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**The Development and Validation of
Turkish Version of the Elementary
Teachers' Efficacy and Attitudes towards
STEM (ET-STEM) Scale**

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The Development and Validation of Turkish Version of the Elementary Teachers' Efficacy and Attitudes towards STEM (ET-STEM) Scale

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Abstract

The purpose of this study was to adapt the Elementary Teachers Efficacy and Attitudes towards STEM Survey (ET-STEM scale; Friday Institute for Educational Innovation, 2012) into Turkish and test the validity and reliability of the instrument. ET-STEM was administered to 313 elementary teachers from different provinces of Turkey. Exploratory and confirmatory factor analyses were conducted to examine the structural validity of the scale. According to exploratory factor analysis results, the ET-STEM survey consists of nine factors. The values of Cronbach's alpha of the factors ranged from 0.891 to 0.964, and corrected item-total scale correlation ranged from 0.313 to 0.417. After the exploratory factor analysis performed, the ET-STEM was administered to 213 elementary school teachers. The results obtained from the confirmatory factor analyses demonstrated adequate reliability and validity for measuring the STEM competencies and attitudes of elementary school teachers.

Introduction

Engineering and science industries are vital source of developed countries' economic growth. It is therefore not surprising to see substantial increase in interest and investment in science, technology, engineering, and mathematics (STEM) education from governments. In today's world, global competitiveness requires countries bring innovation and their capacity to innovate to market (MITRE, 2016). Developed countries came to the realization that a blended, well-reasoned, and "whole-of-government" approach is required to foster innovation, boost productivity and economic growth. Different organizations in developed countries work together to engage young people with STEM, offers professional development opportunities and the curriculum resources for teachers. One developed country example is The United States launched the "Educate to Innovate" initiative to improve American student's capabilities in the areas of STEM. The push for improving STEM education has been a priority for the USA for the following reasons: (1) the lack of information on STEM subjects (2) a shortage in STEM professionals (3) the lack of information on STEM professional areas (4) young people's negative perceptions and decreased interest of STEM subjects (Ostler, 2012; Atkinson and Mayo, 2010; Kelley & Knowles, 2016). To address the status of STEM and to reach STEM-related goals, the US and other nations paid attention to STEM education in K12 and college level.

The acronym STEM is a simple acronym, but the definitions of STEM may vary. STEM is often considered viewing different disciplines, those are science, mathematics, technology, and engineering, as a unit. Science, technology, and innovation are important drivers of economic growth in nations. Economic growth relies on generating new ideas and knowledge that can be used to solve a given problem. Any nations that fails to integrate basic and applied research knowledge over international average will be left behind developed countries. Friedman (2005) used a metaphor, "flat world", to describe globalization. More people on the planet participate in economic, cultural, and political activities on a global scale. This means that the way people, information, money, services, and goods supply has changed. When the job market is global, employer can find needed talents from anywhere in the world. When the services and goods are needed, developing countries, such as China, and India, will offer cheap, the same quality products and companies would prefer them to buy. The current situation shows policymakers that countries' citizens lives will be affected by others who live in distant lands. This concerns in developed countries, pushed them to make changes in their education systems, make them questioned their current education pedagogy.

STEM education in K-12 and college settings foster students to make connection across STEM disciplines and as a result students gain skills that are relevant to life (National Research Council, 2011; NRC, 2010). STEM education also makes students better problem solvers, innovators, collaborative; improve students' ability of

self-control, critical thinking skills, communication and self-regulation skills (NRC, 2010). With all the possible benefits of STEM education, it is important to support teachers, their teaching practices and teachers' self-efficacy. Additionally, materials should be supplied to implement STEM subjects in the classroom.

Successful integration of STEM areas largely depends on teachers' knowledge about STEM subjects, beliefs, teachers' pedagogical content knowledge, 21st century skills knowledge, and integration knowledge (Yildirim, 2017; Benuzzi, 2015; Hudson, English, Dawes, King, & Baker, 2015; Karakaya & Avgin, 2016; Rogers, Winship, & Sun, 2015; Stohlmann, Moore, & Roehrig, 2012; Wang, 2012; Wang, Moore, Roehring, & Park, 2011; Nadelson et al., 2013). Teacher beliefs are linked to behavior and shape their attitudes about teaching, about students, and about their abilities (Bandura, 1982). Beliefs influence teacher behaviors' in the classroom, teacher planning, decision making (Pajares, 1992; Pintrich & De Groot, 1990; Wallace & Kang, 2004). Teacher beliefs include beliefs about teaching and learning, beliefs about students, beliefs about teachers' role in the classroom, teachers' responsibilities, teachers' abilities (Bayraktar, 2011; Pressley et al., 2003). Teachers' belief together with attitude and self-efficacy plays a central role in teachers' approach to teach STEM. When teachers are comfortable with STEM content, it affects students' success in the classroom, their motivation to the subject, and their perception towards the lessons (Beilock, Gunderson, Ramirez, & Levine, 2010; Tschannen-Moran & Woolfolk Hoy, 2001). Teachers' self-efficacy also influence students' success and implementation of STEM pedagogy in the classroom (Klassen & Chiu, 2010; Nadelson, Seifert, Moll, & Coats, 2012). Since teacher self-efficacy is content specific, teacher self-efficacy of STEM should be examined within the context and expectations of STEM pedagogy. The context of self-efficacy includes different factors: content knowledge, classroom management, engagement, and outcomes.

In a review of research published in science education, different instruments were developed to assess teacher self-efficacy (Tepe, 2011; Tekerek, Karakaya, & Tekerek, 2016; Bıkmaz, 2002; Bayraktar, 2011). These self-efficacy instruments were created and tested to assess teacher general aspects of self-efficacy (Yoon, et al., 2012). Some widely used instruments are: Teacher Efficacy Scale (TESS) (Gibson & Dembo, 1984), The Science Teaching Efficacy Belief instrument (STEBI) (Riggs and Enochs, 1990), The Self-Efficacy Beliefs About Equitable Science Teaching (SEBEST) (Ritter, Boone & Rubba, 2002). The 30-item scale called Teacher Efficacy scale (TES) was constructed to investigate the relationship between teacher self-efficacy and teacher behaviors in the classroom (Gibson & Dembo, 1984). Another instrument called the Science Teaching Efficacy Belief instrument (STEBI) was developed by Riggs and Enochs (1990) to measure science teaching efficacy beliefs among preservice teachers. Similar to these instruments, other instrument The Self-Efficacy Beliefs About Equitable Science Teaching (SEBEST) was designed to measure the socioeconomic factors effects on teacher self-efficacy beliefs in science teaching and learning (Ritter, Boone & Rubba, 2002). Another content-specific instruments were developed to measure teacher self-efficacy beliefs in math teaching (The Mathematics Teaching Efficacy Belief Instrument (MTEBI): Enochs, Smith & Huinker, 2000), in language and literacy (Graham, Harris, & Fink, 2001), in technology (Pan & Franklin, 2011; L. Wang, Ertmer, & Newby, 2004) and in engineering (Yoon Yoon, Evans, & Strobel, 2012).

Even though researchers have developed different self-efficacy instruments for teachers in various setting, there are only a few instruments widely used in STEM education. These instruments are the General Perceived Self-Efficacy Scale (also known as the General Self-Efficacy Scale (Dunlap, 2005; Jerusalem & Schwarzer, 1992), the Academic Self-Efficacy Scale (Painter & Bates, 2012; Pintrich & DeGroot, 1990), the Baldwin Confidence Survey Form (Baldwin, Ebert-May, & Burns, 1999), the Student Attitudes toward STEM Survey (S-STEM) survey (Friday Institute for Educational Innovation, 2012b), the Teaching Engineering Self-Efficacy Scale (TESS) (Yoon et al., 2012). Though different instruments exist in the literature, none of them was originally designed to measure teachers' self-efficacy in STEM in general. A STEM education instrument, Teacher Efficacy and Attitudes Toward STEM (ET-STEM) Survey, was developed to measure changes in elementary teachers' confidence and self-efficacy in STEM subjects (science and mathematics), use of technology in the classroom, 21st century learning skills, leadership attitudes, and STEM career awareness (Friday Institute for Educational Innovation, 2012).

On the other hand, Turkish researchers adopted different instruments to measure teacher self-efficacy towards STEM (Taşkın & Hacıömeroğlu, 2010; Çapa, Çakıroğlu and Sarıkaya, 2005; Yıldırım, 2018; Yerdelen, Kahraman, & Taş, 2016). These adopted instruments for science teachers and none of them were for elementary teachers. Scholars also have recognized the need for measures of elementary teacher self-efficacy and integrated STEM (Yıldırım & Selvi, 2015). Therefore, the ET-STEM scale in this study was adapted to Turkish.

Method

Hambleton and Patsula (1999)'s adaptation process was followed in the study. The adaptation process includes following steps; (1) translation of the whole scale from original language (English) to target language (Turkish), (2) experts meet and through a dialogue decide on the best version of each item, (3) validity and reliability of the adopted scale was calculated by Exploratory Factor Analysis (EFA), Confirmatory Factor Analysis (CFA). The translation of the scale was carried out in five stages: (Stage 1) Necessary permissions obtained from Friday Institute for Educational Innovation via email; (Stage 2) After permissions were received from the institute, two experts who were fluent in Turkish and English were invited for translation and back-translation procedures; (Stage 3) To translate the first revised draft of the scale to Turkish, two different experts were invited to English translation process; (Stage 4) Pilot study with three elementary teachers; (Stage 5) Finalization of the Turkish version of the scale. After Friday Institute permission for translation of the scale, two experts who were fluent in Turkish and English translated the scale to Turkish independently, Afterwards, unclear and translated items were examined by the authors and experts. The authors, experts and translators reached a consensus regarding to unclear items and made necessary editing. This version of the scale was translated into English by two language experts. When translation was determined in equivalence between the original ET-STEM scale and the translated form, a pilot ET-STEM scale was administered to three elementary teachers to determine teachers' misunderstandings. Afterwards, the scale was administered to 526 elementary teachers.

Participants

Two independent samples were used in the study. The first sample included 313 elementary teachers, of whom 93 male, 220 females; the second group consisted of 213 elementary teachers, of whom 83 male, 150 females. The experience of the study participants ranged from 1 years to more than 16 years. The participants of this research study are the teachers working for public and private schools (Detailed demographic characteristics of the elementary teachers were shown in Table 1). Exploratory factor analysis (EFA) was carried out on data collected from 313 elementary teachers and the confirmatory factor analysis (CFA) was conducted with second group, 213 elementary teachers. Different sample groups were selected for running exploratory and confirmatory factor analysis to not to replicate the results obtained in EFA. Before participants completed the scale; the teachers were informed about the purpose of this study and were reminded of their right to withdraw from the study at any time. All elementary teachers had volunteered for the study and received no award for their participation.

Table 1. Demographic characteristics of elementary teacher participants

		First Group		Second Group	
		n	%	N	%
Gender	Male	93	23,23	83	38.96
	Female	220	70,28	150	61.04
Experience	0-5 years	63	20,12	55	25.82
	6-10 years	130	41,53	110	51.64
	11-15 years	75	23,96	25	11.73
	16-or more years	45	14,37	33	15.49
School Type	Public School	260	83,06	175	82.15
	Private School	53	20,13	38	17.85
Total		313	100	213	100

Data Analysis

To analyze the data obtained from elementary teachers via ET-STEM scale, descriptive and confirmatory factory analyses were applied. The confirmatory factor analyses generally is used to determine factor pattern of the scale in the target culture (Turkish elementary teachers) and recommended by the researchers (Cokluk, Sekercioglu, & Buyukozturk, 2014). The exploratory factor analyses increase the reliability of the scale by identifying items that needs to be removed. To conduct a confirmatory and exploratory factor analyses two different groups were selected. The confirmatory factor analyses of the scale were performed using the data from 213 elementary teachers and the exploratory factor analyses of the scale were calculated the data from 313 elementary teachers. Since the scale's sample group consisted of 526 elementary teachers, sample size of 500 is very good according to Comrey and Lee (1992). Kas and Tinley (1979) recommended five to ten case per item and in this study the sample group is five times larger than the number of items. Furthermore, Boomsma (1982)

recommended a minimum sample size of 200 to obtain reliable results in order to conduct factor analyses. The varimax rotation applied in this study. The varimax rotation produce simple solutions and each factor has small number of variables. This simplifies the interpretation (Kieffer, 1998). While running confirmatory factor analysis, the Goodness of Fit Index (GFI), the Adjusted Goodness of Fit Index (AGFI), the Root Mean Square Error of Approximation (RMSEA), the Comparative Fit Index (CFI), Standardized Root Mean Square Residual (SRMR), Incremental Fit Index (IFI), and the Normed Fit Index (NFI) statistics were used (Baumgartner & Homburg, 1996; Bentler, 1980; Brown, 2006; Field, 2009; Kılıç & Şen, 2014). Moreover, the correlation analysis was run for determining the relationship(s) between subscales of the STEM scale. The validity and reliability analyses of the scale were calculated using SPSS Statistics (Version 21.0) and LISREL (Version 8). The results of the exploratory and confirmatory factor analyses of the ET-STEM Scale are explained below

Elementary Teacher Efficacy and Attitudes toward STEM (ET-STEM) Scale

The Elementary Teacher Efficacy and Attitudes towards STEM Scale was developed by Friday Institute for Educational Innovation (2012). While developing scale, 228 elementary teachers participated in the study and only an exploratory factor analysis was conducted. Exploratory factor analysis identified nine dimensions with 83 items using a five-point Likert scale.

Table 2. ET-STEM survey reliability

Construct	Number of Items	Cronbach’s Alpha Elementary (n=228)
Science Teaching Efficacy and Beliefs	11	.905
Mathematics Teaching Efficacy and Beliefs	11	.939
Science Teaching Outcome Expectancy Beliefs	9	.854
Mathematics Teaching Outcome Expectancy Beliefs	9	.895
Student Technology Use	8	.943
STEM Instruction	14	.950
21st Century Learning Attitudes	11	.948
Teacher Leadership Attitudes	6	.870
STEM Career Awareness	4	.945

Constructs of ET-STEM Scale

The ET-STEM Scale consisted of nine sub-dimensions. These dimensions were follows as: “STEM Instruction (SI)”, “21st-Century Learning Attitudes (CS)”, “Science Teaching Efficacy And Beliefs (STE)”, “Mathematics Teaching Efficacy And Beliefs (MTE)”, “Student Technology Use (TU)”, Teacher Leadership Attitudes (TL)”, “Science Teaching Outcome Expectancy (SOE)”, “Mathematics Teaching Outcome Expectancy (MOE)”, “STEM Career Awareness (SC)”. The structures, abbreviations and definitions related to the mentioned nine sub-dimensions of ET-STEM were shown in Table 3 (Friday Institute for Educational Innovation, 2012).

Table 3. Definitions of the constructs of the ET-STEM scale

Construct	Abbreviation	Definition
Science Teaching Efficacy and Beliefs	STE	self-efficacy and confidence related to teaching the specific STEM subject
Mathematics Teaching Efficacy and Beliefs	MTE	self-efficacy and confidence related to teaching the specific STEM subject
Science Teaching Outcome Expectancy Beliefs	SOE	degree to which the respondent believes, in general, student-learning in the specific STEM subject can be impacted by actions of teachers
Mathematics Teaching Outcome Expectancy Beliefs	MOE	degree to which the respondent believes, in general, student-learning in the specific STEM subject can be impacted by actions of teachers
Student Technology Use	TU	how often students use technology in the respondent’s classes
STEM Instruction	SI	how often the respondent uses certain STEM instructional practices
21st Century Learning Attitudes	CS	attitudes toward 21st century learning
Teacher Leadership Attitudes	TL	attitudes toward teacher leadership activities
STEM Career Awareness	SC	awareness of STEM careers and where to find resources for further information

Results

Exploratory Factor Analysis was conducted with the first group. While using an EFA, the aim was to determine dimensions of the scale and the number of items. Before running an EFA analyses, Kaiser-Meyer-Olkin (KMO) and Barlett test were utilized. The KMO value of 83 items was calculated as 0.788 and the Bartlett test was found to be meaningful (χ^2 28911,185 df= 3403, $p < .05$). Therefore, the data from Turkish elementary teachers were appropriate to run an EFA.

According to Büyüköztürk (2006), when KMO coefficient was greater than 0.60 and the Barlett test was significant, the EFA would be run. Varimax analysis was performed for the ET-STEM. Varimax analyses gather together factors with high correlations (Doğan, 2011). According to Kaiser (1960), one must consider whether a measure is more than an attribute value of 1 in factor selection. Based on the varimax analysis, nine factors' eigenvalues were found to be greater than 1. To calculate eigenvalue, a scree plot method was used. Figure 1 shows the maximum number of factors.

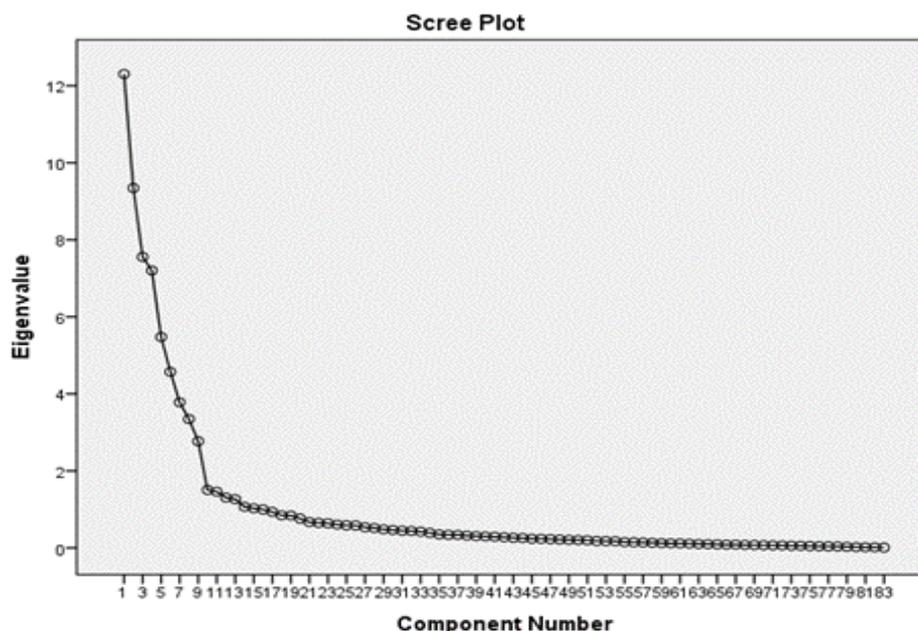


Figure 1. Scatter graph

Reliability Evidence

The ET-STEM's internal consistency coefficients were calculated, and the Cronbach's α s for each factor is presented in Table 4. The Cronbach α value of the ET-STEM scale and the subscale values were high. All values were greater than .70 (Tavşancıl, 2002), meaning good reliability evidence. The results of the EFA statistics of the ET-STEM scale (See Table 4).

Table 4. Internal consistency reliability coefficients of ET-STEM scale

Construct	Cronbach's α
STEM Instruction	.964
21 st Century Learning Attitudes	.935
Science Teaching Efficacy and Beliefs	.956
Mathematics Teaching Efficacy and Beliefs	.908
Student Technology Use	.944
Teacher Leadership Attitudes	.957
Science Teaching Outcome Expectancy	.902
Mathematics Teaching Outcome Expectancy	.891
STEM Career Awareness	.917
T-STEM Scale	.917

Table 5. Results of the exploratory factor analysis of ET-STEM scale

Items	<i>M</i>	<i>SD</i>	Item-total correlation	<i>t</i> -value (bottom 27%, top 27%)	Rotator load	Common factor load
STEM Instruction (14 items)						
SI13	4.14	.79	.443	8.788	.877	.786
SI6	4.11	.85	.391	8.612	.873	.808
SI7	4.33	.69	.542	11.018	.862	.784
SI9	4.08	.83	.442	9.020	.862	.784
SI4	4.18	.88	.494	9.743	.849	.776
SI3	4.20	.88	.504	9.861	.840	.762
SI10	4.17	.69	.503	9.385	.839	.741
SI14	4.18	.89	.425	8.135	.828	.721
SI8	4.19	.86	.472	9.722	.798	.690
SI2	4.20	.71	.423	7.294	.796	.673
SI5	3.99	.91	.406	8.039	.780	.644
SI1	4.12	.86	.394	6.759	.764	.604
SI12	4.12	.91	.468	11.513	.737	.633
SI11	4.22	.71	.405	7.571	.722	.555
Science Teaching Efficacy and Beliefs (11 items)						
STE11	3.67	1.20	.481	10.800	.928	.885
STE4	3.55	1.26	.437	9.441	.920	.878
STE2	3.61	1.26	.453	9.156	.905	.851
STE6	3.50	1.29	.464	10.225	.900	.841
STE9	3.48	1.10	.482	10.780	.879	.803
STE1	3.90	1.15	.477	10.052	.856	.785
STE3	3.77	1.29	.437	9.795	.830	.750
STE8	3.33	1.22	.459	10.607	.821	.704
STE5	3.89	1.23	.397	7.795	.696	.542
STE10	4.34	.95	.355	6.188	.675	.477
STE7	3.68	1.32	.436	9.570	.600	.445
21 st Century Learning Attitudes (11 items)						
CS5	4.64	.50	.374	5.481	.897	.857
CS4	4.56	.59	.327	5.007	.870	.802
CS6	4.42	.68	.338	4.991	.856	.781
CS1	4.61	.53	.356	5.011	.844	.790
CS3	4.66	.54	.338	5.055	.825	.778
CS7	4.56	.64	.364	5.609	.805	.719
CS11	4.51	.58	.353	5.613	.743	.676
CS2	4.60	.58	.371	4.016	.738	.643
CS9	4.57	.59	.353	5.899	.708	.569
CS10	4.32	.87	.328	4.646	.620	.530
CS8	4.66	.57	.315	6.009	.607	.491
Mathematics Teaching Efficacy and Beliefs (11 items)						
MTE8	3.26	1.17	.405	8.032	.857	.766
MTE4	3.56	1.12	.383	7.541	.823	.707
MTE6	3.49	1.21	.388	7.213	.822	.702
MTE11	3.87	1.01	.417	8.355	.800	.702
MTE3	3.87	1.09	.359	6.384	.785	.644
MTE9	3.41	1.04	.409	8.598	.762	.633
MTE2	3.57	1.12	.404	7.876	.719	.609
MTE1	3.89	1.01	.339	7.342	.715	.533
MTE10	4.29	.91	.344	6.133	.544	.418
MTE7	3.96	1.13	.366	4.973	.464	.360
MTE5	4.18	1.07	.388	4.445	.464	.339
Student Technology Use (8 items)						
TU2	4.33	.87	.404	5.529	.884	.808
TU3	4.38	.84	.393	4.922	.873	.787
TU1	4.06	1.06	.341	5.927	.862	.779
TU6	4.15	.89	.320	5.626	.858	.806
TU7	4.02	.89	.333	5.306	.850	.795

TU5	3.90	.84	.390	4.508	.803	.735
TU8	4.33	.90	.311	4.474	.708	.685
TU4	3.55	1.07	.364	5.897	.701	.585
Science Teaching Outcome Expectancy (9 items)						
SOE7	4.14	.78	.300	2.566	.842	.733
SOE2	4.15	.82	.313	3.335	.789	.643
SOE1	3.99	.88	.319	4.073	.782	.626
SOE4	3.67	.96	.390	2.597	.781	.661
SOE6	3.80	.82	.380	2.254	.754	.648
SOE3	4.19	.82	.340	2.564	.740	.575
SOE8	4.38	.79	.347	4.357	.704	.526
SOE9	4.06	.90	.310	2.088	.674	.484
SOE5	3.40	1.09	.367	3.101	.643	.464
Teacher Leadership Attitudes (6 items)						
TL4	4.65	.62	.340	5.884	.924	.910
TL5	4.66	.61	.411	6.605	.890	.884
TL3	4.67	.61	.301	4.653	.880	.805
TL6	4.57	.64	.311	4.629	.878	.767
TL5	4.66	.65	.411	6.605	.870	.884
TL1	4.62	.66	.397	4.255	.838	.818
Mathematics Teaching Outcome Expectancy (9 items)						
MOE7	4.07	.78	.391	5,654	.812	.671
MOE4	3.58	1.01	.336	6,388	.788	.680
MOE3	4.06	.82	.382	5,705	.749	.605
MOE6	3.60	1.03	.380	7,434	.748	.614
MOE5	3.53	.96	.334	4,577	.716	.540
MOE1	3.81	.86	.378	5.164	.704	.524
MOE8	4.26	.87	.344	5,197	.697	.494
MOE2	4.01	.86	.313	3.517	.641	.470
MOE9	3.99	1.00	.381	4.056	.619	.440
STEM Career Awareness (4 items)						
SC4	4.18	.88	.335	4.515	.795	.833
SC2	4.20	.70	.325	4.080	.793	.842
SC3	4.21	.88	.381	3.469	.777	.762
SC1	4.11	.86	.351	3.400	.681	.722

* factor loads value is lower than .30 were not shown in table (Çokluk, Şekercioğlu, & Büyüköztürk, 2014).

The Cronbach's Alpha value was .917 for the entire ET-STEM scale, .964 for the STEM Instruction dimension, .935 for the 21st-century learning attitudes dimension, .956 for Science Teaching Efficacy and Beliefs dimension, .908 for Mathematics Teaching Efficacy and Beliefs dimension, .944 for Student technology use dimension, .957 for teacher leadership attitudes dimension, .902 for the Science Teaching Outcome Expectancy dimension, .891 for the Mathematics Teaching Outcome Expectancy dimension and .917 for the STEM career Awareness dimension.

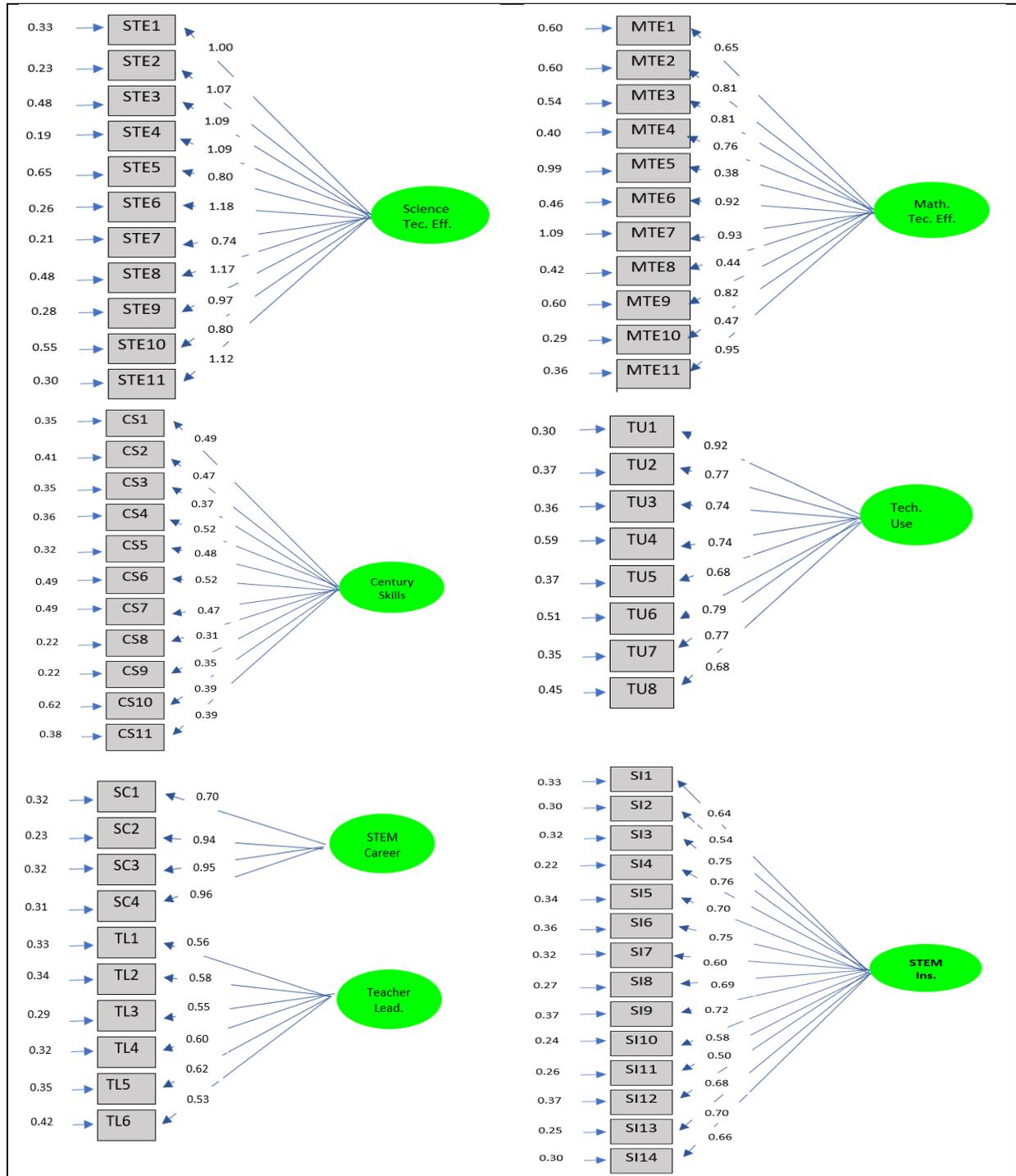
Alpha coefficients were calculated for Science Instruction dimension, 21st-century learning attitudes, Science Teaching Efficacy and Beliefs, Mathematics Teaching Efficacy and Beliefs Student technology use, teacher leadership attitudes, the Science Teaching Outcome Expectancy, the Mathematics Teaching Outcome Expectancy and STEM career Awareness factors and found all were higher than .70 (Tavşancıl, 2002).

The variance quantities were ranked as follows: STEM Instruction was 14.824%, Science Teaching Efficacy and Beliefs was 11.258%, 21st Century Learning Attitudes was 9.104%, Mathematics Teaching Efficacy and Beliefs was 8.678%, Student Technology Use was 6.598%, Science Teaching Outcome Expectancy was 5.505%, Teacher Leadership Attitudes was 4.454%, Mathematics Teaching Outcome Expectancy was 4.028%, and STEM Career Awareness was 3.336. After factor rotation, the number of items for each factor was determined :STEM Instruction included 14 items with factor loadings ranging from .722 to .877; Science Teaching Efficacy and Beliefs consisted of 11 items with factor loads ranging from .600 to .928; 21st Century Learning Attitudes consisted of 11 items with factor loads ranging from .607 to .897; Mathematics Teaching Efficacy and Beliefs consisted of 11 items with factor loads ranging from .464 to .857; Student Technology Use consisted of 8 items with factor loads ranging from .701 to .884; Science Teaching Outcome Expectancy consisted of 9 with factor loads ranging from .643 to .842; Teacher Leadership Attitudes consisted of 6 items

with factor loads ranging from .838 to .924; Mathematics Teaching Outcome Expectancy consisted of 9 items with factor loads ranging from .619 to .812 and STEM Career Awareness consisted of 4 items with factor loads ranging from .681 to .795.

Confirmatory Factor Analysis

As mentioned before, exploratory factor analysis of the ET-STEM Scale was conducted with Study Group 1, and confirmatory factor analysis was conducted with Study Group 2. Study Group 2 consisted of 213 elementary A confirmatory factor analysis using the structural equation model was conducted to determine the existing structure of the scale (see Figure 2).



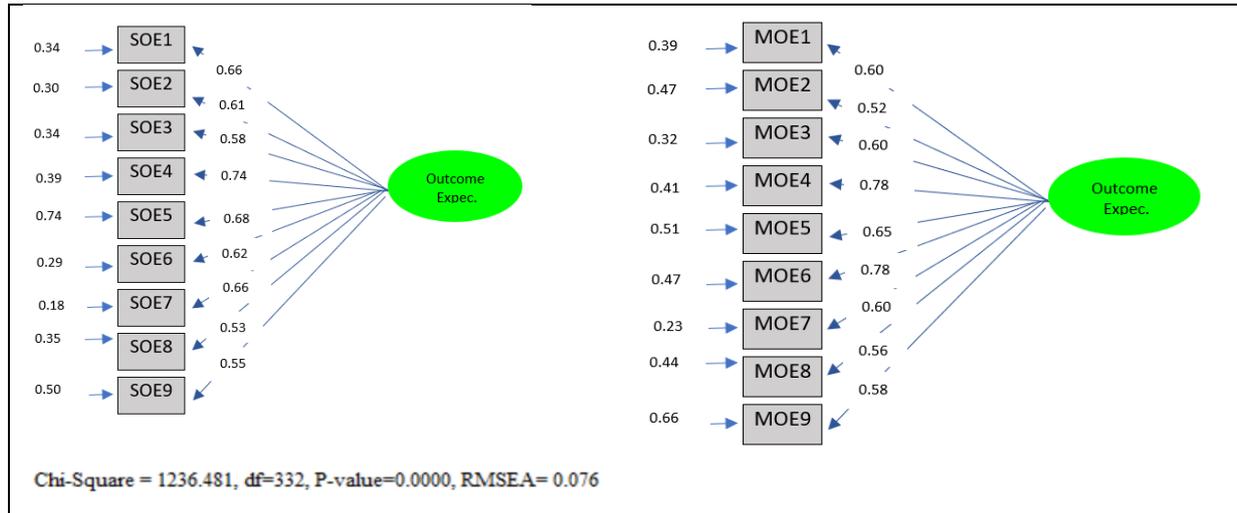


Figure 2. CFA result of ET-STEM scale

If the GFI and AGFI values are higher than 0.90 (Hooper, Coughlan, & Mullen, 2008; Sümer, 2000) and the RMR and RMSEA values are lower than 0.05 (Jöreskog & Sörbom, 1993; Sümer, 2000), the model-data fit is good. Nevertheless, if the GFI value is higher than 0.85, the AGFI is higher than 0.80, and the RMR and RMSEA values are lower than 0.080, model-data fit is acceptable (Anderson & Gerbing, 1984; Hu & Bentler, 1999; Sümer, 2000). The results of the confirmatory factor analysis for the ET-STEM Scale are shown in Table 6.

Table 6. Fit Indices of ET-STEM scale and acceptable fit indices values

Ki-kare	p-value	CFI	NFI	GFI	AGFI	IFI	SRMR	RMSEA
1236.481	$p < .05$	0.83	0.88	0.89	0.82	0.83	0.049	0.076

The results of the confirmatory factor analysis show that conformity between structural equation model and scale is high. Additionally, Chi-square value was found significant. The value of χ^2 depends on the size of the sample, and when the size of the sample increases, it provides significant results. Briefly, when chi-square (χ^2) is divided by the value of the degrees of freedom (df), it shows that the value is less than $5(\chi^2(332) = 1236.481)$; in other words, based on the results the model-data fit is high. In addition, if the CFI, NFI, AGFI values are (Hooper, Coughlan & Mullen, 2008; Sümer, 2000) above 0.80, it indicates that the model-data fit is high. Also, if RMSEA value is 0.076, it indicates that the model-data fit is high. According to confirmatory factor analysis it is determined that ET-STEM scale consists of nine subdimensions and model-data fit is high.

Discussion

In this study, the ET-STEM developed by Friday Institute for Educational Innovation (2012) is adapted to Turkish. Two different populations, a total of 526 elementary teachers were employed for validity and reliability analyses of the Turkish ET-STEM. Varimax analysis of the ET-STEM scale revealed a nine-factor structure, as in its original version (STEM Instruction, 21st Century Learning Attitudes, Science Teaching Efficacy and Beliefs, Mathematics Teaching Efficacy and Beliefs, Student Technology Use, Teacher Leadership Attitudes, Science Teaching Outcome Expectancy, Mathematics Teaching Outcome Expectancy and STEM Career Awareness, respectively). Total variance of these nine factors was 67.885%, and the Cronbach's Alpha value of the scale was 0.917. The Cronbach's Alpha value was calculated as .964 for STEM Instruction, .935 for 21st Century Learning Attitudes, .956 for Science Teaching Efficacy and Beliefs, .908 for Mathematics Teaching Efficacy and Beliefs, for Student Technology Use, .957 for Teacher Leadership Attitudes, .902 for Science Teaching Outcome Expectancy, .891 for Mathematics Teaching Outcome Expectancy, and .917 for STEM Career Awareness. Since adopted scale's Cronbach Alpha values greater than 0.80, Turkish version of the ET-STEM scale is reliable (Field, 2009; Kline, 1999). Also, these results are similar to the results Friday Institute for Educational Innovation found.

Furthermore, based on the confirmatory factor analysis results, the CFI, GFI, IFI, NFI, and AGFI values were above 0.80, indicating that model-data fit was high (Hooper, Coughlan & Mullen, 2008; Jöreskog & Sörbom, 1993). In addition, if the SRMR value is less than 0.05 and RMSEA values are less than 0.08, indicating that

model–data fit was high (Hooper et al., 2008; Anderson & Gerbing, 1984; Hu & Bentler, 1999; Jöreskog & Sörbom, 1993). According to the confirmatory factor analysis results, model–data fit was high, and the Turkish version of ET-STEM Scale was found to have nine subdimensions. This scale was found to be valid and reliable based on the results of the exploratory and confirmatory factor analyses.

The Turkish version of ET-STEM scale will help teacher educators and policy makers to understand teachers' attitudes toward STEM. Second, it will guide school administrators while organizing professional development seminars. It will also give insight to researchers, policy makers, and administrators in the factors that are positively linked with elementary teachers' self-efficacy.

The related Turkish literature includes several different adopted scales and developed self-efficacy scales (Yıldırım, 2018; Çapa, Çakıroğlu & Sarıkaya, 2005; Bıkmaz, 2002; Taşkın & Hacıömeroğlu, 2010; Tepe, 2011) but these instruments mostly lack specificity in different subject areas. An elementary teacher may have high self-efficacy in teaching certain subject such as math, but not in another subject like science. Therefore, Turkish literature and researchers needs STEM content specific self-efficacy instrument.

Limitations of the Study and Suggestions

The Turkish version of ET-STEM scale will be used to measure elementary teachers' STEM-content knowledge, their technology use while teaching, 21st century learning skills, teacher' leadership attitudes, teachers' self-confidence and self-efficacy, and their STEM career awareness. Thus, this scale would be used in further researchers to measure these variables. Furthermore, this scale was originally designed to measure teacher self-efficacy in STEM in general. Other scales were developed and created to assess general aspects of self-efficacy. They are not specific for STEM.

A few of the limitations in the study may have implication on future studies. One limitation was the limit on responses created by the instrument (ET-STEM). Participants may have additional information they would like to share, but the instrument limited these responses. Using different techniques to collect a data would provide more insight into elementary teachers' perspectives. Another limitation is that possible selection bias of respondents. Respondents largely demonstrated high self-efficacy. It is possible that teachers with low self-efficacy did not respond the invitation to participate in the study. More invitations would be sent to bigger groups of elementary teachers in further researchers.

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Appendix-1. Teacher Efficacy and Attitudes toward STEM (T-STEM) Survey (Original Version of the Scale)

Elementary Teacher

Appropriate Use

The Teacher Efficacy and Attitudes Toward STEM (T-STEM) Survey is intended to measure changes in teachers’ confidence and self-efficacy in STEM subject content and teaching, use of technology in the classroom, 21st century learning skills, leadership attitudes, and STEM career awareness. The survey is available to help program coordinators make decisions about possible improvements to their program. The Friday Institute grants you permission to use these instruments for educational, noncommercial purposes only. You may use an instrument as is, or modify it to suit your needs, but in either case you must credit its original source. By using this instrument, you agree to allow the Friday Institute to use the data collected for additional validity and reliability analysis. The Friday Institute will take appropriate measures to maintain the confidentiality of all data.

Recommended citation for this survey:

Friday Institute for Educational Innovation (2012). *Teacher Efficacy and Attitudes Toward STEM Survey-Elementary Teachers*, Raleigh, NC: Author.

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DIRECTIONS:

For each of the following statements, please indicate the degree to which you agree or disagree. Even though some statements are very similar, please answer each statement. There are no "right" or "wrong" answers. The only correct responses are those that are true for you. Whenever possible, let the things that have happened to you help make your choice.

Science Teaching Efficacy and Beliefs

Directions: Please respond to these questions regarding your feelings about your own teaching.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
1. I am continually improving my science teaching practice.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. I know the steps necessary to teach science effectively.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. I am confident that I can explain to students why science experiments work.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. I am confident that I can teach science effectively.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. I wonder if I have the necessary skills to teach science.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. I understand science concepts well enough to be effective in teaching science.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

7. Given a choice, I would invite a colleague to evaluate my science teaching.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8. I am confident that I can answer students' science questions.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9. When a student has difficulty understanding a science concept, I am confident that I know how to help the student understand it better.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10. When teaching science, I am confident enough to welcome student questions.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
11. I know what to do to increase student interest in science.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Science Teaching Outcome Expectancy

Directions: The following questions ask about your feelings about teaching *in general*. Please respond accordingly.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
1. When a student does better than usual in science, it is often because the teacher exerted a little extra effort.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. The inadequacy of a student's science background can be overcome by good teaching.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. When a student's learning in science is greater than expected, it is most often due to their teacher having found a more effective teaching approach.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. The teacher is generally responsible for students' learning in science.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. If students' learning in science is less than expected, it is most likely due to ineffective science teaching.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. Students' learning in science is directly related to their teacher's effectiveness in science teaching.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. When a low achieving child progresses more than expected in science, it is usually due to extra attention given by the teacher.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8. If parents comment that their child is showing more interest in science at school, it is probably due to the performance of the child's teacher.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9. Minimal student learning in science can generally be attributed to their teachers.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Mathematics Teaching Efficacy and Beliefs

Directions: Please respond to these questions regarding your feelings about your own teaching.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
1. I am continually improving my mathematics teaching practice.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. I know the steps necessary to teach mathematics effectively.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. I am confident that I can explain to students why mathematics experiments work.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. I am confident that I can teach mathematics effectively.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. I wonder if I have the necessary skills to teach mathematics.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. I understand mathematics concepts well enough to be effective in teaching mathematics.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. Given a choice, I would invite a colleague to evaluate my mathematics teaching.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8. I am confident that I can answer students' mathematics questions.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9. When a student has difficulty understanding a mathematics concept, I am confident that I know how to help the student understand it better.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10. When teaching mathematics, I am confident enough to welcome student questions.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
11. I know what to do to increase student interest in mathematics.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Mathematics Teaching Outcome Expectancy

The following questions ask about your feelings about teaching in general. Please respond accordingly.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
1. When a student does better than usual in mathematics, it is often because the teacher exerted a little extra effort.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. The inadequacy of a student's mathematics background can be overcome by good teaching.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. When a student's learning in mathematics is greater than expected, it is most often due to their teacher having found a more effective teaching approach.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. The teacher is generally responsible for students' learning in mathematics.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Elementary STEM Instruction

Please answer the following questions about how often students engage in the following tasks during your instructional time.

During elementary STEM instructional meetings (e.g. class periods, after school activities, days of summer camp, etc.), how often do your students...

	Never	Occasionally	About half the time	Usually	Every time
1. Develop problem-solving skills through investigations (e.g. scientific, design or theoretical investigations).	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. Work in small groups.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. Make predictions that can be tested.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. Make careful observations or measurements.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. Use tools to gather data (e.g. calculators, computers, computer programs, scales, rulers, compasses, etc.).	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. Recognize patterns in data.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. Create reasonable explanations of results of an experiment or investigation.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8. Choose the most appropriate methods to express results (e.g. drawings, models, charts, graphs, technical language, etc.).	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9. Complete activities with a real-world context.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10. Engage in content-driven dialogue.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
11. Reason abstractly.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12. Reason quantitatively.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
13. Critique the reasoning of others.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
14. Learn about careers related to the instructional content.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

7.Eğer fırsatım olsaydı meslektaşımı sınıfıma fen öğretimimi değerlendirmesi için davet ederdim.					
8.Öğrencilerin fenle ilgili tüm sorularını cevaplayabileğim konusunda kendime güveniyorum.					
9.Bir öğrenci, bir fen kavramını anlamakta zorluk çektiğinde, o öğrencinin kavramı daha iyi anlayabilmesi için neler yapmam gerektiğini bildiğimden eminim.					
10.Fen öğretirken öğrencilerin soru sormasını hoş karşılayacağım konusunda kendime güvenirim.					
11.Öğrencilerin fene karşı olan ilgilerini artırmak için ne yapılması gerektiğini bilirim.					

Fen Öğretiminde Sonuç Beklentileri

Talimat: Aşağıdaki sorularda sizin öğretimle ilgili genel düşünceleriniz sorulmaktadır. Lütfen uygun bir şekilde cevaplayınız.

	Kesinlikle katılmıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Kesinlikle katılıyorum
1. Bir öğrenci fen dersinde ortalamanın üzerinde başarı gösterdiğinde, bu çoğunlukla öğretmenin gösterdiği fazla çabanın bir sonucudur.					
2. İyi bir öğretim ile bir öğrencinin fen alanlarındaki yetersizliğinin önüne geçilebilir.					
3. Bir öğrencinin fenedeki öğrenimi beklenilenden daha iyi olduğunda, bu çoğunlukla öğretmenin daha etkili bir öğretim yaklaşımı kullanmasının bir sonucudur.					
4. Öğrencinin fen öğreniminden genellikle öğretmen sorumludur.					
5. Öğrencinin fen öğrenimi beklenilenden düşük ise, bu muhtemelen fen öğretiminin etkin bir şekilde yapılamamasından kaynaklanmaktadır.					
6. Öğrencinin fen öğrenimi doğrudan öğretmenin fen öğretiminde etkili oluşuyla alakalıdır.					
7. Düşük seviyeli bir öğrenci fende beklenenden daha yüksek bir başarı gösterirse bu genellikle öğretmen tarafından gösterilen fazla ilginin bir sonucudur.					
8. Eğer ebeveynler çocuklarının okulda fene olan ilgilerinin arttığı çıkarımında bulunurlarsa, bu ilgi artışı muhtemelen çocuğun öğretmenin performansının bir sonucudur.					
9. Öğrencilerin minimum düzeyde fen öğrenmeleri genellikle öğretmene bağlıdır.					

Matematik Öğretimi Yeterliği ve İnançlar

Talimat: Aşağıda kendi öğretiminizle ilgili soruları lütfen duygularınızda göz önünde bulundurarak cevaplayınız.

	Kesinlikle katılmıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Kesinlikle katılıyorum
1. Matematik öğretimimi sürekli geliştiririm.					
2. Matematiği etkili öğretmek için gerekli aşamalarını bilirim.					
3. Matematiksel araştırmaların neden işe yaradıklarını öğrencilere açıklayabilme konusunda kendime güveniyorum.					
4. Matematik dersini etkili bir şekilde öğretebildiğim konusunda kendime güveniyorum.					
5. Matematik öğretimiyle ilgili gerekli becerilere sahip olup olmadığımı merak ederim.					
6. Matematiksel kavramları matematiği etkili bir şekilde öğretecek kadar bilirim.					
7. Eğer fırsatım olsaydı meslektaşımı sınıfıma matematik öğretimimi değerlendirmesi için davet ederdim.					
8. Öğrencilerin matematikle ilgili sorularını cevaplayabileğim konusunda kendime güveniyorum.					
9. Bir öğrenci, bir matematik kavramını anlamakta zorluk çektiğinde, o öğrencinin kavramı daha iyi anlayabilmesi için neler yapmam gerektiğini bildiğimden eminim.					
10. Matematik öğretirken öğrencilerin soru sormasını hoş karşılayacağım konusunda kendime güvenirim					
11. Öğrencilerin matematiğe karşı olan ilgilerini artırmak için ne yapılması gerektiğini bilirim.					

Matematik Öğretiminde Sonuç Beklentileri

Talimat: Aşağıdaki sorular sizin öğretimle ilgili *genel* düşüncelerinizi sormaktadır. Lütfen uygun şekilde cevaplayınız.

	Kesinlikle katılmıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Kesinlikle katılıyorum
1. Bir öğrenci matematikte ortalamanın üzerinde başarı gösterdiğinde, bu çoğunlukla öğretmenin gösterdiği fazla çabanın bir sonucudur.					
2. İyi bir öğretim ile bir öğrencinin matematikle ilgili yetersizliğinin önüne geçilebilir.					
3. Bir öğrencinin matematikteki öğrenimi beklenilenden daha iyi olduğunda, bu çoğunlukla öğretmenin daha etkili bir öğretim yaklaşımı kullanmasının bir sonucudur.					
4. Öğrencinin matematik öğreniminden genellikle öğretmen sorumludur.					
5. Öğrencinin matematik öğrenimi beklenilenden düşük ise, bu muhtemelen matematik öğretiminin etkin bir şekilde yapılamamasından kaynaklanmaktadır.					
6. Öğrencinin matematik öğrenimi doğrudan öğretmenin matematik öğretiminde etkili oluşuyla alakalıdır.					
7. Düşük seviyeli bir öğrenci matematikte beklenenden daha yüksek bir başarı gösterirse bu genellikle öğretmen tarafından gösterilen fazla ilginin bir sonucudur.					

8.Eğer ebeveynler çocuklarının okulda matematiğe olan ilgilerinin arttığı çıkarımında bulunurlarsa, bu ilgi artışı muhtemelen çocuğun öğretmeninin performansının bir sonucudur.					
9.Öğrencilerin minimum düzeyde matematik öğrenmeleri genellikle öğretmene bağlanır					

Öğrencilerin Teknoloji Kullanımı

Talimat: Sizin öğretim yaptığımız yerlerde öğrencilerinizin teknolojiyi ne kadar sıklıkla kullandığıyla alakalı aşağıda verilmiş olan soruları lütfen cevaplayınız. Eğer soru sizin durumunuz için geçerli değil ise lütfen ‘Geçerli Değil’ seçeneğini işaretleyiniz.

STEM öğretimi boyunca (örneğin ders zamanları, okul sonrası aktiviteler, yaz kampı vb.) ne sıklıkla öğrencilerin....

	Asla	Nadiren	Bazen	Genellikle	Her zaman	Geçerli Değil
1. Farklı teknolojileri kullanır (örn. yaratıcılık, veri görselleştirme, araştırma yapmak ve iletişim araçları)						
2. Sınıf ortamı dışındada diğerleriyle haberleşmek ve birlikte çalışmak için teknolojiyi kullanır.						
3. Online kaynaklara ve bilgiye ulaşmak için teknolojiyi etkinliklerin bir parçası olarak kullanır.						
4. Uzman araştırmacıların da kullandığı tarzda araçları kullanır (örn. simülasyonlar, veri tabanları, uydu görüntüleri).						
5. Teknolojinin gerçek yaşam içerisindeki kullanımını ele alan teknoloji-destekli projeler üzerine çalışır.						
6. Teknolojiyi problemlerin çözümüne çözüme yardımcı olması için kullanır.						
7. Üst düzey düşünmeyi desteklemek için teknolojiyi kullanır (örn. analiz, sentez, fikir ve bilgileri değerlendirme).						
8. Yeni fikirler oluşturmak ve bilginin gösterimi için teknolojiyi kullanır.						

STEM Öğretimi

Talimat: Sizin öğretim yaptığımız sırada öğrencilerinizin etkinliklere ne kadar sıklıkla katılım gösterdiği ile ilgili aşağıdaki soruları lütfen cevaplayınız.

STEM öğretimi boyunca (örneğin ders zamanları, okul sonrası aktiviteler, yaz kampı vb.) ne sıklıkla öğrencilerin....

	Asla	Nadiren	Bazen	Genellikle	Her zaman
1. Araştırma yoluyla problem çözüme becerilerini geliştirir (örn. Bilimsel, tasarım, teorik araştırmalar).					
2. Küçük gruplar halinde çalışır.					
3. Test edilebilir tahminlerde bulunur.					
4. Dikkatli ölçümler veya gözlemler yapar.					
5. Veri toplamak için araçlar kullanır (örn. hesap makineleri, bilgisayarlar, bilgisayar programları, ölçekler, cetveller, pusulalar, vb.)					
6. Verilerdeki desenleri farkeder.					
7. Bir deney veya araştırmanın sonuçlarından yola çıkarak mantıklı açıklamalar oluşturur.					

8. Sonuçları ifade etmek için en uygun yöntemleri seçer (örn. çizimler, modeller, grafikler, tablolar, teknik dil, vb.)					
9. Gündelik hayat içinden verilen etkinlikleri tamamlar.					
10. İçerik odaklı diyaloglar içerisindedir.					
11. Soyut düşünür.					
12. Nicel düşünür.					
13. Diğerlerinin düşüncelerini eleştirir.					
14. Öğretilen içerikle ilgili kariyer alanlarını öğrenir.					

21. Yüzyıl Öğrenim Tutumları

Talimat: Lütfen öğrenimle ilgili *genel* fikirlerinizi içeren aşağıdaki soruları cevaplayınız.

	Kesinlikle katılmıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Kesinlikle katılıyorum
1. Bence öğrencilerin diğerlerinin hedeflerine ulaşmasını sağlayacağı öğretim ortamlarında olmaları önemlidir.					
2. Bence öğrencilerin diğer öğrencilerin ellerinden gelen en iyisini yapmalarını sağlayabilecekleri öğretim ortamlarında olmaları önemlidir.					
3. Bence öğrencilerin yüksek kaliteli, nitelikli çalışmalar üreteceği öğretim ortamlarında olmaları önemlidir.					
4. Bence öğrencilerin akranları arasındaki farklılıklara saygı duyabileceklerini sağlayan öğretim ortamında olmaları önemlidir.					
5. Bence öğrencilerin akranlarına yardım edebilecekleri öğretim ortamında olmaları önemlidir.					
6. Bence öğrencilerin karar verirken başkalarında fikirlerinin alındığı öğretim ortamında olmaları önemlidir.					
7. Bence öğrencilerin işler planlandığı gibi gitmediğinde değişimler yapılabilecekleri öğretim ortamında olmaları önemlidir.					
8. Bence öğrencilerin kendi hedeflerini belirledikleri öğretim ortamında olmaları önemlidir.					
9. Bence öğrencilerin kendi başlarına çalışırken zamanı planlayabilecekleri öğretim ortamında olmaları önemlidir.					
10. Bence öğrencilerin birçok görev arasından hangisinin önce yapılacağını seçebileceği öğretim ortamında olmasının önemlidir.					
11. Bence öğrencilerin farklı sosyal çevrelerden, deneyimlerden gelen öğrencilerle birlikte uyum içinde çalışabilecekleri öğretim ortamında olmaları önemlidir.					

Öğretmen Liderlik Tutumu

Talimat:

Lütfen öğretmen liderliği ile ilgili *genel* düşünceleriniz hakkındaki aşağıdaki soruları cevaplayınız.

	Kesinlikle katılmıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Kesinlikle katılıyorum
1. Öğretmenlerin tüm öğrencilerin öğrenmeleri için sorumluluk almalarının önemli olduğunu düşünüyorum.					

2. Öğretmenlerin vizyonlarını öğrencilere anlatmasının önemli olduğunu düşünüyorum.					
3. Öğretmenlerin yıl boyunca çeşitli ölçme değerlendirme yaklaşımlarını kullanarak öğrenci gelişimini değerlendirmesinin önemli olduğunu düşünüyorum.					
4. Öğretmenlerin farklı verileri kullanarak organizasyon yapmalarının, planlamalarının ve hedefler belirlemelerinin önemli olduğunu düşünüyorum.					
5. Öğretmenlerin güvenli ve düzenli bir ortam sağlamasının önemli olduğunu düşünüyorum.					
6. Öğretmenlerin öğrencileri teşvik etmesinin önemli olduğunu düşünüyorum.					

STEM Kariyer Farkındalığı

Talimat: Lütfen aşağıdaki ifadelere ne kadar katılıp katılmadığınız ile ilgili aşağıdaki soruları cevaplayınız.

	Kesinlikle katılmıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Kesinlikle katılıyorum
1. Mevcut STEM mesleklerini biliyorum.					
2. STEM meslekleri hakkında daha fazla bilgi sahibi olmak için nereye gitmem gerektiğini biliyorum.					
3. STEM mesleklerini öğrencilere öğretmek istediğimde hangi kaynaklara bakacağımı biliyorum.					
4. STEM meslekleriyle ilgili bilgi edinmek isteyen öğrencileri veya ebeveynleri nereye yönlendireceğimi biliyorum.					