intra-Group Heterogeneity Value, *** Q_B = Intergroup Heterogeneity Value

When we compared the overall effect sizes by application time, it was determined that the overall effect size of the applications that lasted between 5-10 weeks ($ES=1.014$) was higher compared to the applications that lasted between 1-4 weeks ($ES=0.997$). The intergroup homogeneity value was calculated as $Q_B=0.955$. The value of the degree of freedom ($df=1$) was found to be 3.841 at a significance level of 95% from the χ^2 table. The fact that the intergroup homogeneity value was smaller than the Q_B critical value indicated that the intergroup effect sizes had a homogeneous distribution. Since the p value was greater than 0.05, it was concluded that there was no significant difference between the effect sizes of the studies included in the study.

CONCLUSION, DISCUSSION AND RECOMMENDATIONS

While 11.53% of the studies investigating the effect of STEM education on students' academic achievement in science course were conducted with the secondary school 5th grade students, 30.76% of them were conducted with the 6th grade students, 38.46% of them were conducted with the 7th grade students, and 19.23% of them were conducted with the 8th grade students. In the studies conducted at various grade levels, it was observed that STEM education did not differ significantly in terms of students' academic achievement in science course. Nevertheless, less number of STEM studies conducted with the 8th grade students compared to other grades, 8th grade students' preparation for LGS (High School Entrance Exam), and students' intense study along with courses or private lessons in addition to school during the exam preparation process may have an effect.

While 11.53% of the studies investigating the effect of STEM education on the academic achievement of students in science courses included activities suitable for STEM education for the learning domain of "Living Things and Life", 23.07% of them included activities suitable for STEM education for the learning domain of "Matter and Nature", 53.84% of them included activities suitable for STEM education for the learning domain of "Physical Events", 7.69% of them included activities suitable for STEM education for the learning domain of "Earth and the Universe", and 3.84% of them included activities suitable for STEM education for all three learning domains of "Matter and Nature", "Physical Events" and "Living Things and Life". When the results of the subgroup analyses were examined, a significant difference was found between the effect sizes of the learning domains in the categories of "Living Things and Life", "Matter and Nature", "Physical Events", "Earth and the Universe" and "General" in terms of affecting the academic achievement of the students. In the study conducted by Eroğlu and Bektaş (2016), it was concluded that teachers associated the activities suitable for STEM education with physics subjects. Similarly, as a result of this study, it was observed that the activities related to the "Physical Events" learning domain were prepared in 53.84% of the studies included in the meta-analysis. In the study conducted by Çolakoğlu and Günay-Gökben (2017), it is

necessary to increase the competencies of teachers in the field of STEM with in-service training and seminars (Herdem and Ünal, 2018).

When the sample numbers of the researchers in the experimental groups were examined, it was determined that while the sample consisted of 50 and less students in 50% of the 26 studies, the sample consisted of 50 and more students in 50% of them. In the subgroup analyses, it was observed that the effect sizes of the groups formed according to the number of samples differed significantly in terms of affecting the academic achievement of the students, which was due to the fact that the overall effect sizes of the studies with a sample number of 51 and above were higher compared to the studies with a sample number of 50 and less. In experimental studies, the number of subjects is important in terms of both internal and external validity (Büyüköztürk 2016). It is recommended to conduct studies with larger student groups in the future in order to determine the overall effect size most accurately.

When the experimental application times of the studies were examined, while lessons were taught with STEM-based activities for 2 weeks in 3.84% of the studies, they were taught for 3 weeks in 11.53% of them, for 4 weeks in 38.46% of them, for 5 weeks in 11.53% of them, for 6 weeks in 19.23% of them, for 7 weeks in 3.84% of them, for 8 weeks in 7.69% of them, and for 10 weeks in 3.84% of them. When we examined the subgroup analyses, it was observed that the effect sizes of the experimental application times of the studies did not differ significantly in terms of affecting the academic achievement of the students.

Since all of the studies constituting the data set of the study were conducted in Turkey, the overall effect value found as a result of this study is valid for Turkey.

As a result of this meta-analysis, it was concluded that STEM education was more effective in increasing the academic achievement of students in science courses compared to traditional teaching method. Therefore, teachers and pre-service teachers should be encouraged to enrich the course content by using STEM education activities more frequently while teaching science courses.

The multidisciplinary nature of STEM education and inadequate education of science teachers about other fields other than their own fields cause teachers to have difficulties in preparing STEM-based activities (Eroğlu and Bektaş, 2016). It is recommended to provide teachers and pre-service teachers with effective in-service training for the solution of these problems (Öner, Navruz, Biçer, Peterson, Capraro and Capraro, 2014; Öner and Capraro, 2016).

Many countries have started to develop different STEM programs under the influence of the STEM movement that started in the USA. However, the difference in interpretation in STEM programs has led to diversity in applications (Akgündüz and Ertepinar, 2015). Drawing the framework more clearly in the prepared STEM education programs can eliminate the question marks and confusion in the minds of teachers and students in the process of producing STEM-based activities.

In experimental studies, students in the experimental group can get much higher scores than the students in the control group since they are under the influence of innovation. The fact that both the experimental and control groups were trained by the same teacher is also effective in the emergence of this situation. Careful examination of all aspects of the studies included in the meta-analysis and the inclusion of studies above certain standards in the analysis in terms of features such as objectivity, consistency, construct validity and reliability are recommended for a higher quality meta-analysis study.

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Annex 1. Coding Form

Number of the study:

Theme of the study:

Name of the study:

Author's Name:

Year of Publication:

Type of Publication:

Course Domain:

Applied Grade Level:

Analyses Used in the Study:

Scale Type:

Province where the Study is Applied:

Application Time:

Experimental Group Sample Volume:

Control Group Sample Volume:

	Experimental group	Control Group
Pre-test mean score		
S.D.		
Post-test mean score		
S.D.		

59

p Value:

Effect Size

Cohen's *d*:

Annex 2. Number, Mean and Standard Deviation Values of the Experimental and Control Groups of the Studies Combined with the Meta-Analysis Method

Item No	Author	Date	N (e)	X (e)	Sd(e)	N(c)	X(c)	Sd (c)
1	Study İNCE et al.	2018	28	30.10	5.08	30	26.30	4.51
2	Study UÇAR	2019	30	31.46	3.43	30	28.30	4.51
3	Study ŞEN	2019	15	46.73	21.41	15	31.60	14.07
4	Study PARLAKAY	2017	33	63.17	18.86	31	47.90	22.324
5	Study DEDETÜRK et al.	2019	74	14.82	3.54	84	9.93	5.35
6	Çalışma DEDETÜRK et al.	2019	74	33.72	4.95	84	12.35	7.95

7	Study GAZİBEYOĞLU	2018	26	16.46	3.658	26	13.92	4.939
8	Study DOĞANAY	2018	20	82.80	5.81	20	65.50	9.19
9	Study KARCI	2018	28	20.82	3.54	22	17.77	5.73
10	Study NAĞAÇ	2018	24	12.7	5.8	20	10.9	6.1
11	Study ÇALIŞICI	2018	22	27.86	5.24	22	22.13	6.76
12	Study NECCAR	2019	19	71.84	19.66	18	76.66	17.573
13	Study ÇİMENTEPE	2019	23	17.26	3.36	22	12.59	1.99
14	Study ÖZLEN	2019	23	8.173	1.945	24	8.1667	2.973
15	Study ÖZCAN and KOCA	2019	20	148.6	12.75	13	142.3	24.618
16	Study ÖZASLAN	2020	36	75.61	12.8	34	66.33	13.5
17	Study AKKAYA	2019	20	13.80	4.323	20	5.500	1.605
18	Study KURT	2019	13	0.71	0.15	13	0.55	0.12
19	Study KAYABAŞ	2019	20	12.90	4.23	22	9.55	2.74
20	Study İZGİ	2020	25	23.52	4.63	25	16.24	6.44
21	Study GÜNDOĞDU	2019	29	27.28	9.584	30	15.27	4.076
22	Study ÇETİN	2019	20	24.85	0.930	20	18.900	1.370
23	Study CEYLAN	2014	28	17.46	4.11	28	12.89	5.79
24	Study CEYLAN	2014	28	29.82	12.22	28	19.64	11.13
25	Study BÜYÜKBASTIRMACI	2019	41	12.61	0.432	41	8.951	0.600
26	Study BUYRUK	2019	30	5.80	3.08	24	4.96	3.57
27	Study BAHŞİ	2019	18	12.88	4.18	14	12.07	3.54
28	Study AYSU	2019	32	17.68	2.33	32	12.59	1.29