EĞİTİMDE YENİ YAKLAŞIMLAR DERGİSİ
JOURNAL OF NEW APPROACHES IN EDUCATION
Cilt/Volume: 7 | Research Article | Yıl/Year: 2024
Sayı/Issue: 2 | Araştırma Makalesi | ISSN: 2667-5390

TEACHERS' STEM CLUB ACTIVITIES IMPLEMENTATION LEVELS

Dr. Seyide EROĞLU
seyideeroglu@gmail.com
Nuh Mehmet Baldoktu Anatolian High School

Dr. Hasan GÖKÇE
hasangokce3838@gmail.com
Bünyan Topsöğüt Secondary School

Dr. Melek KARACA
melekkaraca38@gmail.com
Independent Researcher

Prof. Dr. Oktay BEKTAŞ
obektas@erciyes.edu.tr
Erciyes University
Department of Science Education

Makale Bilgisi (Article Info): Geliş (Received): **07.08.2024**, Kabul (Accepted): **05.11.2024**, Yayın (Published): **25.12.2024**

ABSTRACT

The aim of this research is to determine the level of implementation of STEM club activities by teachers in schools in terms of teacher, student, planning and implementation dimensions, taking into account gender and seniority variables. The study uses the cross-sectional survey model design and explanatory correlation model. The study has chosen the purposive sampling design. The sample of the research consists of 139 teachers and carried out STEM club activities in the 2019-2020 academic year. The STEM Club Evaluation Scale was used as the data collection tool. As a result of descriptive statistical analyses, the independent samples t-test, correlation and regression analyses, each dimension in the scale was found to statistically significantly predict the level at which teachers implement STEM club activities. In this context, the dimensions of teachers and students explain a high level of the variance in teachers' STEM club activities implementation level, while the dimension of planning and implementation explains this at a moderate level. The study has concluded teachers' STEM club activities implementation level to not differ according to gender in terms of the dimensions of teachers and of planning and implementation, while this level does differ in favor of females in terms of the dimension of students. At the end of the study, suggestions were made that other studies on STEM clubs could be enriched by taking into account different dimensions such as teachers, students, planning and implementation, and that studies examining variables such as gender and professional seniority not only as independent variables but also as moderating and mediating variables could be added to the literature.

Keywords: STEM education, social club studies, quantitative research.

Öğretmenlerin STEM Kulübü Etkinliklerini Uygulama Seviyeleri

ÖZ

Bu araştırmanın amacı, öğretmenlerin STEM kulübü etkinliklerini okullarda uygulama düzeylerini öğretmen, öğrenci, planlama ve uygulama boyutları açısından cinsiyet ve kıdem değişkenlerini dikkate alarak belirlemektir. Araştırmada kesitsel tarama modeli tasarımı ve açıklayıcı korelasyon modeli kullanılmıştır. Araştırmada amaçlı örnekleme seçilmiştir. Araştırmanın örneklemini 2019-2020 eğitim öğretim yılında STEM kulübü etkinlikleri yürüten 139 öğretmen oluşturmaktadır. Veri toplama aracı olarak STEM Kulübü Değerlendirme Ölçeği kullanılmıştır. Tanımlayıcı istatistiksel analizler, bağımsız örneklem t-testi, korelasyon ve regresyon analizleri sonucunda, ölçekte yer alan her bir boyutun öğretmenlerin STEM kulübü etkinliklerini uygulama düzeyini istatistiksel olarak anlamlı şekilde yordadığı bulunmuştur. Bu bağlamda öğretmen ve öğrenci boyutları öğretmenlerin STEM kulübü etkinliklerini uygulama düzeyindeki varyansı yüksek düzeyde açıklarken, planlama ve uygulama boyutu bunu orta düzeyde açıklamaktadır. Öğretmen ile planlama ve uygulama boyutları açısından öğretmenlerin STEM kulübü etkinliklerini uygulama düzeylerinin cinsiyete göre farklılaşmadığı, öğrenci boyutu açısından ise bu düzeyin kadınlar lehine farklılaştığı sonucuna ulaşılmıştır. Çalışma sonunda, STEM kulüpleri ile ilgili diğer çalışmalarda, öğretmen, öğrenci, planlama ve uygulama gibi farklı boyutların da dikkate alınarak çalışmaların zenginleştirilebileceği, cinsiyet ve mesleki kıdem gibi değişkenlerin yalnızca bağımsız değişkenler olarak değil, aynı zamanda düzenleyici ve aracı değişkenler olarak incelendiği çalışmaların alan yazına kazandırılabileceği şeklinde öneriler ortaya konmuştur.

Anahtar Kelimeler: STEM eğitimi, sosyal kulüp çalışmaları, nicel araştırma.

Atıf için (To cite this article):

Eroğlu, S., Gökçe, H., Karaca, M., & Bektaş, O. (2024). Teachers' STEM club activities implementation levels. *Eğitimde Yeni Yaklaşımlar Dergisi (EYYAD), 7*(2), 141-161. https://doi.org/10.70325/eyyad.1529931

INTRODUCTION

STEM education is an innovative and interdisciplinary education strategy. Studies have emphasized the need for STEM education to support raising the new generation of scientists and innovators (Altunel, 2018; Holdren & Lander, 2010). STEM education increases student abilities such as communication and cooperation while also increasing their social and environmental awareness (Thomas, 2014). STEM allows students to carry out collaborative teamwork by bringing real-life problems to in-class or extracurricular activities (Wang, 2012). When evaluated from this aspect, STEM education's philosophical foundations overlap with the social constructivism theory Vygotsky (1978) put forth in terms of content and purpose. According to Vygotsky, learning is an active process affected by one's social and cultural environments. Having students solve real-life problems supports the process of learning, stating in contact with teachers, family communication with teachers, and teacher communication with families. For this reason, this research is philosophically based on Vygotsky's (1978) theory of social constructivism.

STEM education is not often integrated into lessons due to time constraints, course load, and lack of teacher knowledge/experience (National Research Council [NRC], 2009). Due to these and other reasons, STEM activities are generally carried out in non-school learning environments and after-school programs (Sahin et al., 2014; Vandell et al., 2005; Wagner, 2008). STEM activities have been investigated in terms of various variables; extracurricular/after-school activities have been reported to contribute to learning the outcomes of STEM disciplines and students to develop such 21st-century skills and competencies as creativity, innovation, communication, cooperation, and complex problem-solving (NRC, 2009; Sahin, 2015). In addition, students have been found to be able to transfer what they learn in extracurricular STEM activities to daily life (Vandell et al., 2005; Wagner, 2008). Some studies have stated students to gain interest in STEM fields and science courses and to increase their performance in STEM fields through extracurricular STEM activities (Sahin et al., 2014).

Out-of-class STEM activities are commonly carried out through a club (e.g., a STEM club; Gonsalves et al., 2013). STEM clubs carry out activities to support formal education and integrate STEM into lessons during non-school hours. These activities may involve field trips and experimental or research-based studies (Eshach, 2007). The related literature has stated activities carried out in STEM clubs to increase students' academic success in STEM fields and to increase their tendency toward a STEM career (Gottfried & Williams, 2013). In addition, STEM has been reported to support students' skill development (Ferrara et al., 2017). While a limited number of studies are found regarding the effects STEM club activities have on students (Ferrara et al., 2017; Gottfried & Williams, 2013; Sahin, 2013), no study is found to have evaluated STEM club activities in schools. However, evaluating the effectiveness of STEM club activities has great

importance in determining whether STEM activities are planned and carried out in an appropriate framework, in making future improvements, in producing good examples, and in developing an application standard (Nguyen et al., 2020). Therefore, determining teachers' STEM club activities implementation level in schools is necessary. Many studies have tried to determine the level of social club activities' implementation and functionality by taking teachers' opinions (Akay, 2012; Saglam & Yayla, 2014; Polat, 2017). These studies analyzed the teachers by generally evaluating the level to which social clubs are implemented in schools as a medium (Saglam & Yayla, 2014) and how teachers' views differ in terms of various variables (e.g., gender, seniority; Polat, 2017). Teachers have stated social club activities to be carried out with a purpose and to have been planned for improving students' academic success, interests, skills, and competencies (Kose, 2004). Therefore, teachers' opinions on this issue should be taken to acquire information about the effectiveness of STEM club activities carried out in schools. Regarding the effectiveness of STEM clubs, studies have noteworthily mainly included students' opinions (Akar & Nayir, 2015; Gottfried & Williams, 2013; Gogebakan, 2016; Onay, 2012), with a limited number of studies having included teachers' opinions (Ferrara et al., 2017). However, the experience and observations teachers who've implemented the program have about themselves, their students, and the general structure of the practices while performing them in the field have key importance in revealing the current situation. For example, Lang et al (2018) carried out various STEM activities in the STEM maker space club. Despite mainly focusing on students, they also acquired some findings on teachers. Accordingly, they emphasized that teachers should be supported for STEM content and their interest in STEM activities should be increased. In addition, Lang et al. stressed the importance of supporting inter-teacher cooperation, content promotion activities, workshops with application examples, and mentor support. At the end of the study, they determined teachers and teacher candidates to become more motivated in lessons and activities (Lang et al., 2018). Based on this, teachers' motivation toward implementing STEM activities was concluded to have increased, as well as determining the current problems related to the subject and making plans to carry out support studies to be necessary for overcoming these problems. However, no study in the literature is found to have revealed the problems teachers face in implementing STEM club activities in Turkey.

Meanwhile, identifying the problems teachers experience is not enough for being able to present the current picture (Akay, 2012). Again, the need exists to evaluate students' perceptions of the positive and negative aspects of the subject based on teachers' experiences and observations in the field. When examining the subject in terms of students, science lessons supported by after-school club activities have been stated to increase student interest in the subject (Eccles & Barber, 1999), to support meaningful student learning (Gibson & Chase, 2002), and to enable students to develop positive attitudes towards STEM fields (Bell et al., 2009; Gabrielson et al., 2009; Miller et al. 2017; Sahin et al., 2014). Effective execution of STEM club activities has a complementary effect on science subjects and is also important for students. Finally, the applicability of STEM club or social club activities in schools should be revealed from teachers' perspectives. This will allow school administrators to take the precautions needed to eliminate the problems in planning studies and to make the necessary revisions regarding the existing club's contents. When examining related studies, the most common problems can be expressed as school administrations' negative attitudes, schools' limited opportunities, and failures in carrying out school practices according to any standard (Akay, 2012).

In summary, extracurricular STEM club activities positively affect students. No study is found in the literature to have aimed to determine STEM club activities' effectiveness in terms of various variables. The current situation should be revealed in order to improve and eliminate problems in the STEM club activities carried out in schools. Teachers' opinions have key importance in doing this. It has been reported that STEM education is targeted, facilitated and the success of the activities increases in the guiding role in the operation of STEM activities in the relevant field (Han et al., 2015). In addition, factors have an important place in the successful execution of the activities and in the control of their effects. Because it is emphasized that the relevant studies in the literature in the field can develop more comprehensive and inclusive solutions in the activities by directly observing the interests and needs (Shernoff et al., 2017). As a result of these arguments, the decision has been made to conduct such a study.

This study aims to determine teachers' STEM club activities implementation level in schools by taking into account the variables of gender and seniority in terms of the dimensions of teachers, students, and planning and implementation. STEM clubs' effectiveness in schools has been examined in this way in terms of the various dimensions based on the variables of gender and seniority with the aim of determining the interrelationships. Considering the gender variable in this study is a step towards understanding whether the effects of STEM clubs on students vary according to different demographic characteristics. It is seen in the

literature that STEM activities can have different effects according to gender. For example, Carlone and Johnson (2007) emphasized that the experiences of male and female students in participating in STEM activities may differ and that it is especially important to support the interest of female students in STEM fields. Gender is considered one of the factors affecting STEM participation; therefore, observing gender-based differences in STEM clubs can contribute to making the clubs more inclusive and effective. In this way, STEM club activities in schools will be able to be organized and effectively planned, with the deficiencies being identified and measures being taken to eliminate them. This will ensure that STEM club activities in schools are carried out effectively, which will contribute to students benefitting at a high level from STEM club activities. This will also provide a roadmap for facilitating the work of practicing teachers, the administrators responsible for planning implementations, and the high-level officials responsible for planning and executing social events.

The research questions and null hypotheses determined in line with the aims of this study are as follows:

1. At what level do teachers implement STEM club activities concerning the dimensions of "teachers", "planning and implementation" and "students"?
2. Does teachers' STEM club activities implementation level differ according to gender concerning the dimension of "teachers", "planning and implementation" and "students"?

   $H_0$4: The level at which teachers implement STEM club activities concerning the dimension of teacher does not differ according to gender.

   $H_0$5: The level at which teachers implement STEM club activities concerning the dimension of planning and implementation does not differ according to gender.

   $H_0$6: The level at which teachers implement STEM club activities concerning the dimension of students does not differ according to gender.
3. Does teachers' STEM club activities implementation level differ according to professional seniority with respect to the dimension of "teachers", "planning and implementation" and "students"?

   $H_0$7: The level at which teachers implement activities concerning the dimension of teachers does not differ according to professional seniority.

   $H_0$8: The level at which teachers implement STEM club activities concerning the dimension of planning and implementation does not differ according to professional seniority.

   $H_0$9: The level at which teachers implement STEM club activities concerning the dimension of students does not differ according to professional seniority
4. Does a statistically significant relationship exist between the dimensions of "teachers", "planning and implementation" and "students"?

   $H_0$10: No statistically significant relationship exists between the dimensions of teachers and planning and implementation.

   $H_0$11: No statistically significant relationship exists between the dimensions of planning and implementation and students.

   $H_0$12: No statistically significant relationship exists between the dimensions of teachers and students.
5. Do the dimensions of "teachers", "planning and implementation" and "students" predict teachers' STEM club activities implementation level?

   $H_0$13: The dimension of teachers does not predict teachers' STEM club activities implementation level.

   $H_0$14: The dimension of planning and implementation does not predict teachers' STEM club activities implementation level.

   $H_0$15: The dimension of students does not predict teachers' STEM club activities implementation level.
6. Does the level at which the dimensions of "teachers", "planning and implementation" and

"students" predicts teachers' STEM club activities implementation level vary according to the variables of gender and professional seniority?

$H_0$16a: Gender has no moderating role in explaining the relationship between the dimension of teachers and teachers' STEM club activities implementation level.

$H_0$16b: Professional seniority has no moderating role in explaining the relationship between the dimension of teachers and teachers' STEM club activities implementation level.

$H_0$17a: Gender has no moderating role in explaining the relationship between the dimension of planning and implementation and teachers' STEM club activities implementation level.

$H_0$17b: Professional seniority has no mediating role in explaining the relationship between the dimension of planning and implementation and teachers' STEM club activities implementation level.

$H_0$18a: Gender has no moderating role in explaining the relationship between the dimension of students and teachers STEM club activities implementation level.

$H_0$18b: Professional seniority has no moderating role in explaining the relationship between the dimension of students and teachers STEM club activities implementation level.

METHOD

Research Design

This study aims to examine teachers' STEM club activities implementation level in terms of the dimensions of teachers, students, and planning and implementation in terms of the variables of gender and professional seniority. For this purpose, the cross-sectional survey model is used to answer the first nine questions of the research. This model will determine the participants' views on any subject at any time, as well as their knowledge, anxieties, attitudes, skills, and beliefs. The cross-sectional survey model expresses a description of characteristics (Fraenkel & Wallen, 2008). This design has been chosen for determining teachers' opinions regarding STEM club activities, whether their STEM club activities were carried out effectively based on their opinions, and whether this varies concerning the variables of gender and professional seniority. The reason for choosing this model is to be able to describe the level at which teachers implement or plan to implement STEM applications in terms of the different variables and various dimensions.

The explanatory correlation model (Fraenkel & Wallen, 2008) has been used to answer the last nine questions of the research. The reason for choosing this design is to reveal the correlations among the dimensions of teachers, planning and implementation, and students as well as the level at which STEM clubs are generally implemented and to investigate the moderating roles gender and professional seniority may have on the status of these correlations. Thus, teachers' STEM club implementation levels will be analyzed in terms of various variables concerning the different dimensions.

Population and Sample

The target population for this study involves all teachers who conduct STEM club activities in Turkey. Meanwhile, the accessible population includes all teachers in a Central Anatolian province. Tabachnick and Fidell (2001) stated the appropriate sample size for an analysis should be five times the number of items. The STEM Club Evaluation Scale used in the study consists of 29 items, and five times this number of items makes for 145 participants. The sample of the study consists of 139 teachers the authors could access who conducted STEM club activities during the 2019-2020 academic year and this number is approximately five times the number of items. The population size could not be determined because no official record exists regarding how many teachers work on STEM club practices. For this reason, five times the number of items was taken as a reference while determining the sample size. Table 1 provides the frequencies and percentage values regarding the participant teachers' genders and professional seniority.

Table 1. Distribution of Teachers by Gender and Professional Seniority

Demographic features		f	%
Gender	Female	100	71,9
	Male	39	28,1
Professional Seniority	1-5 years	13	9,4
	6-10 years	33	23,7
	11-15 years	45	32,4
	16-20 years	21	15,1
	20 year and above	27	19,4
Total		139	100

Data Collection Tool

The STEM Club Evaluation Scale (SCES) was developed by the authors and used as the measurement tool (Gokce et al., 2022). The SCES is a five-point Likert scale comprising 29 items and three factors. The factor of teachers has 17 items, the factor of planning and implementation has five, and the factor of students has seven. Cronbach's alpha of reliability for the scale was calculated as .92. To examine teachers' STEM club application levels in-depth in terms of the different dimensions, the scale's factors (i.e., teachers, planning and implementation, and students) formed the main variables of the research. In addition, demographic information regarding the variables of gender and professional seniority have also been included in the scale as they directly serve the purpose of the research.

Data Collection Process

The authors considered the principle of voluntariness during the data collection process and based the participants' participation in the study on a completely voluntary basis. The teachers participating in the study were informed about the purpose, scope, and confidentiality principles of the study and it was stated that personal data would be kept anonymous and used only for scientific purposes. The participants filled out the scale knowing that they had the right to withdraw from the study at any time without being under any pressure. The authors collected the study data using Google Forms, taking into account the pandemic conditions in the 2019-2020 academic year. The scale was filled out during a certain time, at the hours when the teachers were available. In addition, the necessary permissions were obtained from the relevant institutions and organizations before the data collection process, and the research was conducted by ethical rules. The obtained raw data were transferred to the program SPSS 25, and reverse-scored items were recoded and prepared for analysis.

Data Analysis

Before analyzing the data obtained from the research, the normality of distribution was examined for each group's scores according to the three dimensions and the variables of gender and professional seniority. As a result of the performed analyses, the scores in terms of the variables of gender and professional seniority for the dimension of students were determined to not be normally distributed; as a result, the 7^{th}, 18^{th}, 32^{nd}, and 70^{th} persons with the respective scores of 7, 12, 15, and 17 at the bottom of the histogram graphs have been excluded. Upon repeating the normality analysis, the scores for all three dimensions and the two variables were determined to have normal distribution; these scores are reported in the section on findings.

Descriptive statistical analyses have been used to answer the first three research questions. The average values of the participants for the three dimensions forming the basis of the research were calculated in SPSS 25. The lowest, highest, and average possible scores the participants could get were calculated for each dimension. For example, five items exist on the 5-point Likert-type scale regarding the dimension of planning and implementation. The lowest score a participant can get for this factor is 5*1 = 5 points, and the highest score is 5*5 = 25 points. The value of the average score for this dimension is 15 (5+25 = 30, and 30 ÷ 2 = 15). As a result of the analysis, the participants' average scores were evaluated as low or high according to the range of the criteria scores (Gursakal, 2012; Karaman & Sahin, 2014). Table 2 provides the criteria scores as determined for the first three research questions.

Table 2. Criteria Score Ranges

Dimension	Lowest	Average	Highest
Teacher	17	51	85
Planning and implementation	5	15	25
Student	7	21	35

To answer the 3rd, 4th, and 5th research questions, the independent samples t-test was performed; one-way analysis of variance (ANOVA) was performed to answer the research's Questions 6, 7, and 8. both analyses were applied to test whether the independent samples differ from each other in terms of a certain variable (Pallant, 2020). The current study has chosen these analyses as it investigates whether a statistically significant difference exists between scores for each dimension according to gender and professional seniority.

Correlation and regression analyses were performed to reveal the status of correlations in terms of the study's three dimensions and two variables for Questions 10, 11, 12, 13, 14, and 15. correlation analyses examine the presence of a relationship between two or more variables as well as the strength of this relationship if one exists; regression analyses examine how the presence of other changes when one specific unit changes. These analyses are the most frequently preferred statistical methods (Fraenkel & Wallen, 2008). This study has chosen correlation and regression analyses due to the study examining teachers' STEM implementation levels concerning the relationships among three dimensions, as well as the variables of gender and professional seniority.

In light of the findings obtained as a result of the relational analyses, regression analyses were performed using the SPSS PROCESS macro plugin developed by Hayes (2013) to answer the last of the research questions. These analyses functionally make sense of the relationships among the variables and explain these relationships using a model (Chatterjee & Hadi, 2015). This type of analysis is preferred for Questions 16, 17, and 18 because the intention is to investigate the moderating effects gender and professional seniority have in explaining the relationships each dimension has with teachers' STEM club implementation levels. Correlation and regression analyses have limitations in modeling such unexpected variables (Hayes & Preacher, 2013).

FINDINGS

The frequency and percentage distributions of the sample are given under the heading Descriptive Statistics Findings, as well as general information about the frequency, mean, mode, median, skewness, and kurtosis values of the sample concerning gender and seniority. The research hypotheses have been analyzed by providing the statistical results between the independent and dependent variables under the heading Inferential Statistics Findings.

Descriptive Statistics Findings

Findings Related to Questions 1, 2, and 3

The first assumption of the t-test and ANOVA analyses, which are appropriate for answering the research questions, requires the data obtained from the sample to be normally distributed (Fraenkel & Wallen, 2008). As a result of the analyses made in this context, the mode, median, and arithmetic mean values from the teachers' SCES scores are seen to resemble each other, with skewness and kurtosis values found between -2 and +2; thus, the data show normal distribution (see Table 3, George & Mallery, 2016). In addition, the range of the mean values for the calculated SCES scores has been classified as high, medium, and low. Accordingly, the mean score is high for the dimension of teachers, medium for the dimension of planning and implementation, and high for the dimension of students.

Table 3. Descriptive Statistics Results

Dimension	Independent variables	Sub Categories	Frequency	Mean	Median	Mod	Skewness	Kurtosis
Teacher	Gender	Female	97	71.87	74.00	80	-.744	-.433
		Male	38	68.26	69.50	82	-.631	-.345
	Professional Seniority	1-5 Years	12	63.17	67.00	72	-.358	-1.586
		6-10 Years	31	68.29	70.00	70	-.441	-1.035
		11-15 Years	44	71.20	74.00	74	-.807	.216
		16-20 Years	21	74.43	77.00	71	-.687	-.759
		21 year and above	27	73.85	76.00	80	-.867	-.001
Planning and implementation	Gender	Female	97	15.49	15.00	14	.021	-.542
		Male	38	15.26	15.00	15	-.442	.228
	Professional Seniority	1-5 Years	12	12.17	13.50	15	-.974	-.489
		6-10 Years	31	15.71	16.00	15	-.146	-.484
		11-15 Years	44	14.64	15.00	15	-.105	-.308
		16-20 Years	21	16.62	18.00	18	-.380	-.416
		21 year and above	27	16.93	17.00	15	.224	-.232
Student	Gender	Female	97	31.30	32.00	35	-1.121	.526
		Male	38	29.32	30	35	-.316	-.918
	Professional Seniority	1-5 Years	12	26.75	27.50	21	.260	-.831
		6-10 Years	31	30.65	32.00	35	-.678	-.690
		11-15 Years	44	30.95	31.50	35	-1.155	.842
		16-20 Years	21	31.52	33.00	35	-1.039	.574
		21 year and above	27	31.67	33.00	35	-1.062	.238

Inferential Statistics Findings

Findings Related to Questions 4, 5, and 6

The study conducted the independent samples t-test analysis to determine the variance in teachers' STEM club activities implementation levels according to gender. As a result of the analysis, the significance value exceeded 0.05 according to the Levene statistical test ($p = .761$ for the dimension of teachers, $p = .501$ for the dimension of planning and implementation, and $p = .125$ for the dimension of students), and no significant variance was detected. The output file displayed a significance value of $p > 0.05$. As a result, the total scores show no statistically significant difference in terms of gender, and hypotheses $H_0$4, $H_0$5, and $H_0$6 are accepted in the study (see Table 4).

Table 4. Independent Samples t-Test Results

Dimension	Variance	Levene statistic		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Teacher	If the variances are equal	.093	.761	-1.872	133	.063	-3.603	1.925
Planning and implementation	If the variances are equal	.455	.501	-.267	133	.790	-.232	.868
Student	If the variances are equal	2.385	.125	-5.519	133	0.13	-1.983	.787

Findings Related to Questions 7, 8, and 9

The study conducted one-way ANOVA to determine the variance in teachers' STEM club activities implementation levels according to the variable of professional seniority. The equality of variances was checked first (see Table 5).

Table 5. Levene Test Results

Dimension	Levene Statistic	df1	df2	Sig.
Teacher	1.782	4	130	.136
Planning and implementation	.544	4	130	.704
Student	.650	4	130	.628

As seen in Table 5, the Levene test showed the significance values to exceed 0.05 (p = .136 for the dimension of teachers, p = .704 for the dimension of planning and implementation, and p = .628 for the dimension of students). Therefore, the analysis was continued due to the assumption of homogeneity of variances being provided. The one-way ANOVA results are given in Table 6.

Table 6. ANOVA Results

					Anova				
Dimensions	**Group**	**N**	**$\bar{x}$**	**ss**	**Source of variance**	**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Teacher	1-5	12	63.17	11.34	Between Groups	1429.274	4	357.318	3.752	.006
	6-10	31	68.29	11.38	Within Groups	12379.763	130	95.229		
	11-15	44	71.20	8.99	Total	13809.037	134			
	16-20	21	74.43	8.66						
	21+	27	73.85	8.99						
Planning and implementation	1-5	12	12.17	3.57	Between Groups	248.042	4	62.010	3.239	.014
	6-10	31	15.71	4.47	Within Groups	2489.040	130	19.146		
	11-15	44	14.64	4.47	Total	2737.081	134			
	16-20	21	16.62	4.91						
	21+	27	16.93	3.96						
Student	1-5	12	26.75	4.67	Between Groups	229.432	4	57.358	3.503	.009
	6-10	31	30.65	4.26	Within Groups	2128.494	130	16.373		
	11-15	44	30.95	4.05	Total	2357.926	134			
	16-20	21	31.52	4.01						
	21+	27	31.67	3.51						

The analysis results show significant values concerning the factors to be less than 0.05. Therefore, the total scores show a statistically significant difference in terms of the variable of professional seniority, and the study's second null hypothesis $H_0$2 has been rejected. Significant differences occurred for the dimensions of teachers and of planning and implementation concerning teachers having between 1-5 years and those with 16-20 years and between those with 1-5 years and those with 20 or more years of seniority; this difference favored the groups with 16-20 years and those with 20 or more years seniority. For the dimension of students, this difference was significant for those with 1-5 years of seniority compared to all other groups, favoring the latter. Based on the present findings, the research's null hypotheses $H_0$7, $H_0$8, and $H_0$9 have been rejected.

Findings Related to Questions 10, 11, and 12

The correlation coefficient was checked to determine the relationships among the dimensions. The relationships between the dimensions of teachers and planning and implementation, of planning and implementation and students, and of teachers and students were examined in this context (Table 7).

Table 7. Relationships between dimensions

Dimension	N	r	p
Teacher-Planning and implementation	135	.283	.001
Planning and implementation-Student	135	.204	.017
Teacher-Student	135	.603	.000

Table 7 reveals a low, positive, and significant relationship to exist between the dimensions of teachers and planning and implementation ($r = .283$, $p < .05$), a significant positive low-level relationship to exist between the dimensions of students and planning and implementation ($r = .204$, $p < .05$), and a significant positive high-level relationship to exist between the dimensions of teachers and students ($r = .603$, $p < .05$). As a result, the research has rejected the null hypotheses $H_0$10, $H_0$11, and $H_0$12.

Findings Related to Questions 13, 14, and 15

The dimension of teachers statistically significantly predicts t teachers' STEM club activities implementation level ($r = .93$), and this relationship explains 86% of the variance (see Table 8). The dimension of planning and implementation statistically significantly predicts teachers' STEM club activities implementation level ($r = 55$), and this relationship explains 30% of the variance (see Table 8). The dimension of teachers statistically significantly predicts teachers' STEM club activities implementation level and this relationship explains 56% of the variance (see Table 8). As a result, null hypotheses $H_0$13, $H_0$14, and $H_0$15 have been rejected based on these findings.

Table 8. Regression Analysis Results Concerning the Dimension's Ability to Predict SCES Implementation Levels

Dimension	Variable	B	Standard error $_B$	β	T	p	Binary	Partial
Teacher	Fixed	19.580	3.418	-	5.729	.000	-	-
	Teacher	1.375	.048	.928	28.800	.000	.928	.928
	R= .928.	R^2= .862						
	$F_{(1, 133)}$= 829.430	p= .000						
Planning and implementation	Fixed	88.843	3.877	-	22.917	.000	-	-
	Planning and implementation	1.826	.241	.549	7.572	.000	.549	.549
	R= 549,	R^2= .296						
	$F_{(1, 133)}$= 57.332	p= .000						
Student	Fixed	34.669	6.409	-	5.409	.000	-	-
	Student	2.679	.207	.747	12.967	.000	.747	.747
	R= 747,	R^2= .558						
	$F_{(1, 133)}$= 168.154	p= .000						

Findings Related to Questions 16, 17, and 18

Analyses were made based on Model 1 in SPSS PROCESS macro to measure regulatory effects (Hayes, 2013). When examining the moderating effect results given in Table 9, gender is seen to have a moderating effect on the relationship between the dimension of teachers and teachers' STEM club activities implementation level at a 95% CI [0.125, .4196] (ß = .2161; p = .0377). Therefore, $H_0$16a is rejected. When examining the conditional effects of the focal predictor on gender's moderating value, the value was determined as t = 14.35 for male teachers and t = 24.86 for female teachers. This mediating effect resulted in a significant change in the total variance ($p < 0.05$). When examining the results of the mediating effect as given in Table 9 at the 95% CI [-0.0275, .1215], professional seniority is seen to have no significant mediating effect on the relationship between the dimension of teachers and teachers' STEM club activities implementation levels (ß = .0470; p = .2141). As a result, $H_0$16b has been accepted.

When examining the results in Table 9 for the mediating effect of gender on the relationship between teachers' STEM club activities implementation levels and the dimension of planning and implementation at a 95% CI [-0.1172, 1.9524]; gender is seen to have no mediating effect (ß = .9176; p = .0817). Therefore, $H_0$17a has been accepted. When examining Table 9 in terms of professional seniority's mediating effect on this same relationship at a 95% CI [-0.0775, .7042], no mediating effect is seen on the relationship for the dimension of planning and implementation with teachers' STEM club activities implementation levels (ß = .3133; p = .1152). As a result, $H_0$17b has been accepted.

Table 9 also shows the mediating effect of gender on the relationship between the dimension of students and teachers STEM club activities implementation level at a 95% CI [-0.1802, 1.5774]. Gender is seen to have no effect (ß = .6986; p = .1182). As a result, $H_0$18a has been accepted. When examining the mediating

effect of professional seniority on this same relationship at a 95% CI (-0.2472, .3910), professional seniority is seen to have no mediating effect (ß = .0719; p = .6565). As a result, $H_0$18b has also been accepted.

Table 9. Analysis Results of the Mediating Effects of Gender and Professional Seniority

Dimension	Variable	Coefficient (ß)	Standard error	t	p	R^2	LLCI	ULCI
Teacher	Int_gender	.2161	.1029	2.0997	.0377	.87	.0125	.4196
	Int_ professional seniority	.0470	.0377	1.2481	.2142	.87	-.0275	.1215
Planning and implementation	Int_gender	.9176	.5231	1.7541	.0817	.34	-.1172	1.9524
	Int_ professional seniority	.3133	.1976	1.5859	.1152	.36	-.0775	.7042
Student	Int_gender	.6986	.4442	1.5725	.1182	.57	-.1802	1.5774
	Int_ professional seniority	.0719	.1613	.4458	.6565	.59	-.2472	.3910

DISCUSSION and CONCLUSION

This study has aimed to determine teachers' STEM club activities implementation levels in schools by taking into account the variables of gender and seniority in terms of the dimensions of teachers, students, and planning and implementation. Accordingly, the research has concluded each dimension in the scale to statistically significantly predict teachers' STEM club activities implementation level. In this context, the dimensions of teachers and students predict at greater levels teachers' STEM club activities implementation level, whereas the dimension of planning and implementation predicted this at a moderate level. In parallel with the literature, the dimensions of teachers (Ferrara et al., 2017), planning and implementation (Young et al., 2017), and students (Carver & Iruka, 2006; Sahin et al., 2014) in particular have been preferred for examining teachers' STEM club activities implementation level in more detail. To interpret teachers' STEM club activities implementation levels from different perspectives, the correlations between these three dimensions were also examined. According to the results from the research, a low correlation exists between the dimension of planning and implementation and other two dimensions, while a statistically significant high-level correlation was found between the dimensions of teachers and students. Young et al.'s (2017) study concluded the quality and planning of extracurricular STEM practices to affect students' interest in STEM fields. While students were determined as having high interest levels in quality STEM applications that were well-planned/designed, no remarkable increase was observed in students' interest toward STEM fields for poorly planned or medium-quality STEM applications. Thus, the planning and quality of extracurricular STEM practices (e.g., STEM club activities) have an observable effect only for those that have high quality levels and are well-planned. Therefore, the planning and quality of STEM club activities need to be improved, as a low-level correlation has been found between the dimension of planning and implementation dimension and the other two dimensions, which is why this dimension can moderately explain teachers' STEM club activities implementation levels. Another reason may be that the scale's dimension of planning and implementation is less representative of teachers' STEM club activities implementation levels compared to the other two dimensions.

Teachers' STEM Club Activities Implementation Level in Terms of the Dimensions

The Dimension of Teachers

Teachers have a perception that STEM club activities are applied at a high level in schools. The participants can be stated as having positive perspectives regarding how STEM club activities are implemented. Social club activities have generally been determined to be carried out in schools at a moderate level (Gokyer & Zincirli, 2011; Saglam & Yayla, 2014). Other studies have underlined club activities only remain on paper with no actual activities (Gokyer & Zincirli, 2011) or with activities that are unable to be carried out effectively (Onay, 2012; Timurlenk, 1998). These results are different from those in many studies in the literature. Our study may have seen such a difference arise because the teachers answered the questions with a more optimistic approach and by taking into account their practices. The fact that the teachers who participated in our study were implementing STEM activities with their efforts may have caused them to

think this way.

The Dimension of Planning and Implementation

Teachers have the perception that STEM club activities are implemented at a moderate level in terms of planning and implementation in schools. This situation brings to mind various problems in schools such as lack of materials; financial resources being inaccessible, inadequate opportunities; and planning, execution, and orientation problems related to club activities (Yaman & Ersal, 2015). These and similar problems in schools can be said to negatively affect STEM club activities. It may also make it difficult for teachers who are willing to implement it.

The Dimension of Students

We have concluded teachers to have the perception that STEM club activities are implemented at a high level for students in schools. This result is consistent with those in the literature regarding the positive effects extracurricular club activities have on students (Sahin et al., 2014; Young et al., 2017). These studies stated extracurricular club activities to increase student interest in STEM fields (Young et al., 2017) and student motivation toward lessons, as well as to support their future professional inclination toward STEM fields (Sahin, 2013). For this reason, the dimension of students can be determined to have a high impact on teachers' STEM club activities implementation levels. According to the results from Akay's (2012) study on teachers, properly planned social club activities were additionally underlined to contribute directly to education by creating positive effects for students and teachers. This result supports ours where teachers were determined to have high STEM club activities implementation levels in terms of the dimensions of students and teachers.

The Level at Which Teachers Implement STEM Club Activities in Terms of Gender

The Dimension of Teachers

Our study has concluded teachers' STEM club activities implementation levels do not vary according to gender in terms of the dimension of teachers. Similarly, many studies investigating the functionality of social clubs have shown gender to make no significant difference in terms of teachers and students (Gogebakan, 2016; Onay, 2012). For example, Onay (2012) sought teachers', students', administrators', and parents' opinions regarding the effectiveness of social club practices. Accordingly, their research results determined no significant difference existed in terms of gender for any of the participant groups.

Meanwhile, studies are also found in the literature to have differing research results (Akay, 2012; Dabney et al., 2012; Saglam & Yayla, 2014). For example, Sağlam and Yayla found a significant difference to exist in terms of gender for all but two dimensions (i.e., individual and disciplinary dimensions) in their study on 412 teachers for determining the functionality of social club activities. The difference favored boys, who had more positive views on the functionality of social clubs. Because this study focused only on the teacher dimension of STEM clubs, their scale items had a different scope than the scale in our study. This may be one of the reasons for the difference in research results.

In addition, no significant difference has been found in terms of gender in studies in the literature carried out based on various variables such as interest (Carlone & Johnson, 2007), attitude (Karakaya & Avgin, 2016), academic achievement (Ayaz et al., 2020), or awareness (Sahin et al., 2014) toward STEM. This may be due to gender not making a difference in STEM-related fields, and the reason for this is that STEM's multi-disciplinary structure addresses participants' different interests and personal characteristics.

Although gender as an independent variable made no significant difference, gender did have a moderating effect in favor of girls on the relationship between the dimension of teachers and teachers' STEM club activities implementation level. The reason for this result differing from those in the literature may be that the moderating variable analysis offers a deeper statistical perspective that reveals the factors affecting the relationship (Hayes, 2013). Young et al. (2017) examined the effects extracurricular STEM practices have on students' STEM interests by examining studies published between 2009 and 2015. They did not identify the variables for this effect, only aiming to reveal those with the greatest effect. They found academic and socially oriented extracurricular STEM practices to have the greatest impact on increasing STEM-related areas. In addition, they determined gender to have no moderating effect on students' interest in STEM. The current study determined gender to only have a moderating effect for the dimension of teachers, with no moderating effect from gender being detected for the dimension of students. The reason for such a result

may be that teachers play a more active role in club practices.

The Dimension of Planning and Implementation

We have concluded teachers' STEM club activities implementation levels in schools do not differ according to gender in terms of the dimension of planning and implementation. When examining the studies in the literature investigating the effectiveness of extracurricular STEM activities or social club activities (Kilicarslan, 2009; Yigit, 2008; Young et al., 2017), the dimension of planning and implementation was seen to have not been investigated. On the other hand, studies have noteworthily investigated the effectiveness of extracurricular STEM activities or social club activities in terms of other dimensions. For example, Yigit (2008) aimed to evaluate the effectiveness of student clubs implemented in high schools in terms of students' and teachers' attitudes. Their study examined the effectiveness of the practices under the dimensions of continuity, planning, participation, volunteering, and productivity. Kilicarslan (2009) also revealed four different dimensions in his research on social contribution, loss of functionality, teacher willingness, and student participation. We argue that the dimension of planning and implementation should also be included in STEM club research due to the idea that teachers as the practitioners of STEM clubs will provide more effective practices for students through good planning. Thus, we think that by looking at STEM club research from this perspective, versatile and profound results will be obtained that can contribute to the field.

The Dimension of Students

Our study has found teachers' STEM club activities implementation level at schools to vary in favor of females in terms of the dimension of students. The literature shows no study to have attempted to reveal teachers' STEM club activities implementation levels according to the dimension of students. On the other hand, many studies exist in the literature in which students have evaluated the effectiveness of extracurricular STEM or social club activities (Akar & Nayir, 2015; Gottfried & Williams, 2013; Gogebakan, 2016; Onay, 2012). For example, Gogebakan (2016) tried to determine the effectiveness of social club activities in high schools concerning students' opinions and found gender to have no significant effect on their views toward social club practices. Likewise, Akar and Nayir (2015) and Onay (2012) reached similar results. The fact that female teachers consider club activities to be implemented at a higher level for students reveals a different perspective from the literature. In addition, although students' views on the implementation of social club activities are at a moderate level, the high level at which female teachers perceive this situation draws attention to a different result. This contradiction suggests that teachers cannot evaluate students' situations or that students have difficulty evaluating themselves objectively. For this reason, increasing the number of scales similar to the one used in this study and examining the views of teachers and students about the current situation comparatively are thought to be beneficial.

Another study whose results support those from the current research is Akar and Nayir's (2015) study, which involved students' opinions about the ineffectiveness of social club activities. Accordingly, approximately 89% of students were identified to have presented the factor of teachers as the reason for social clubs' ineffectiveness. This situation supports the current study's result revealing a significant and positive high-level relationship between the dimensions of teachers and students.

Teachers' STEM Club Activities Implementation Level in Terms of Professional Seniority

The Dimension of Teachers

We found teachers' STEM club activities implementation level in schools to differ according to professional seniority in terms of the dimension of teachers. As teachers' professional seniority increases, so does their STEM club activities implementation level. Gokyer and Zincirli (2011) also concluded teachers' STEM club activities implementation level to increase alongside their professional seniority. Ayers et al. (2020) revealed the effect of extracurricular STEM club activities, underlining a teacher profile with high qualifications needed for carrying out an effective club study and increasing the effectiveness of club activities for students. This result has been evaluated alongside the results from the current study because one of the factors required for a high teacher profile is professional experience. For this reason and due to efforts carried out by teachers with more professional experience being more effective, this situation can be considered to result in the perception of STEM club activities being implemented at high levels. Therefore, teachers can be considered to gain experience alongside their professional seniority and therefore can implement social club activities more effectively.

Studies are also found in the literature to have reached different results than those from the current research (Kirdar, 2002; Saglam & Yayla, 2014). For example, Saglam and Yayla examined the effectiveness of social clubs in terms of various variables and found young teachers with less professional seniority to report more positive opinions about the functionality and operability of social club activities compared to teachers with more professional seniority. Akay (2012) also examined the problems teachers encounter while carrying out social club activities and stated young teachers with less seniority are more successful in conducting social club activities. On the other hand, studies are also found in the literature to have concluded no significant relationship exists between the effectiveness of social club activities and professional seniority (Ekmekci, 2006; Polat, 2017; Yigit, 2008). The reason for these different results in the literature in terms of professional seniority may be due to the different samples being used or to the structure of the data collection tool.

The Dimension of Planning and Implementation

We have obtained the result that teachers' STEM club activities implementation level in schools differs according to professional seniority in terms of the dimension of planning and implementation. Teachers with higher professional seniority were determined to have higher STEM club activities implementation levels in terms of the dimension of planning and implementation. One of the obstacles mentioned in the literature regarding social club activities is planning and implementation. As a proposed solution to these obstacles, supporting teachers with pre-service and in-service training has been expressed so that they have sufficient knowledge and tools (Karakucuk, 1997). From this point of view, because having greater professional experience allows teachers to be able to cope with the problems related to planning and implementation, teachers with higher professional seniority may be thought to perceive their STEM club activities implementation level to be higher in terms of the dimension of planning and implementation.

The Dimension of Students

We have concluded teachers' STEM club activities implementation level in schools differ according to professional seniority in terms of the dimension of students. Teachers with higher professional seniority were determined to have higher STEM club activities implementation levels concerning the dimension of students. No study is found to have reached a result directly related to this in the relevant literature. As stated before, studies should take the dimension of students, who are the addressees of STEM clubs, into consideration due to its importance for the program's effectiveness.

In summary, teachers' STEM club implementation levels are related to the dimensions of teachers, planning and implementation, and students. These three dimensions have also been determined to be related to one another. As predicted by social constructivism, a high-level relationship has been determined between the dimensions of students and teachers. Teachers are seen to have the perception that STEM club activities are implemented at a high level in terms of the dimensions of teachers and students and at a moderate level in terms of the dimension of planning and implementation. Gender has also been concluded to be effective regarding the dimension of students and to have a mediating effect on the dimension of teachers. Increases in professional experience have also been observed to correlate to higher implementation levels of STEM club activities for all three dimensions.

SUGGESTIONS

- The dimensions of teachers, students, and planning and implementation should be taken into consideration in research on STEM club studies.
- Variables such as gender and professional seniority can be examined not only as independent variables but also as moderating and mediating variables.
- Analyses of STEM club research that have not used the variables of gender or professional seniority can be further validated by checking against these variables to obtain more realistic results.
- Quantitative research can be conducted to investigate the efficiency of STEM club activities by using a sample that includes teachers, students, parents, and administrators. Mixed-methods studies can be conducted by interviewing the participants selected from the quantitative phase of the research. Thus, the causal relationships revealed by quantitative research can be investigated in depth.
- Separate scales for the dimensions of teachers, planning, and implementation, and students from

the scale used in the study can be developed, and these dimensions can be examined in more detail. Thus, suggestions for measures or practices to be taken to make STEM clubs more efficient can be obtained from three different perspectives.

- In order to make STEM club activities more effective, teachers and students can be supported with in-service training.
- Possible problems that teachers may encounter in the planning and implementation stages and solution suggestions can be investigated.
- The reasons for the low participation of early students in STEM club activities can be investigated. In light of the data obtained, arrangements can be made in club planning.

Ethical Statements

This study was not supported by any institution. There is no conflict of interest among the researchers. This study was conducted in accordance with ethical rules. Researchers' contribution rate to the article is as follows: 1st researcher 30%, 2nd researcher 30%, 3rd researcher 30%, 4th researcher 10%.

REFERENCES

Akar, F., & Nayir, K. F. (2015). Examining effectiveness of social clubs in educational organizations: Need for change in implementation. *Pegem of Education and Instruction, 5*(2), 167-186. https://doi.org/167-186. 14527/pegegog.2015.009

Akay, S. (2012). *Teachers 'attitudes to club social studies and analysis of the problems encountered in these studies: For Gediz district (*Publication No. 313322). [Unpublished master's thesis, Yeditepe University]. The Thesis Database of the Turkish Council of Higher Education.

Altunel, M. (2018). STEM education and Turkey: opportunities and risks. *Seta Perspective, 207*, 1-7.

Ayaz, M., Gulen, S., & Gok, B. (2020). Examination of the effect of electronic portfolio use on the academic achievement and STEM attitude of eighth grade students in the application process of STEM activities. *Journal of Education Faculty, 17*(1), 1153-1179. https://doi.org/10.33711/yyuefd.801394

Ayers, K. A., Wade-Jaimes, K., Wang, L., Pennella, R. A. ve Pounds, S. B. (2020). The St. Jude STEM Clubs: An Afterschool STEM Club for Upper Elementary School Students in Memphis, TN. *Journal of STEM outreach*, *3*(1), 1-14. https://dx.doi.org/10.15695%2Fjstem%2Fv3i1.13

Bell, R. L., Blair, L. M., Crawford, B. A., & Lederman, N. G. (2009). *The nature of science and scientific inquiry as contexts for the learning of science and achievement of scientific literacy*. International Journal of Science Education, 25(9), 1147–1178. https://doi.org/10.1080/0950069022000016942

Carlone, H. B., & Johnson, A. (2007). Understanding the science experiences of successful women of color: Science identity as an analytic lens. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, *44*(8), 1187-1218. https://doi.org/10.1002/tea.20237

Carver, P. R., & Iruka, I. (2006). *National Household Education Surveys program of 2005: After-school programs and activities: 2005*. National Center for Education Statistics.

Chatterjee, S., & Hadi, A. S. (2015). *Weighted least squares. Regression analysis by example*. 5th edition, Wiley, 179-196.

Dabney, K. P., Tai, R. H., Almarode, J. T., Miller-Friedmann, J. L., Sonnert, G., Sadler, P. M., & Hazari, Z. (2012). Out-of-school time science activities and their association with career interest in STEM. *International Journal of Science Education, Part B*, *2*(1), 63-79. https://doi.org/10.1080/21548455.2011.629455

Eccles, J. S., & Barber, B. L. (1999). Student council, volunteering, basketball, or marching band: What kind of extracurricular involvement matters? *Journal of Adolescent Research, 14*(1), 10–43. https://doi.org/10.1177/0743558499141003

Ekmekci, A. (2006). *Sufficiency level of educative branch training in the first grade of primary school* (Publication No. 187354). [Unpublished master's thesis, Zonguldak Karaelmas University]. The Thesis Database of the Turkish Council of Higher Education.

Eshach, H. (2007). Bridging in-school and out-of-school learning: Formal, non-formal, and informal education. *Journal of science education and technology, 16*(2), 171-190. https://doi.org/10.1007/s10956-006-9027-1

Ferrara, M., Mason, H., Wee, B., Rorrer, R., Jacobson, M., & Gallagher, D. (2017). Enriching undergraduate experiences with outreach in school STEM clubs. *Journal of College Science Teaching, 47*(6), 74. https://doi.org/10.31235/osf.io/k7kwn

Fraenkel, J. R., & Wallen, N. E. (2008). *How to design and evaluate research in education* (7th Edition). Boston, McGraw-Hill.

Gabrielson, I., Lu, Y., & Nath, S. R. (2009). *STEM club participation: Increasing engagement in science and technology*. Journal of Science Education and Technology, 18(4), 337–347. https://doi.org/10.1007/s10956-009-9147-7

George, D., & Mallery, P. (2016). *IBM SPSS statistics 26 step by step: A simple guide and reference*. (14th ed.). Routledge.

Gibson, H. L., & Chase, C. (2002). Longitudinal impact of an inquiry-based science program on middle school students' attitudes toward science. *Science Education, 86*(5), 693–705. https://doi.org/10.1002/sce.10039

Gogebakan, M. (2016). *The effectiveness of social club activities in high schools.* (Publication No. 440724). [Unpublished master's thesis, Istanbul Sabahattin Zaim University]. The Thesis Database of the Turkish Council of Higher Education.

Gokce, H., Eroglu, S., Karaca, M., & Bektas, O. (2022). STEM club evaluation scale: validity and reliability study. *Journal of Science Learning, 5*(2), 250-265. http://dx.doi.org/10.17509/jsl.v5i2.39826

Gokyer, N., & Zincirli, M. (2011). The perceptions of advisors and social club representative students on the level of realization of social club activities performed. *E-Journal of New World Sciences Academy Education Sciences*, *6*(2), 1836-1851.

Gonsalves, A., Rahm, J., & Carvalho, A. (2013). "We could think of things that could be science": Girls' re-figuring of science in an out-of-school-time club. *Journal of Research in Science Teaching, 50*(9), 1068-1097. https://doi.org/10.1002/tea.21105

Gottfried, M. A., & Williams, D. N. (2013). STEM club participation and STEM schooling outcomes. *Education Policy Analysis Archives/Archivos Analíticos de Políticas Educativas, 21*, 1-24. http://epaa.asu.edu/ojs/article/view/1361

Gursakal, S. (2012). An evaluation of PISA 2009 student achievement levels' affecting factors. *Suleyman Demirel University Journal of Faculty of Economics & Administrative Sciences, 17*(1), 441-452.

Han, S., Capraro, R., & Capraro, M. M. (2015). How science, technology, engineering, and mathematics (STEM) project-based learning (PBL) affects high, middle, and low achievers differently: The impact of student factors on achievement. *International Journal of Science and Mathematics Education, 13*(5), 1089-1113. https://doi.org/10.1007/s10763-014-9526-0

Hayes, A. F. (2013). *Introduction to mediation, moderation, and conditional process analysis. A regression-based approach.* New York, NY: The Guilford Press.

Hayes, A. F., & Preacher, K. J. (2013). Conditional process modeling: Using structural equation modeling to examine contingent causal processes. In G. R. Hancock & R. O. Mueller (Eds.), *Structural equation modeling: A second course* (2 ed., pp. 217–264). Greenwich, CT: Information Age.

Holdren, J. P., & Lander, E. (2010). Prepare and inspire: K-12 science, technology, engineering, and math

(STEM) education for America's future. *Executive Office of the President, The President's Council of Advisors on Science and Technology*. Retrieved from https://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-stem-ed-final.pdf

Karakaya, F., & Avgin, S. S. (2016). Effect of demographic features to middle school students' attitude towards FeTeMM (STEM). *Journal of Human Sciences*, *13*(3), 4188-4198.

Karakucuk, S. (1997). Recreation leisure time evaluation concept scope and a research. *Seren Ofset, Ankara*, 30-51.

Karaman, P., & Sahin, C. (2014). Investigating the assessment literacy of teacher candidates. *Ahi Evran University Journal of Kırşehir Education Faculty (KEFAD), 15*(2), 175-189.

Kilicarslan, T. (2009). *Teachers' attitudes of educational club activities* (Publication No. 239207). [Unpublished master's thesis, Yeditepe University]. The Thesis Database of the Turkish Council of Higher Education.

Kirdar A. (2002). *The Adequancy level of educational club stuties at the first step of primary schools* (Publication No. 108730). [Unpublished master's thesis, Sakarya University]. The Thesis Database of the Turkish Council of Higher Education.

Kose, E. (2004, July). *The reasons why primary school students prefer extracurricular activities*. 13. National Educational Sciences Congress, Malatya.

Lang, C., Powell, G., Moore, N. J., & Ibrahim, F. (2018). Connecting teachers, students and pre-service teachers to improve STEM pathways in schools. *International Journal of Innovation in Science and Mathematics Education*, *26*(8), 45-66.

Miller, K. W., Sonnert, G., & Sadler, P. M. (2017). The influence of specific STEM extra curricular activities on career choice. *International Journal of Science Education, 39*(9), 1209–1228. https://doi.org/10.1080/09500693.2017.1328466

National Research Council. (2009). *Learning science in informal environments: People, places, and pursuits*. Retrieved from http://www.nap.edu/catalog.php?record_id=12190

Nguyen, T. T. K., Van Bien, N., Lin, P. L., Lin, J., & Chang, C. Y. (2020). Measuring teachers' perceptions to sustain STEM education development. *Sustainability*, *12*(4), 1-15. https://doi.org/10.3390/su12041531

Onay, I. (2012). *Evaluation of student-teacher-parent and administrator views about the efficiency of student club practices in primary schools* (Publication No. 308761). [Unpublished master's thesis, Ondokuz Mayıs University]. The Thesis Database of the Turkish Council of Higher Education.

Pallant, J. (2020). *SPSS user guide Step-by-step data analysis with SPSS*. (S. Balcı and B. Ahi, Translation). Ankara: Memoir Publishing.

Polat, B. S. (2017). *Investigation of opinions of administrators, teachers and students about the effectiveness of social club activities in secondary schools* (Publication No. 458740). [Unpublished master's thesis, Ataturk University]. The Thesis Database of the Turkish Council of Higher Education.

Saglam, A., & Yayla, A. (2014). Views of teachers towards functions of social clubs implemented in primary and secondary schools. *Ahi Evran University Journal of Kırşehir Education Faculty (KEFAD)*, *15*(2), 279-296.

Sahin, A. (2013). STEM clubs and science fair competitions: Effects on post-secondary matriculation. *Journal of STEM Education: Innovations and Research*, *14*(1), 5-11.

Sahin, A., (2015). STEM Students on the Stage (SOS): Promoting Student Voice and Choice in STEM Education through an Interdisciplinary, Standards-focused Project Based Learning Approach. *Journal of STEM Education, 16*(3), 24-33.

Sahin, A., Ayar, M. C., & Adıguzel, T. (2014). STEM related after-school program activities and associated outcomes on student learning. *Educational Sciences: Theory and Practice, 14*(1), 309-322. http://dx.doi.org/10.12738/estp.2014.1.1876

Shernoff, D. J., Sinha, S., Bressler, D. M., & Ginsburg, I. (2017). Assessing teacher education and professional development needs for the implementation of integrated approaches to STEM education. *International Journal of STEM Education, 4*(1), 1-16. https://doi.org/10.1186/s40594-017-0068-1

Tabachnick, B. G., & Fidell, L. S. (2001). *Using Multivariate Statistics*. Pearson Education Company.

Thomas, T. A., (2014). *Elementary teachers' receptivity to integrated science, technology, engineering, and mathematics (STEM) education in the elementary grades* (Publication No. 3625770). [Doctoral dissertation, University of Nevada]. ProQuest Dissertations and Theses Global.

Timurlenk, M. (1998). *The Administration of the educational club activities at secondary schools (Kars example)* (Publication No. 72903). [Unpublished master's thesis, Dokuz Eylul University]. The Thesis Database of the Turkish Council of Higher Education.

Vandell, D. L., Pierce, K. M., & Dadisman, K. (2005). Out-of-school settings as a developmental context for children and youth. *Advances in Child Development and Behavior, 33*, 43-77. https://doi.org/10.1016/S0065-2407(05)80004-7

Vygotsky, L. (1978). Interaction between learning and development (p.79-91). *In Mind in Society*. (Trans. M. Cole). Cambridge, MA: Harvard University Press.

Wagner, T. (2008). Rigor redefined. Educational Leadership, 66(2), 20–24.

Wang, H. (2012). *A New era of science education: science teachers' perceptions and classroom practices of science, technology, engineering, and mathematics (STEM) integration.* (Publication No. 3494678). [Doctoral dissertation]. Retrieved from Proquest.

Yaman, E., & Ersal, Ö. (2015). Problems and solutions encountered in social clubs. *International Peer-Reviewed Journal of Humanities and Academic Science, 4*(11), 238–254.

Yıgıt, N. (2008). *The evaluation of the student club in high schools* (Publication No. 229241). [Unpublished master's thesis, Anadolu University]. The Thesis Database of the Turkish Council of Higher Education.

Young, J. R., Ortiz, N., & Young, J. L. (2017). STEMulating interest: A meta-analysis of the effects of out-of-school time on student STEM interest. *International Journal of Education in Mathematics, Science and Technology*, *5*(1), 62-74. https://10.18404/ijemst.61149

GENİŞLETİLMİŞ ÖZET

STEM eğitimi yenilikçi ve disiplinler arası bir eğitim stratejisidir. Araştırmalar, yeni nesil bilim insanlarının ve yenilikçilerin yetiştirilmesini desteklemek için STEM eğitimine duyulan ihtiyacı vurgulamaktadır (Altunel, 2018; Holdren ve Lander, 2010). STEM eğitiminin felsefi temelleri, içerik ve amaç açısından Vygotsky'nin (1978) ortaya koyduğu sosyal yapılandırmacılık kuramı ile örtüşmektedir. Bu nedenle bu araştırma felsefi olarak Vygotsky'nin (1978) sosyal yapılandırmacılık teorisine dayanmaktadır. STEM eğitimi, zaman kısıtlamaları, ders yükü ve öğretmen bilgi/deneyim eksikliği gibi nedenlerle genellikle derslere entegre edilememektedir (National Research Council [NRC], 2009). Bu ve benzeri nedenlerden dolayı STEM etkinlikleri genellikle okul dışı öğrenme ortamlarında ve okul sonrası programlarda gerçekleştirilmektedir (Şahin vd., 2014; Vandell vd., 2005; Wagner, 2008). Ders dışı STEM etkinlikleri yaygın olarak bir kulüp aracılığıyla yürütülür (örneğin, bir STEM kulübü; Gonsalves vd., 2013). STEM kulüpleri, örgün eğitimi desteklemek ve STEM'i okul dışı saatlerde derslere entegre etmek için faaliyetler yürütür. Bu faaliyetler saha gezileri ve deneysel ya da araştırmaya dayalı çalışmaları içerebilir (Eshach, 2007). STEM kulüp etkinliklerinin etkililiğinin değerlendirilmesi, STEM etkinliklerinin uygun bir çerçevede planlanıp yürütülüp yürütülmediğinin belirlenmesinde, geleceğe yönelik iyileştirmelerin yapılmasında, iyi örnekler üretilmesinde ve bir uygulama standardı geliştirilmesinde büyük önem taşımaktadır (Nguyen vd., 2020). Bu nedenle öğretmenlerin STEM kulüp etkinliklerini okullarda uygulama düzeylerinin belirlenmesi gereklidir. STEM kulüplerinin etkililiğine ilişkin çalışmalarda ağırlıklı olarak öğrenci görüşlerine yer verildiği (Akar ve Nayir, 2015; Gottfried ve Williams, 2013; Gogebakan, 2016; Onay, 2012), öğretmen görüşlerine yer veren çalışmaların ise sınırlı sayıda olduğu dikkat çekmektedir (Ferrara vd., 2017). Oysa programı uygulayan öğretmenlerin sahada gerçekleştirirken kendileri, öğrencileri ve uygulamaların genel yapısı hakkında sahip oldukları deneyim ve gözlemler mevcut durumu ortaya koymada kilit öneme sahiptir. STEM kulübü

faaliyetlerinin etkili bir şekilde yürütülmesi fen derslerini tamamlayıcı bir etkiye sahiptir ve öğrenciler için de önemlidir. Bu çalışma, öğretmenlerin okullarda STEM kulübü etkinliklerini uygulama düzeylerini öğretmen, öğrenci, planlama ve uygulama boyutları açısından cinsiyet ve kıdem değişkenlerini dikkate alarak belirlemeyi amaçlamaktadır. Bu çalışmanın amaçları doğrultusunda belirlenen araştırma soruları ve sıfır hipotezler aşağıdaki gibidir:

1. Öğretmenler STEM kulübü etkinliklerini "öğretmen", "planlama ve uygulama" ve "öğrenci" boyutları açısından ne düzeyde uygulamaktadır?

2. Öğretmenlerin STEM kulübü etkinliklerini uygulama düzeyleri "öğretmenler", "planlama ve uygulama" ve "öğrenciler" boyutlarında cinsiyete göre farklılık göstermekte midir?

$H_0$4: Öğretmenlerin STEM kulüp etkinliklerini uygulama düzeyleri öğretmen boyutunda cinsiyete göre farklılık göstermemektedir.

$H_0$5: Öğretmenlerin STEM kulübü etkinliklerini planlama ve uygulama boyutuna ilişkin uygulama düzeyleri cinsiyete göre farklılık göstermemektedir.

$H_0$6: Öğretmenlerin STEM kulübü etkinliklerini öğrenci boyutunda uygulama düzeyleri cinsiyete göre farklılık göstermemektedir.

3. Öğretmenlerin STEM kulübü etkinliklerini uygulama düzeyi "öğretmenler", "planlama ve uygulama" ve "öğrenciler" boyutunda mesleki kıdeme göre farklılaşmakta mıdır?

$H_0$7: Öğretmenlerin öğretmenler boyutuna ilişkin etkinlikleri uygulama düzeyi mesleki kıdeme göre farklılaşmamaktadır.

$H_0$8: Öğretmenlerin STEM kulübü etkinliklerini planlama ve uygulama boyutuna ilişkin uygulama düzeyleri mesleki kıdemlerine göre farklılık göstermemektedir.

$H_0$9: Öğretmenlerin STEM kulübü etkinliklerini öğrenci boyutuna ilişkin uygulama düzeyleri mesleki kıdeme göre farklılık göstermez.

4. "Öğretmenler", 'planlama ve uygulama' ve 'öğrenciler' boyutları arasında istatistiksel olarak anlamlı bir ilişki var mıdır?

$H_0$10: Öğretmenler ile planlama ve uygulama boyutları arasında istatistiksel olarak anlamlı bir ilişki yoktur.

$H_0$11: Planlama ve uygulama ile öğrenci boyutları arasında istatistiksel olarak anlamlı bir ilişki yoktur.

$H_0$12: Öğretmen ve öğrenci boyutları arasında istatistiksel olarak anlamlı bir ilişki yoktur.

5. "Öğretmenler", 'planlama ve uygulama' ve 'öğrenciler' boyutları öğretmenlerin STEM kulübü etkinliklerini uygulama düzeylerini yordamakta mıdır?

$H_0$13: Öğretmen boyutu, öğretmenlerin STEM kulübü etkinliklerini uygulama düzeyini yordamamaktadır.

$H_0$14: Planlama ve uygulama boyutu öğretmenlerin STEM kulübü etkinliklerini uygulama düzeyini yordamamaktadır.

$H_0$15: Öğrenci boyutu, öğretmenlerin STEM kulübü etkinliklerini uygulama düzeyini yordamamaktadır.

6. "Öğretmenler", 'planlama ve uygulama' ve 'öğrenciler' boyutunun öğretmenlerin STEM kulübü etkinliklerini uygulama düzeyini yordama düzeyi cinsiyet ve mesleki kıdem değişkenlerine göre farklılaşmakta mıdır?

$H_0$16a: Öğretmenler boyutu ile öğretmenlerin STEM kulübü etkinliklerini uygulama düzeyi arasındaki ilişkiyi açıklamada cinsiyetin moderatör rolü yoktur.

$H_0$16b: Mesleki kıdemin, öğretmen boyutu ile öğretmenlerin STEM kulübü etkinliklerini uygulama düzeyi arasındaki ilişkiyi açıklamada moderatör rolü yoktur.

$H_0$17a: Cinsiyetin planlama ve uygulama boyutu ile öğretmenlerin STEM kulübü etkinliklerini uygulama düzeyi arasındaki ilişkiyi açıklamada moderatör rolü yoktur.

$H_0$17b: Mesleki kıdemin, planlama ve uygulama boyutu ile öğretmenlerin STEM kulübü etkinliklerini uygulama düzeyi arasındaki ilişkiyi açıklamada aracı rolü yoktur.

$H_0$18a: Cinsiyetin, öğrenci boyutu ile öğretmenlerin STEM kulübü etkinliklerini uygulama düzeyi arasındaki ilişkiyi açıklamada aracı rolü yoktur.

$H_0$18b: Mesleki kıdemin, öğrenci boyutu ile öğretmenlerin STEM kulübü etkinliklerini uygulama düzeyi arasındaki ilişkiyi açıklamada moderatör rolü yoktur.

Araştırmanın ilk dokuz sorusunu cevaplamak için kesitsel tarama modeli kullanılmıştır. Araştırmanın son dokuz sorusunu yanıtlamak için açıklayıcı korelasyon modeli (Fraenkel ve Wallen, 2008) kullanılmıştır. Araştırmanın örneklemi, 2019-2020 eğitim-öğretim yılında STEM kulübü faaliyetlerini yürüten ve yazarların ulaşabildiği 139 öğretmenden oluşmaktadır ve bu sayı madde sayısının yaklaşık beş katıdır. STEM Kulübü Değerlendirme Ölçeği (SCES) yazarlar tarafından geliştirilmiş ve ölçme aracı olarak kullanılmıştır (Gökçe vd., 2022). SCES, 29 madde ve üç faktörden oluşan beşli Likert tipi bir ölçektir. Araştırmadan elde edilen veriler analiz edilmeden önce her bir grubun üç boyuta göre puanları ile cinsiyet ve mesleki kıdem değişkenleri için dağılımın normalliği incelenmiştir. Yapılan analizler sonucunda, öğrenciler boyutu için cinsiyet ve mesleki kıdem değişkenleri açısından puanların normal dağılmadığı tespit edilmiş; bunun sonucunda histogram grafiklerinin en altında yer alan 7, 12, 15 ve 17'nci puanlara sahip 7, 18, 32 ve 70'inci kişiler çıkarılmıştır. Normallik analizi tekrarlandığında, her üç boyut ve iki değişken için puanların normal dağılıma sahip olduğu tespit edilmiş; bu puanlar bulgular bölümünde raporlanmıştır.

Araştırmanın 3., 4. ve 5. sorularını yanıtlamak için bağımsız örneklemler t-testi; 6., 7. ve 8. sorularını yanıtlamak için ise tek yönlü varyans analizi (ANOVA) yapılmıştır. Her iki analiz de bağımsız örneklemlerin belirli bir değişken açısından birbirlerinden farklı olup olmadığını test etmek için uygulanmıştır (Pallant, 2020). Korelasyon ve regresyon analizleri, 10, 11, 12, 13, 14 ve 15. sorular için çalışmanın üç boyutu ve iki değişkeni açısından korelasyonların durumunu ortaya koymak için yapılmıştır (Fraenkel & Wallen, 2008). İlişkisel analizler sonucunda elde edilen bulgular ışığında, araştırma sorularının sonuncusunu yanıtlamak üzere Hayes (2013) tarafından geliştirilen SPSS PROCESS makro eklentisi kullanılarak regresyon analizleri gerçekleştirilmiştir. Bu analizler işlevsel olarak değişkenler arasındaki ilişkileri anlamlandırmakta ve bu ilişkileri bir model kullanarak açıklamaktadır (Chatterjee & Hadi, 2015). Bu tür bir analiz 16, 17 ve 18. sorular için tercih edilmiştir çünkü amaç, her bir boyutun öğretmenlerin STEM kulübü uygulama düzeyleriyle olan ilişkilerini açıklamada cinsiyet ve mesleki kıdemin sahip olduğu ılımlaştırıcı etkileri araştırmaktır. Korelasyon ve regresyon analizleri aslında bu tür beklenmedik değişkenleri modellemede sınırlılıklara sahiptir (Hayes ve Preacher, 2013).

Araştırmada ölçekte yer alan her bir boyutun öğretmenlerin STEM kulübü etkinliklerini uygulama düzeylerini istatistiksel olarak anlamlı bir şekilde yordadığı sonucuna ulaşılmıştır. Bu bağlamda, öğretmen ve öğrenci boyutlarının öğretmenlerin STEM kulübü etkinliklerini uygulama düzeylerini daha yüksek düzeyde yordadığı, planlama ve uygulama boyutunun ise orta düzeyde yordadığı görülmüştür.

Öğretmenlerin STEM kulübü etkinliklerini uygulama düzeylerini farklı açılardan yorumlayabilmek için bu üç boyut arasındaki korelasyonlar incelenmiştir. Araştırmadan elde edilen sonuçlara göre, planlama ve uygulama boyutu ile diğer iki boyut arasında düşük düzeyde bir korelasyon bulunurken, öğretmen ve öğrenci boyutları arasında istatistiksel olarak anlamlı yüksek düzeyde bir korelasyon bulunmuştur. Young ve diğerlerinin (2017) çalışmasında, ders dışı STEM uygulamalarının kalitesi ve planlamasının öğrencilerin STEM alanlarına ilgisini etkilediği sonucuna varılmıştır. İyi planlanmış/tasarlanmış kaliteli STEM uygulamalarında öğrencilerin ilgi düzeylerinin yüksek olduğu belirlenirken, kötü planlanmış veya orta kaliteli STEM uygulamalarında öğrencilerin STEM alanlarına yönelik ilgilerinde kayda değer bir artış gözlenmemiştir. Dolayısıyla, ders dışı STEM uygulamalarının (örneğin, STEM kulüp etkinlikleri) planlanması ve kalitesi, yalnızca yüksek kalite düzeyine sahip ve iyi planlanmış olanlar için gözlemlenebilir bir etkiye sahiptir. Bu nedenle, planlama ve uygulama boyutu ile diğer iki boyut arasında düşük düzeyde bir korelasyon bulunduğundan ve bu boyutun öğretmenlerin STEM kulüp etkinliklerini uygulama düzeylerini orta düzeyde açıklayabildiğinden, STEM kulüp etkinliklerinin planlanması ve kalitesinin iyileştirilmesi gerekmektedir.

Öğretmenler, STEM kulübü etkinliklerinin okullarda yüksek düzeyde uygulandığına dair bir algıya sahiptir. Katılımcıların STEM kulübü etkinliklerinin nasıl uygulandığına ilişkin olumlu bakış açılarına sahip oldukları söylenebilir. Öğretmenler, STEM kulüp etkinliklerinin okullarda planlama ve uygulama açısından orta düzeyde uygulandığı algısına sahiptir. Öğretmenlerin STEM kulüp etkinliklerinin okullarda öğrenciler için yüksek düzeyde uygulandığı algısına sahip olduğu sonucuna ulaşılmıştır.

Çalışmamız, öğretmenlerin STEM kulübü etkinliklerini uygulama düzeylerinin öğretmen boyutunda cinsiyete göre farklılık göstermediği sonucuna ulaşmıştır. Bağımsız değişken olarak cinsiyet anlamlı bir fark yaratmasa da cinsiyetin öğretmen boyutu ile öğretmenlerin STEM kulübü etkinliklerini uygulama düzeyi arasındaki ilişkide kızlar lehine ılımlaştırıcı bir etkisi olmuştur. Mevcut çalışmada cinsiyetin sadece öğretmenler boyutu için ılımlaştırıcı bir etkisi olduğu, öğrenciler boyutu için bir etkisi olmadığı tespit edilmiştir. Böyle bir sonucun ortaya çıkmasının nedeni, öğretmenlerin kulüp uygulamalarında daha aktif bir rol oynaması olabilir. Çalışma öğretmenlerin okullarda STEM kulübü etkinliklerini uygulama düzeylerinin planlama ve uygulama boyutları açısından cinsiyete göre farklılık göstermediğini ama öğrenciler boyutu açısından kadınlar lehine farklılık gösterdiğini ortaya koymuştur. Okullarda öğretmenlerin STEM kulübü etkinliklerini uygulama düzeylerinin öğretmenler, planlama ve uygulama, öğrenciler boyutunda mesleki kıdeme göre farklılaştığı sonucuna ulaşılmıştır.

Özetle, öğretmenlerin STEM kulübü uygulama düzeyleri öğretmen, planlama ve uygulama ile öğrenci boyutlarıyla ilişkilidir. Bu üç boyutun birbiriyle de ilişkili olduğu tespit edilmiştir. Sosyal yapılandırmacılığın öngördüğü gibi öğrenci ve öğretmen boyutları arasında yüksek düzeyde bir ilişki tespit edilmiştir. Öğretmenlerin STEM kulübü etkinliklerinin uygulandığı algısına öğretmen ve öğrenci boyutları açısından yüksek düzeyde, planlama ve uygulama boyutu açısından ise orta düzeyde sahip oldukları görülmektedir. Cinsiyetin de öğrenciler boyutunda etkili olduğu, öğretmenler boyutunda ise aracılık etkisinin bulunduğu sonucuna ulaşılmıştır. Mesleki deneyimdeki artışların, her üç boyut için de STEM kulübü etkinliklerinin daha yüksek uygulama düzeyleriyle ilişkili olduğu görülmüştür.