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Adaptation of teaching engineering self-efficacy scale into Turkish

Filiz DEMİRCİ[1*]

[1]School of Engineering Education, Purdue University, Indiana, U.S.A.

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Abstract

By means of a good understanding of teachers' motivational components in teaching, we are able to gain insight into their teaching performance. One of these personal components is self-efficacy. The aim of the study was to adapt the Teaching Engineering Self-Efficacy Scale (TESS) developed by Yoon (2014) into Turkish to measure the engineering teaching self-efficacy of K-12 teachers. The analysis of the data consisting of 439 science and technology design teachers from across Türkiye was performed using the Mplus program. According to the results obtained from this research, it was determined that the X^2/sd ratio was 2.97, RMSEA was .07, CFI was .95, TLI was .94 and SRMR was .04. in the findings obtained from Model C, with the best fit index values. In addition, it was found that the Cronbach α reliability coefficients (.94 for engineering-pedagogical content knowledge self-efficacy, .95 for engineering engagement self-efficacy, .93 for engineering discipline self-efficacy, and.87 for engineering outcome expectancy, .96 for the entire scale) were found to be at a high level. In sum, the Turkish version of TESS is a valid and reliable scale with 23 items and a four-dimensional structure as in the original.

1 Introduction

In the 21st century associated with digitalization, individuals who are equipped with engineering principles and skills to be trained in many innovative technology fields, such as cloud computing, artificial intelligence, the internet of things, and 3D printing, are necessary. The importance of engineering principles and skills, which deal with many skills such as creative thinking, solving complex problems, critical thinking, effective communication, and cooperation, in terms of economic development has been recognized by many developed countries, and the necessity of engineering education has been emphasized in their national standards.

In this regard, engineering standards were included in the Next Generation Science Standards (NGSS Lead States, 2013) due to the growing national awareness of the United States to include engineering in K-12 education settings (Moore et al., 2014). The United States has incorporated engineering standards into existing science standards at the national and state level (e.g., Oregon, Massachusetts, and Maine) (Moore et al., 2014). In 2009, Minnesota integrated engineering concepts into its K-12 science education standards (Wang et al., 2011). Thus, a set of performance

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*Correspondency: fdemirci@purdue.edu

expectations about what students should do and know about engineering at various stages of their K-12 education are stated in these frameworks (Sneider & Purzer, 2014).

The 2018 Science Education Standards include the 'science, engineering, and entrepreneurship practices' unit ranging from 4th to 8th grades, which aims for the students to have an interdisciplinary perspective to solve engineering problems (Ministry of National Education [MoNE], 2018a). In addition, the integration of engineering in science education has gained importance and necessity by including the 'engineering and design skills' dimension under the field-specific skills section of the program. Similarly, the 2018 Technology and Design Education Standards includes the 'engineering and design' unit in the 8th grade (MoNE, 2018b). Therefore, teachers are expected to have a sufficient level of performance regarding effective engineering teaching practices, which is a new type of knowledge, and studies on engineering practices are becoming increasingly important.

Engineering education can provide an important bridge role in supporting the development of 21st-century skills (National Academy of Engineering [NAE], 2010) and increasing students' science achievement. Using evidence from scientific observations and experiments and applying scientific knowledge is necessary to solve engineering problems. These aspects of science education contribute to the integration of teaching engineering (Ganesh & Schnittka, 2014). Many researchers argue that engineering design used as a focus in engineering teaching is the best approach for teaching science subjects (Hynes, 2009; Massachusetts Department of Education [MDE], 2019; Massachusetts Department of Elementary and Secondary Education [MDESE], 2016; NGSS Lead States, 2013; Pleasant, 2018; Vessel, 2011).

In addition, K-12 engineering education applied in public schools of the United States is a vital part of the STEM (Science, Technology, Engineering, and Mathematics) education initiative (Anonymous, 2020). The main purpose of engineering education is to use inquiry and design skills to solve daily life problems. Viewed in this light, Purzer and Shelley (2018) stated that engineering focused on problem-solving can help bridge the gaps in the success of STEM and globally create prerequisites for stronger analytical skills. Engineering can act as a bridge for students to meaningfully learn mathematics and science content in K-12 settings (Moore et al., 2014). Engineering is a natural connector for integrating STEM disciplines. Therefore, K-12 educators need to understand the nature of engineering to integrate STEM education into their classrooms (Moore et al., 2014).

Investigating the belief systems of teachers is important for gaining insight into their teaching performance (Riggs & Enochs, 1990). One of these emotional factors that directly affect teacher behaviors is self-efficacy. The concept of self-efficacy was introduced in Bandura's (1977) social-cognitive learning theory. According to Bandura (1997), self-efficacy is defined as 'individuals' belief about their ability to perform the actions necessary to achieve a certain goal and to organize these goals.'

Teacher self-efficacy, which is a motivational concept, directly affects their teaching behaviors and student outcomes (Ashton, 1984; Azar, 2010; Boriack, 2013; Gavora, 2010; Gibson & Dembo, 1984; Muijs & Reynolds, 2002; Riggs & Enochs, 1990; Tschannen-Moran & Woolfolk- Hoy, 2001; 2002,). In addition, teaching self-efficacy, affected by teachers' tenure, enthusiasm levels, and motivation, emerges as an important variable that contributes to teacher and student success (Settlage et al., 2009; Tschannen-Moran et al., 1998). Teachers with high self-efficacy beliefs tend to use inquiry-based teaching practices, spend more time on teaching, and apply student-centered innovative teaching strategies (Crawford et al., 2021; Gavora, 2010; Gibson & Dembo, 1984; Schunk, 2014). Teachers with low self-efficacy beliefs tend to spend less time on teaching practices and use more teacher-centered teaching strategies (Bayraktar, 2009). Although teacher self-efficacy is a belief that is hard to change, it can help teachers' self-confidence, and teaching competencies increase in the teaching of engineering concepts and provide a variety of opportunities to engage in engineering activities (Ivey et al., 2016).

Engineering teaching self-efficacy is defined as “a teacher’s personal belief about their ability to positively affect students' engineering learning” (Yoon et al., 2014, p. 464). Teacher self-efficacy is important for the training of secondary school teachers in teaching engineering (Hynes, 2009). Teachers’ teaching approaches related to engineering in their classrooms are affected by their self-efficacy in teaching engineering (Hammack, 2016, p. 38). Therefore, teachers' self-efficacy in engineering practices needs to be strengthened (Lee & Strobel, 2014). Especially since science and technology design teachers are expected to have a sufficient level of performance regarding effective engineering teaching practices, determining their relevant self-efficacy levels is necessary to elicit their classroom practices.

1.1 Related Work

In the literature, there are a couple of studies examining teachers' engineering teaching self-efficacy (Hammack, 2016; Marquis, 2015; Sibuma et al., 2018; Webb, 2015; Yoon et al., 2012, 2014). Sibuma et al. (2018) used the Teacher Efficacy and Attitudes Toward STEM Questionnaire developed by the Friday Institute for Educational Innovation (2012) to measure the engineering teaching self-efficacy of preschool teachers. Webb (2015) also used the Teacher Sense of Self-Efficacy Scale developed by Tschannen-Moran and Hoy (2001) to examine the self-efficacy of classroom teachers by adapting it to engineering teaching. The teaching engineering self-efficacy scale (TESS) as an instrument to examine the effects on teachers' engineering teaching self-efficacy was mostly used in various professional development programs (Benitz & Yang, 2020; Hammack, 2016; Ivey et al., 2016; Marquis, 2015; Pleasants et al., 2021; Schnittka et al., 2014), since TESS is the first valid and reliable scale developed by Yoon et al. (2014) to measure the effectiveness of K-12 engineering teaching (Hammack, 2016; Ivey et al., 2016).

When relevant literature in Turkish culture was examined, it was seen that there was not any instrument available to measure their engineering self-efficacy levels related to teaching engineering in K-12 settings. To address this need, the purpose of this research was to adapt TESS into Turkish to be used in measuring the engineering teaching self-efficacy of Turkish teachers. It is hoped that the adapted scale contributes to the researchers and educational practitioners in terms of studies on determining teachers' self-efficacy levels about engineering teaching and thus, improvement of their self-efficacy.

2 Method

2.1 Research Design

The design of the study was a scale adaptation which was the preparation of a scale whose reliability and validity were tested and proven by conducting a reliability and validity study in another language and culture (Seçer, 2015). The Turkish Version of TESS (see Appendix A) was implemented for the teachers via Google forms.

In this study, steps of the scale adaptation process suggested by Hambleton and Patsula (1999) are presented as follows:

1. Ensuring the existence of structural equivalence in the language and cultural groups
2. Deciding to adapt an existing instrument or to develop a new instrument
3. Selection of qualified translators
4. Translation and adaptation of the original scale into the target language
5. Reviewing the adapted scale and making corrections
6. Implementation of adapted scale in a smaller group
7. Implementation of adapted scale in a larger group
8. Choosing a statistical design to correlate the scores in the original and the target. languages
9. Ensuring language equivalence of the scale
10. Performing validation studies appropriately
11. Preparation of the user guide for the adapted scale and reporting of the process
12. Training of users
13. Keeping the adapted scale up to date

2.2 Participants and dataset

The research group was made up of science and technology design teachers teaching in the fall semester of the 2020-2021 academic year. Teachers were selected using a convenient sampling method across Türkiye. This method involves selecting the closest people to serve as responders and continuing this process until the required sample size is sufficiently obtained from those who are available and accessible (Cohen et al., 2018). In the original scale, K-12 teachers were identified as the target group to measure engineering teaching self-efficacy (Yoon et al., 2014). Therefore, the participants of the study consist of a total of 446 teachers, who involve 301 (67.5%) female, 145 (32.5%) male, 281 (63%) science teachers, and 165 (37%) technology design teachers.

2.3 Instrument

Engineering Teaching Self-Efficacy Scale (TESS) was developed by Yoon et al. (2014) to measure the self-efficacy of K-12 teachers working in the United States regarding teaching engineering (Yoon et al., 2012, 2014). TESS consists of 23 items with a 6-point Likert structure ranging from strongly disagree (1 point) to strongly agree (6 points). Moreover, the scale includes a total of four dimensions: (a) Engineering Pedagogical Content Knowledge Self-Efficacy, (b) Engineering Engagement Self-Efficacy, (c) Engineering Discipline Self-Efficacy, and (d) Engineering Outcome Expectancy. The Cronbach alpha (α) internal consistency coefficients were calculated for each dimension of the TESS and the whole scale through the data obtained from a total of 434 teachers and are presented in Table 1 (Yoon et al., 2014).

The validity and reliability analysis of TESS was obtained from the data of 19 states to conduct validity studies at different education levels. There are two ways to calculate the TESS score: (a) calculating the raw average score of each construct and (b) the overall raw score of TESS. In the first method, one of the four dimensions aims to evaluate the teacher's relevant self-efficacy. First, the total score obtained by the teacher from the items of each dimension is calculated by dividing the number of items in the relevant dimension (for example, KS score = the total score of this dimension/9). Since the scale is a 6-point Likert type, each construct's average score ranges from 1 to 6. The second scoring method calculates a teacher's overall average score of TESS. For this, the first method is completed for each dimension, and then the average scores calculated for the four dimensions are summed. Therefore, the highest score of TESS is 24, while the lowest score is 4 (Yoon et al., 2014).

Table 1 Reliability analysis results of TESS (Yoon et al., 2014, p. 479)

Scale and Dimensions	Abbreviation	Definitions	Cronbach α	Number of Items
Engineering Pedagogical Content Knowledge Self-Efficacy	KS	Teachers' personal beliefs about their ability to teach engineering to facilitate student learning, based on knowledge of engineering that will be useful in a teaching context.	.96	9
Engineering Engagement Self-Efficacy	ES	Teachers' personal beliefs about their ability to engage students while teaching engineering.	.93	4
Engineering Discipline Self-Efficacy	DS	Teachers' personal beliefs about their ability to cope with a wide range of student behaviors during engineering activities.	.92	5
Engineering Outcome Expantancy	OE	Teachers' personal beliefs about the effect of teaching on student learning of engineering.	.89	5
Teaching Engineering Self-Efficacy Scale	TESS	Teachers' personal beliefs about their ability to positively affect students' learning of engineering that reflects the multifaceted nature of self-efficacy of teaching engineering.	.98	23

2.4 Data analysis

Confirmatory Factor Analysis (CFA) was performed with the Mplus program to ensure whether the factor structure of the scale confirms the theoretical structure in the Turkish sample. In this study, chi-square/standard deviation (X^2/df) ratio, Root Mean Square Error of Approximation (RMSEA), Standardized Root-Mean Square Residual (SRMR), Tucker-Lewis Index (TLI), and Comparative Fit Index (CFI) fit indices were used to evaluate the data-model fit of the CFA model. When the fit indices obtained for the model X^2/df ratio is less than 3, the CFI value is ≥.90, the RMSEA and SRMR values are ≤.06 and the TLI value is ≥.90; the model shows a good fit (Bentler & Bonett, 1980; Hu & Bentler, 1999; Thompson, 2004; Kline, 2005).

Before performing CFA, whether the data provided the necessary assumptions for the analysis was examined. First, whether there was missing data in the data was examined, and it was seen that there was no missing data. Then, standard scores (z score +4 to -4) for univariate outliers and Mahalanobis distance ($p<.001$) for multivariate outliers were calculated (Tabachnick & Fidell, 2001). The data of seven individuals with univariate and multivariate outliers were removed from the analysis. Therefore, the validity and reliability studies of the scale were carried out with 439 teachers. The mean, standard deviation, skewness and kurtosis coefficients, and inter-item correlation coefficients were calculated for each item of the scale. While the mean values of the items vary between 2.175 and 5.382, the standard deviation values vary between .878 and 1.282. While the skewness values vary -1,799 and 2,521, the kurtosis values vary between .689 and 2,158. The Mardia test MVN package was used for the multivariate normality of the data (Korkmaz et al., 2015). The two values, one of them is 8912.096 ($p<.05$) for multivariate skewness, and the other is 57.260 ($p<.05$) for multivariate kurtosis, showed that multivariate normality was not met. It was observed that the correlation values of the items vary between .268 and .712 and there was no multicollinearity between the items. Since the data did not normally distribute, the Robust Maximum Likelihood (RML) estimation method was used in the Mplus program.

2.5 Ethical considerations

The ethics committee approval of the study was obtained with the decision dated 25/11/2020 and numbered 2020-96 by the Social and Human Sciences Research Ethics Committee of a university in Türkiye. Before implementing the scale, this approval form, the purpose of the study, and privacy protection were informed to the teachers, and then a checkbox was prompted to make sure that they approved to voluntarily participate in the research.

3 Findings

3.1 Findings of linguistic validation

First, the responsible author who developed the TESS in the original language was gotten permission for the adaptation study. The translation phase of the scale was carried out with four experts, two of whom are linguistic experts in English and Turkish, and the others have expertise in science education and in psychological counseling and guidance (PCG). Two linguistic experts were asked to independently translate the original scale into Turkish.

Secondly, expert opinions in science education and PCG were received about the scale translated into Turkish, and thus, the coherence of translated scale in terms of the meaning, and cultural and theoretical structure was evaluated together. As a result of the expert opinions, the draft translation form of the original scale was created.

Thirdly, a linguistic expert in Turkish was asked to examine the items of the scale in terms of their compatibility with grammar rules and their simplicity and clarity.

Fourthly, the scale translated into Turkish was translated into English, and two of them were academics in the foreign languages department.

Fifthly, the linguistic equivalence of both scales was examined. The original form of the scale and the Turkish Version of TESS were presented to two experts in science education who are fluent in both languages, and they were asked to evaluate the scales in terms of linguistic equivalence. Both experts stated that the Turkish Version of TESS is conceptually and linguistically equivalent to the original scale.

Finally, the translation process was completed after all the experts had a consensus that there was no difference between the original scale and TESS Turkish version.

3.2 Findings related to validity and reliability analysis

The original scale consists of a total of 23 items and four dimensions. CFA was used to reveal whether the scale's factor structure confirmed the Turkish sample's theoretical structure. First-order CFA (Model A) was performed for four dimensions of the scale. Since the total score was obtained from the whole scale and each dimension measures the engineering teaching self-efficacy, a four-factor second-order CFA (Model B) was performed. When the first-order and second-order CFA results were examined, it was observed that a modification was suggested between item 3 and item 9 in the EPCKS dimension and item 19 and item 20 in EOE dimension. Since these items were in the same dimension, second-order CFA (Model C) was reconstructed by adding modifications to the items. The fit indices of the first-order and second-order CFA results are presented in Table 2.

Table 2 Fit indices results of models

Model	X^2	sd	X^2/sd	RMSEA [CI]	CFI	TLI	SRMR
Model A	825.108	224	3.684	.078 (.073-.084)	.925	.915	.040
Model B	838.931	226	3.712	.079 (.073-.084)	.923	.914	.042
Model C	664.656	224	2.967	.067 [.061-.073]	.945	.938	.036

As seen in Table 2, the fit indices obtained from the first and second-order CFAs are very close to each other, and the fit indices of each model are at an adequate level. Since the chi-square is sensitive to the sample size (Schermelleh-Engel et al., 2003), the X^2/sd ratio was considered. When X^2/sd ratio of Model C is less than 3, that means indicating a good fit (Kline, 2005). As a result of the fit index values obtained from the models, that RMSEA, CFI, and TLI showed an acceptable fit, and SRMR showed a good fit. Also, the fit indices of Model C were higher than others.

Also, it was found that standardized item factor loads vary between .574 and .932 for KS dimension, between .846 and .951 for ES dimension, between .797 and .920 for DS dimension, and between .683 and .856 for OE dimension. The R^2 values obtained for each item range from .329 (item 1) to .904 (item 12). Moreover, it was found that the z values of the factor load between the items and the dimensions measured by the items range from 95.227 to 11.086. Also, these values were significant at the .01 level since they were greater than the critical value of 2.58. Relationships and z values between first-order and second-order variables are presented in Table 3.

Table 3 Results of second-order CFA for the Turkish Version of TESS

Second-Order	Beta	SE	z
TESS ➡ KS	.799	.039	20.259*
TESS ➡ ES	.953	.015	62.691*
TESS ➡ DS	.863	.029	29.501*
TESS ➡ OE	.897	.030	30.330*

*: p<.01

As seen in Table 3, the relations between the dimensions measured by the items and the second-order latent variable were high, and the z-values of the standardized factor loads obtained were statistically significant at the .01 level.

Viewed in this light, it was seen that the Turkish Version of TESS was revealed with the second level and four dimensions. The item parameters and standard errors of the scale obtained from the second-order model are presented in Figure 1.

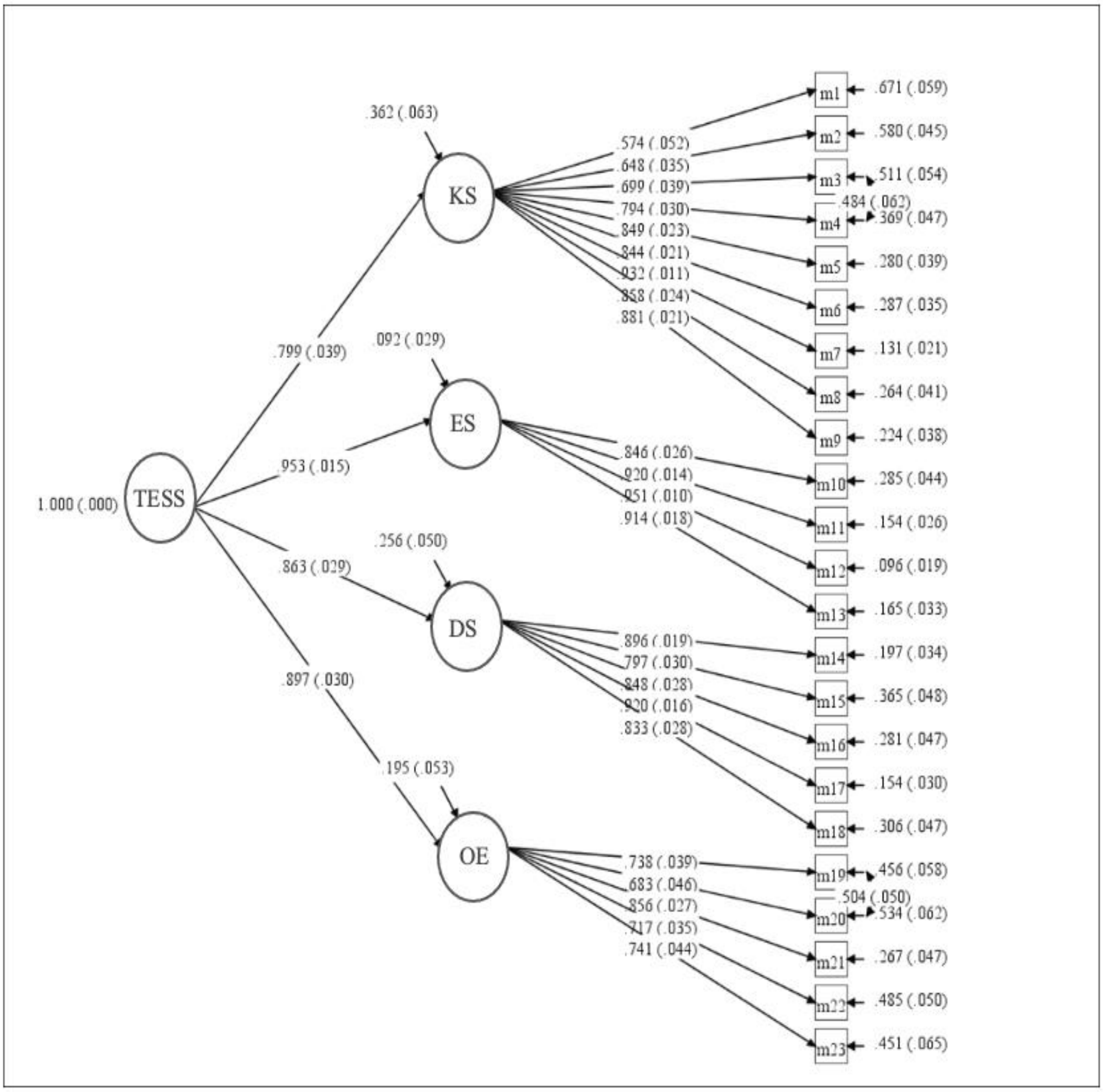

Figure 1 Results of second-order CFA for the Turkish Version of TESS

Convergent and divergent validity methods and explained mean-variance (EMV) values were also examined in the study. Fornell and Larcker (1981) stated that the EMV value should be greater than .50, otherwise, the variance resulting from measurement error would be larger than the variance obtained by the construct, and in this case, the validity of the measured construct could be questioned. The EMV, composite reliability (CR), Cronbach's alpha, and stratified alpha values obtained for each dimension of the scale are presented in Table 4.

Table 4 Values obtained regarding the dimensions for the Turkish version of TESS

Dimensions	EMV	CR	Cronbach α	Stratified Cronbach α
KS	.630	.938	.936	.937
ES	.825	.950	.949	.949
DS	.742	.935	.933	.934
OE	.517	.840	.870	.880
TESS			.961	.963

As seen in Table 4, EMV values are higher than .50 and less than composite confidence values. In addition, the reliability coefficients for the dimensions of the scale and the total scale were found to be higher than .70. Hence, it can be said that the scale has sufficient reliability (Nunnally & Bernstein, 1994). Fornell and Larcker (1981) stated that the EMV values should be larger than the square of the correlation between the constructs, and in this case, discriminant validity would be ensured. The square of the correlation values between the dimensions is presented in Table 5.

Table 5 Square of Correlation Values Between Dimensions

Dimensions	KS	ES	DS	OE
KS	1			
ES	.503	1		
DS	.377	.417	1	
OE	.389	.444	.494	1

As seen in Table 5, the square values of the correlation coefficients between the dimensions were smaller than the EMV values obtained for each dimension. Overall, it can be said that the scale has discriminant validity based on the findings.

4 Discussion and conclusion

Teaching engineering self-efficacy is teachers' personal belief about their ability to positively affect students' learning of engineering (Yoon et al., 2014). When we consider its importance, first determining the current self-efficacy levels regarding their teaching engineering is necessary. To do this, there is a need for a valid and reliable instrument to measure the engineering teaching self-efficacy levels of teachers. In this regard, the purpose of the study is to adapt TESS developed by Yoon et al. (2014) into Turkish to provide an instrument that can be used to measure teachers' self-efficacy in teaching engineering.

TESS was originally developed for K-12 teachers throughout the United States (Yoon et al., 2012). In the study, the scale adaptation process was carried out for science and technology education teachers since the standards science (MoNE, 2018a) and technology and design (MoNE, 2018b) involve the concept of engineering, Therefore, the target users of the Turkish version of TESS are only these two types of teachers.

The scale's validity and reliability analyzes were carried out with the data obtained from 439 teachers who participated in the study from various provinces of Türkiye. CFA was used to reveal whether the scale's factor structure confirmed the Turkish sample's theoretical structure. First-order CFA (Model A) was performed for four dimensions of the scale. As a result of the second-order CFA (Model C) which includes the best fit index values, the X^2/sd ratio of Model C is less than 3, indicating a good fit (Kline, 2005). As a result of the fit index values obtained from each model, that RMSEA, CFI, and TLI showed an acceptable fit and SRMR showed a good fit. Also, the fit indices of Model C were higher values than the indices of others. Viewed in this light, it was explored that the Turkish Version of TESS was revealed with the second-order and four dimensions. In addition, since Cronbach alpha reliability coefficients of the adapted scale vary between .87 to .96 (.94 for engineering pedagogical content knowledge self-efficacy, .95 for engineering engagement self-efficacy, .93 for engineering discipline self-efficacy, and .87 for engineering outcome expectancy, .96 for the whole scale), all of which have high reliability (Nunnally & Bernstein, 1994). The results demonstrated that the Turkish version of TESS is a valid and reliable scale with 23 items and a four-dimensional structure as in the original scale.

In sum, the Turkish Version of TESS is expected to enable researchers in this field to gain insight into their teaching behaviors by eliciting teachers' self-efficacy in teaching engineering.

4.1 Limitations and future directions

Based on the results obtained from this research, the following are suggested for researchers and educational practitioners in K-12 settings:

i. With the reconceptualization of teaching engineering in future studies, the dimensions of the scale may change. The Turkish Version of TESS will be a pioneer for future development or adaptation studies of self-efficacy scales related to teaching engineering for teacher preparation programs in Türkiye.
ii. The Turkish Version of TESS can be guided to investigate the effect of teacher professional development programs focused on K-12 engineering education on teachers' teaching self-efficacy. Especially the teachers' self-efficacy dimensions with low levels can be detected through this scale, and then various strategies can be developed to improve relevant self-efficacy dimensions.
iii. Classroom teachers are responsible for the "science, engineering and entrepreneurship practices" unit of the 4th-grade science curriculum, according to which students are expected to effectively present their products designed during the year in a science festival. For this reason, the Turkish Version of TESS can be the pioneer of adaptation studies for elementary school teachers to understand their classroom behaviors.
iv. One of the limitations of the study is that there is not any framework to define teachers' competencies related to pre-college engineering education in Türkiye. This scale can contribute to revising teacher competencies of Turkish MoNE based on the engineering teaching self-efficacy scale. Similarly, The MoNE may also provide researchers with a framework including national teacher competencies related to teaching engineering to develop a new self-efficacy scale compatible with the framework.

5 Statement of Researchers

5.1 Contribution rate statement of researchers: None

5.2 Conflict statement: None

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Appendix A: Turkish Version of Teaching Engineering Self-Efficacy Scale

Mühendislik Öğretimi Öz-Yeterlik Ölçeği

Burada mühendislik öğretimi öz-yeterliği, öğrencilerin mühendislik öğrenimini olumlu yönde etkileyecek öğretim yeteneğine ilişkin kişisel inançlar olarak tanımlanır. Lütfen ölçekteki her bir ifadeye ilişkin katılım derecenizi, sizin için en uygun kutucuğu işaretleyerek belirtiniz.	**1:** Kesinlikle katılmıyorum **2:** Kısmen katılmıyorum **3:** Kabul etmekten biraz daha fazla katılmıyorum **4:** Kabul etmemekten biraz daha katılıyorum **5:** Kısmen katılıyorum **6:** Kesinlikle katılıyorum

1	Mühendisliğin günlük hayatımla nasıl bağlantılı olduğunu tartışabilirim.	1	2	3	4	5	6
2	Tüm konu alanlarındaki mühendislik kavramlarını tanıyabilir ve anlayabilirim.	1	2	3	4	5	6
3	Sınıfıma mühendislik dersleri planlamak için gerekli zamanı harcayabilirim.	1	2	3	4	5	6
4	Sınıfımda mühendislik etkinliklerini etkin şekilde uygulayabilirim.	1	2	3	4	5	6
5	Öğrencilerime mühendislik hakkında iyi sorular oluşturabilirim.	1	2	3	4	5	6
6	Verilen kriterlerin bir mühendislik projesinin sonucunu nasıl etkilediğini tartışabilirim.	1	2	3	4	5	6
7	Öğrencilerimin mühendislik tasarım süreciyle çözüm geliştirmelerine rehberlik edebilirim.	1	2	3	4	5	6
8	Öğrettiğim mühendislik materyallerine ilişkin öğrenci kavrayışlarını ölçebilirim.	1	2	3	4	5	6
9	Öğrencilerimin mühendislik ürünlerini değerlendirebilirim.	1	2	3	4	5	6
10	Öğrencilerimde mühendislik öğrenmeye yönelik pozitif bir tutum geliştirilebilirim.	1	2	3	4	5	6
11	Mühendislik uygulamaları yaparken öğrencilerimi eleştirel düşünmeye teşvik edebilirim.	1	2	3	4	5	6
12	Mühendislik etkinliklerinde uygulama yaparken öğrencilerimi birbirleriyle etkileşimde bulunmaya teşvik edebilirim.	1	2	3	4	5	6
13	Mühendislik etkinlikleri ve dersleri boyunca öğrencilerimi yaratıcı düşünmeye teşvik edebilirim.	1	2	3	4	5	6
14	Mühendislik etkinlikleri boyunca rahatsız edici veya gürültülü bir öğrenciyi sakinleştirebilirim.	1	2	3	4	5	6
15	Mühendisliği öğretirken davranış problemi olan öğrencilerin anlamasını sağlayabilirim.	1	2	3	4	5	6
16	Birkaç problemli öğrencinin bütün mühendislik dersini mahvetmelerinden alıkoyabilirim.	1	2	3	4	5	6
17	Mühendislik etkinlikleri boyunca sınıfımdaki rahatsız edici davranışları kontrol edebilirim.	1	2	3	4	5	6
18	Mühendislik etkinlikleri için bir sınıf yönetimi sistemi kurabilirim.	1	2	3	4	5	6
19	Bir öğrenci mühendislikte genelde aldığından daha iyi bir not aldığında, bu genellikle öğrenciye daha iyi öğretim yolları bulmamdan kaynaklanır.	1	2	3	4	5	6
20	Öğrencim mühendislikte genelde olandan daha iyi olduğu zaman, bu genellikle biraz daha çaba sarf etmemden kaynaklanır.	1	2	3	4	5	6
21	Mühendislik öğretiminde çabamı artırırsam, öğrencilerin mühendislik başarılarında önemli değişiklik görürüm.	1	2	3	4	5	6
22	Öğrencilerimin mühendislik başarılarından genellikle sorumluyum.	1	2	3	4	5	6
23	Mühendislik öğretimindeki etkililiğim düşük motivasyonlu öğrencilerin başarılarını etkileyebilir.	1	2	3	4	5	6