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Adaptation of STEM Parent Awareness Scale into Turkish: Validity and Reliability Study

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Abstract

STEM is a new educational approach that enables learning to be multidimensional by integrating and linking different disciplines of knowledge and skills in the fields of science, technology, engineering and mathematics. From an early age, parents play an important role in raising awareness of STEM by making them interested in the disciplines that make up STEM, making them love STEM and creating a positive attitude towards STEM. In this context, parents need to be aware of the knowledge and skills related to STEM for the education and economy of our country. Accordingly, this study aims to examine the validity and reliability of STEM Parent Awareness Scale developed by Yun, Cardella, Purzer, Hsu and Chae (2016) and adapted by Gonyea (2017). This scale consists of two sub-scales: knowledge and attitude. Firstly, translation procedures and arrangements were made with the support of experts. The final scale was administered to 207 parents (131 females, 76 males) with children aged 6-18 years. Subsequently, item-total correlations were calculated and the correlation values were found to be between .55 and .86. For the item discrimination, the lower and upper group averages of 27% were compared with independent t-test and found to be significant at p <.001 level for all test items. The correlation value between knowledge and attitude subscales was .51 and it was found to be significant at p <.001 level. As a result of confirmatory factor analysis, it was observed that the values of the fit indices were within the acceptable value limits. Finally, Cronbach's Alpha coefficients were calculated for the internal consistency of the scale. Cronbach's Alpha coefficients were .96 for knowledge subscale, .97 for attitude subscale and .96 for the total scale. As a result, STEM Awareness Scale parents to have enough mental properties of the Turkish version, from primary school to higher education of children with their parents, to measure knowledge and attitudes which it can be used in Turkey.

Keywords

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Introduction

With globalization in the 21st century, the economy, technological developments and defense industry have become more and more crucial day by day. With these developments brought about by globalization, reforms in education started to be implemented to increase the quality of education with the idea of spreading to all segments of the society. The United States of America (USA) has played an important role in this area. In the race brought about by globalization, with the USA seeing other countries as a threat, it has turned to invest in the field of engineering and technological developments. Considering that development in the economic field can be possible with entrepreneurship activity in the field of science and technology, STEM education has emerged in the United States to raise entrepreneurial and creative individuals (Martin-Paez, Aguilera, Perales-Palacios & Vilchez-Gonzales, 2019). Achieve Inc, a curriculum under the name of Next Generation Science Standards (NGGS, 2012), has received STEM support and become widespread in many countries, especially in the USA (Akgündüz et al., 2015).

Dugger (2010) and Thomas (2014) stated that experts did not reach a consensus about STEM that there was no common definition and that this concept was defined with more than one expression in the literature (Eroğlu & Bektaş, 2016). In its most acceptable form, STEM education enables learning to take place in a versatile way by bringing together different disciplines and establishing relationships between these disciplines (Smith & Karr-Kidwell, 2000). It is said that the emphasis on STEM education was first made with the abbreviation SMET after 1990, but this abbreviation was changed to STEM as it caused difficulties in pronunciation (Derin, Aydın & Kırkıç, 2017). STEM is an acronym consisting of the initials of the words "Science, Technology, Engineering and Mathematics" (Yıldırım & Altun, 2015). In our country, FeTeMM abbreviation is used as the abbreviation of STEM education, which consists of the first letters of Science (Fen), Technology (Teknoloji), Engineering (Mühendislik) and Mathematics (Matematik) (Yılmaz, Yiğit Koyunkaya, Güler, & Güzey, 2017). The disappearance of US students' interest in science, mathematics and engineering fields is the reason for the emergence of STEM education (Ostler, 2012).

Science, Technology, Engineering and Mathematics (STEM) education plays a critical role in the development of 21st century skills. STEM education includes 21st-century skills such as critical thinking, collaboration, creativity, and communication that will be needed to achieve success in a globalizing world, and enables them to be developed by making them experiential (Akaygün & Aslan Tutak, 2016). In the 21st-century, it is necessary for individuals to be included in an education process that can reveal these skills in line with the expected characteristics. Individuals should be involved in STEM education practices in order to reveal these skills. With its integrative structure that brings different disciplines together, STEM education enables individuals to develop these skills. It is thought that individuals will be able to adapt to business life without any problems when they are included in business life thanks to these skills (Milli Eğitim Bakanlığı [MEB], 2018).

Providing the integration of science, technology, engineering and mathematics disciplines, STEM education is an innovative approach, but it also enables STEM literate individuals to be trained (Bybee, 2013). Yıldırım and Altun (2015) stated that STEM education can be considered as an education that brings together different disciplines, enables to use information in daily life, increases skills that can be used in daily life, and includes critical thinking. Although that the term STEM brings together different disciplines, experts state that the STEM field is not open and that it may be problematic to exclude some disciplines from this field (Yıldırım & Altun, 2015). Based on this, when the effects of these fields on each other are examined, it can be said that an interdisciplinary approach is inevitable.

According to the Turkish Industrialists' and Businessmen's Association (Türk Sanayicileri ve İş Adamları Derneği [TÜSİAD]), accurate and efficient work areas for the graduates of 2023 must take place in Turkey in the field of STEM business. According to PwC analysis results for the year 2023, it is estimated that STEM field will be approximately 3.5 million of about 34 million total workforces in Turkey, between 2016 and 2023 the workforce need in the STEM field will approach 1 million and a deficit of approximately 31% will occur in meeting this need based on undergraduate and graduate graduates (TÜSİAD, 2017).

On the other hand, it is very important for the development of children that families, who have a great responsibility for the care and education of the child, are a part of education. For this reason, the educator needs to know the child and the family, as well as the family to know the school and the child, as they are important factors affecting the psychological and educational development of the children. Timely warning of individuals, creating environments in which they will contribute to their development, and meeting their spiritual needs are behaviors that should be realized consciously. In our country, STEM education, which aims to develop skills such as teamwork, critical thinking, creativity and problem-solving, which is called as 21st-century skills, as well as enriching the intellectual and cultural worlds of our students, will raise awareness of STEM by raising interest in the disciplines that make up STEM from early ages. Parents have an important role to play in promoting STEM, popularizing STEM and developing a positive attitude towards STEM (Azgın, 2019). In this context, parents need to be aware of STEM-related knowledge and skills for the education and economy of our country.

When the literature on STEM studies was examined, although there were various scale development and adaptation studies regarding STEM education attitude scale (eg. Aydın, Saka & Güzey, 2017; Derin, Aydın & Kırkıç, 2017; Yılmaz, Koyunkaya & Güler, 2017), STEM teaching orientation scale (eg. Hacıömeroğlu & Bulut, 2016), teachers' awareness of STEM approach (eg. Çevik, 2017; Karakaya, Ayçin & Çimen, 2018), and students' awareness of STEM approach (eg. Buyruk & Korkmaz, 2014), no scale measuring parents' STEM awareness was found. With the scale adapted in this study, STEM awareness levels of parents can be measured. Based on this information, it is thought that this scale will contribute to the relevant literature. The aim of this study is to study the adaptation, validity and reliability of STEM Parent Awareness Scale to Turkish in a sample of parents.

Method

Participants

The sample of the study consists of 207 parents (131 females, 76 males) who can be reached by using the convenient sampling method due to limitations such as time and money in a district located in the Aegean Region. The average age of the parents participating in the study is 38.85. The ages of the children that parents have are between 6-18, 164 of them are girls and 168 are boys.

Instrument

As a data collection tool, the measurement tool adapted as the STEM Parent Awareness Scale by Gonyea (2017), which was developed as the Purdue Parent Engineering Awareness Scale by Yun, Cardella, Purzer, Hsu, and Chae (2010), was used. Original scale data were collected from parents who had children from preschool to university period. For the STEM Parent Awareness Scale, the appropriate "engineering" words in the original scale were replaced with the word "STEM" and necessary adaptations were made. While adapting for STEM, the scale was administered to parents who had a child in high school. 5-strongly agree, 4-agree, 3- neither agree nor disagree, 2-disagree, 1-strongly disagree) STEM Parent Awareness Scale has 2 sub-dimensions: 16 in the knowledge sub-dimension and 22 in the attitude sub-dimension. and 38 items. The reliability coefficients of the scale developed and adapted for STEM are given in Table 1.

Table1. Reliability coefficients of the scale developed and adapted

	Developed (Yun, Cardella, Purzer, Hsu, & Chae, 2010)	Adapted for STEM (Gonyea, 2017)
Knowledge	.94	.94
Attitude	.91	.90

Procedure

As the first step of the adaptation of the STEM Parent Awareness Scale to Turkish, Dr. Gonyea was contacted and permission was obtained for the Turkish adaptation of the scale. Then the items of the scale were translated into Turkish. The translation of the scale from English to Turkish, which is the source language, was made by one of the researchers has a good level of English and Turkish and is an expert in science education. The translation was examined by two academicians, who are also experts in science education and have good Turkish and English proficiency. After the necessary revisions were made at the end of the check, an English language expert completed the translation of the scale items back to the source language, English, in order for the two forms to have the same quality in terms of language use and grammar. It was determined that there was no difference in meaning between the two scales. To control the conformity of the translated scale with Turkish, the scale was checked by a Turkish language expert, and revisions were made in terms of grammar rules and words that the expert deemed necessary. The scale items were discussed with four parents. For the content validity of the finalized scale, the opinions of two science educators who have worked on STEM were consulted. As a result of the interviews with them, an item was removed from the scale because it was not suitable for the MEB program and the practices in schools.

After employing the scale to the participants, many analyzes were made for item analysis and construct validity. Item discrimination of the items was determined by the item analysis. For this purpose, Pearson product-moments correlation analysis was performed and the scores of the lower 27% and upper 27% groups were compared with an independent t-test. In addition, the correlation between sub-dimensions forming the scale was calculated. Then, confirmatory factor analysis was performed for the construct validity of the scale. Cronbach's Alpha coefficients were examined for the reliability of the scale.

Results

For the discrimination levels of the items in the Turkish adaptation of the scale, corrected item-total Pearson product-moment correlation values were calculated for each item by item analysis. As seen in Table 2, the correlation values of the items in the attitude sub-dimension except for item 17 and item 18 are between .55 and .86. These two items with a correlation coefficient of $r < .30$ were removed from the scale.

Table 2. Pearson product moment correlation results

Sub-dimension	Items	Corrected item-total r
Knowledge	Item 1	.76
	Item 2	.81
	Item 3	.78
	Item 4	.55
	Item 5	.85
	Item 6	.85
	Item 7	.87
	Item 8	.85
	Item 9	.85
	Item 10	.85
	Item 11	.86
	Item 12	.83
	Item 13	.60
	Item 14	.78
	Item 15	.71
	Item 16	.67
Attitude	Item 1	.74
	Item 2	.79
	Item 3	.80
	Item 4	.78
	Item 5	.79
	Item 6	.83
	Item 7	.68
	Item 8	.73
	Item 9	.85
	Item 10	.87
	Item 11	.85
	Item 12	.76
	Item 13	.81
	Item 14	.76
	Item 15	.86
	Item 16	.79
	Item 17	.20
	Item 18	.17
	Item 19	.76
	Item 20	.67
	Item 21	.80

As another item analysis method, the raw scores obtained from the scale were ranked in ascending order. According to the results of this ranking, the results of the comparison of item scores of the lower 27% and upper 27% groups with the independent t-test are given in Table 3. According to the results of the independent t-tests, the scores of those in the upper 27% group are significantly different from those in the lower 27% group.

Tablo 3. Independent t-tests results

Knowledge		X	SD	t	Attitude		X	SD	t
Item 1	L 27%	1.62	.48	-29.75*	Item 1	L 27%	2.57	.65	-26.92*
	U 27%	4.30	.46			U 27%	4.98	.13	
Item 2	L 27%	1.67	.47	-29.83*	Item 2	L 27%	2.58	.68	-22.99*
	U 27%	4.26	.44			U 27%	4.89	.31	
Item 3	L 27%	1.75	.54	-26.66*	Item 3	L 27%	2.75	.83	-20.12*
	U 27%	4.33	.47			U 27%	5.00	.00	
Item 4	L 27%	2.58	.91	-18.80*	Item 4	L 27%	2.83	.82	-19.56*
	U 27%	4.94	.22			U 27%	5.00	.00	
Item 5	L 27%	1.78	.56	-26.28*	Item 5	L 27%	2.62	.61	-28.67*
	U 27%	4.42	.49			U 27%	5.00	.00	
Item 6	L 27%	1.71	.45	-29.75*	Item 6	L 27%	2.57	.70	-24.97*
	U 27%	4.32	.47			U 27%	4.98	.13	
Item 7	L 27%	1.71	.45	-29.75*	Item 7	L 27%	2.50	.68	-25.28*
	U 27%	4.32	.47			U 27%	4.94	.22	
Item 8	L 27%	1.71	.45	-29.75*	Item 8	L 27%	2.71	.59	-22.70*
	U 27%	4.32	.47			U 27%	4.83	.37	
Item 9	L 27%	1.64	.48	-29.68*	Item 9	L 27%	3.12	.81	-17.31*
	U 27%	4.32	.47			U 27%	5.00	.00	
Item 10	L 27%	1.55	.50	-30.11*	Item 10	L 27%	2.94	.77	-19.88*
	U 27%	4.30	.46			U 27%	5.00	.00	
Item 11	L 27%	1.60	.49	-24.65*	Item 11	L 27%	3.19	.77	-17.46*
	U 27%	4.24	.63			U 27%	5.00	.00	
Item 12	L 27%	1.62	.48	-29.72*	Item 12	L 27%	2.76	.53	-26.24*
	U 27%	4.33	.47			U 27%	4.91	.28	
Item 13	L 27%	2.07	.62	-22.55*	Item 13	L 27%	3.26	.75	-17.27*
	U 27%	4.50	.50			U 27%	5.00	.00	
Item 14	L 27%	1.98	.75	-20.30*	Item 14	L 27%	2.85	.84	-19.07*
	U 27%	4.42	.49			U 27%	5.00	.00	
Item 15	L 27%	1.92	.65	-22.93*	Item 15	L 27%	3.32	.78	-15.92*
	U 27%	4.46	.50			U 27%	5.00	.00	
Item 16	L 27%	1.58	.49	-29.76*	Item 16	L 27%	3.26	.84	-15.39*
	U 27%	4.32	.47			U 27%	5.00	.00	
					Item 17	L 27%	3.42	.82	-14.20*
						U 27%	5.00	.00	
					Item 18	L 27%	2.46	.73	-25.72*
						U 27%	5.00	.00	
					Item 19	L 27%	2.96	.89	-17.04*
						U 27%	5.00	.00	

*p<.001

The correlation between knowledge and attitude, which are sub-dimensions of the scale, was calculated. The correlation value between knowledge and attitude is .51 and it is statistically significant at the $p < .001$ level.

Construct Validity

The construct validity of the scale was tested by confirmatory factor analysis using the LISREL program as seen in Figure 1. When the fit indices of the first confirmatory factor analysis were examined, it was determined that the values were within the acceptable value limits. The fit indices are as follows: $\chi 2$ /df=2.48, NNFI=.96, CFI=.96, RMSEA=.11, PGFI=.57.

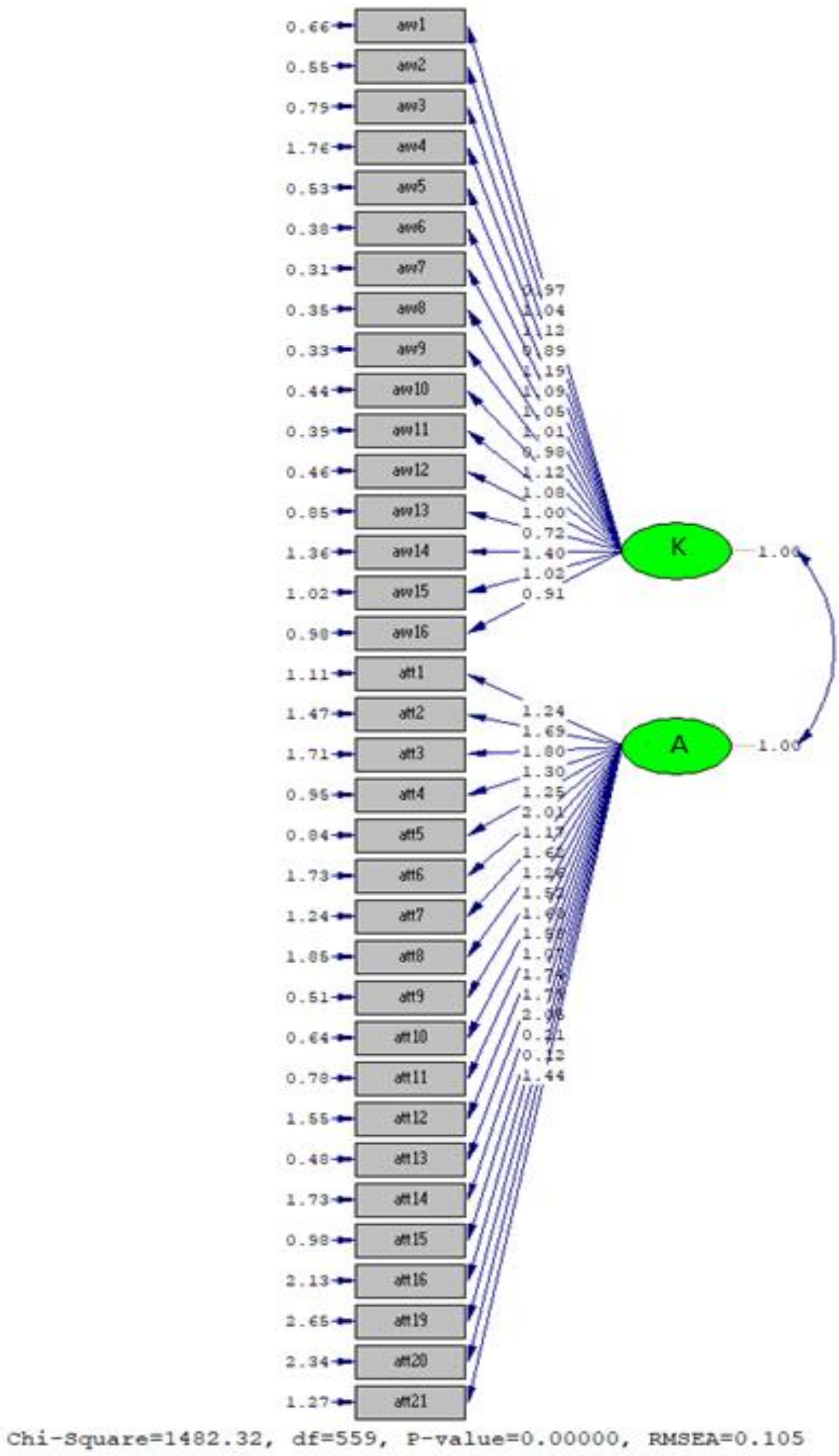

Figure 1. Confirmatory factor analysis

Reliability

In order to determine the internal consistency of the STEM Parent Awareness Scale, the coefficients were calculated. Cronbach's Alpha coefficients were .96 for the knowledge sub-dimension, .97 for the attitude sub-dimension, and .96 for the total scale.

Discussion and Conclusion

In this study, STEM Parent Awareness Scale adapted by Gonyea (2017) was adapted into Turkish. In this study conducted with 207 parents, translation procedures were performed and then content validity was examined. As a result of this analysis, an item that was not compatible with the

MEB program and practices in schools was removed from the scale. Subsequently, the construct validity of the translated scale was checked. Accordingly, item analysis was done first. For item analysis, corrected item-total correlation values were calculated. Corrected item-total correlation values acceptable for item analysis are ≥.30 (Nunnally & Bernstein, 1994). Two items with calculated correlation values below this reference value were removed from the scale. The correlation values of the other items were between .55 and .86, and it was concluded that these items were discriminatory. For item analysis, another method was used and the mean scores of those in the lower 27% and upper 27% groups were compared with the independent t-test. Based on the results of the independent t-tests, it was determined that it was significant at the $p < .001$ level for all items. Therefore, it can be said that the item discrimination level of the scale is high and it distinguishes high and low scores.

In order to examine the construct validity, correlation values between sub-dimensions of the scale were calculated and the result was found to be significant at $p < .001$ level. In addition, the fit indices of the confirmatory factor analysis performed are $\chi 2$ / df = 2.48, NNFI = .96, CFI = .96, RMSEA = .11, PGFI = .57, PNFI = .88. For model fit, $\chi 2$ / df <5 indicates that the model is suitable (Wheaton, Muthen, Alwin, & Summers, 1977). Besides, NNFI and CFI values should be greater than .90 (Bentler & Bonet, 1980; Hu & Bentler, 1999), PGFI and PNFI values should be greater than .50 (Meyers, Gamst, & Guarino, 2006), and RMSEA value should be less than .08 (Browne & Cudeck, 1993). When all these parameter values are compared with the values obtained in the study, it can be interpreted that the factor structure of the Turkish adaptation of the scale is similar to the factor structure of the original scale, except for the RMSEA value. Since the RMSEA value is affected by the sample size (Chen, Curran, Bollen, Kirby, & Paxton, 2008), the reason why the RMSEA value of the study is higher than the reference value may be the small sample size.

The reliability study was examined by calculating Cronbach's Alpha coefficients. The accepted value for reliability in the literature is> .7 (Nunnally, 1978). Considering the results of Cronbach's Alpha coefficients of .96 and .97 in the sub-dimensions and .96 for the total scale, it can be said that the scale is reliable.

As a result, there is no reverse item in the STEM Parent Awareness Scale, the minimum score that can be obtained from the scale is 35 and the maximum score is 175. The application time of the scale is approximately 20 minutes. It is thought that the scale can be used to measure STEM awareness of parents with children from primary school to higher education level.

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EK 1- STEM FARKINDALIK ÖLÇEĞİ

	Kesinlikle Katılıyorum	Katılıyorum	Kararsızım	Katılmıyorum	Kesinlikle Katılmıyorum
1. STEM alanlarında çalışanların mühendislik tasarım ilkelerini nasıl kullandıklarını biliyorum.					
2. STEM alanlarında çalışanların problem çözme stratejilerini nasıl kullandıklarını biliyorum.					
3. STEM alanlarında çalışanların neler yaptığını biliyorum.					
4. Mühendisliğin fen bilimleri, matematik ve teknoloji ile nasıl ilişkili olduğunu biliyorum.					
5. Topluma faydalı olmak için STEM'i nasıl kullanılabileceğimi biliyorum.					
6. STEM'in fen bilimlerinden farklı yanlarını biliyorum.					
7. STEM'in matematikten farklı yanlarını biliyorum.					
8. STEM'in teknolojiden farklı yanlarını biliyorum.					
9. Çocuğuma STEM becerilerini nasıl öğretebileceğimi biliyorum.					
10. STEM ile ilgili kavramları günlük hayatımda nasıl kullanabileceğimi biliyorum.					
11. Çocuğuma STEM ile ilgili kavramları nasıl açıklayabileceğimi biliyorum.					
12. Çocuğumun STEM ile ilgili fikirlerini ve becerilerini geliştirmesinde ona nasıl yardımcı olabileceğimi biliyorum.					
13. Problemleri nasıl tanımlayacağımı ve çözeceğimi biliyorum.					
14. Çocuğumun STEM hakkında daha fazla bilgi edinmesi için gerekli kaynakları nasıl bulacağımı biliyorum.					
15. STEM ile ilgili daha fazla bilgiyi nerede bulacağımı biliyorum.					
16. Çocuğumun okulunda yapılan STEM etkinliklerinin farkındayım.					
1. STEM'in yaşam kalitemizi iyileştirmede rol oynadığına inanıyorum.					
2. STEM alanında yapılan çalışmaların hayatımızı daha kolay hale getirdiğine inanıyorum.					
3. STEM çalışmaya değerdir.					
4. STEM toplumumuzu geliştirir.					
5. STEM alanındaki çalışmaların insanlara yardım ettiğini düşünüyorum.					
6. STEM alanında yapılan çalışmaların, çocuğumun hayatını kolaylaştırdığına inanıyorum.					
7. Çocuğumun STEM alanlarından birinde meslek sahibi olmasını isterim.					
8. Çocuğum üniversitede STEM alanında eğitim almaktan keyif alacaktır.					
9. STEM ile ilgili fikirleri ve becerileri öğrenmenin çocuğum için iyi olacağına inanıyorum.					
10. STEM becerileri çocuğumun kariyeri için faydalı olacaktır.					
11. Çocuğumun okulu, STEM kavramlarını ve becerilerini öğretmelidir.					
12. Çocuğum, eğitim hayatı boyunca (okul öncesinden üniversiteye kadar) STEM öğrenmekten hoşlanacaktır.					
13. Eğitim hayatında STEM öğrenmesi, çocuğumun fen bilimleri, matematik ve teknoloji gibi diğer konuları daha iyi anlamasını sağlar.					
14. Eğitim hayatında STEM öğrenmesi, çocuğumun daha iyi bir yaşam kalitesine sahip olmasını sağlar.					
15. Çocuğumun STEM becerilerini öğrenmesini istiyorum.					
16. Çocuğumun STEM alanında çalışanların ne yaptığını anlamasını istiyorum.					
17. Kız ve erkek çocukların STEM öğrenmeleri eşit derecede önemlidir.					
18. Çocuğumun okulunda yapılan STEM atölyelerine katılmak isterim.					
19. STEM alanları hakkında mümkün olduğunca erken yaşta bilgi edinmek gerektiğini düşünüyorum.					