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Mathematics Teaching Anxiety Scale: Construction, Reliability and Validity

Vesile Alkan [1,*], **Tolga Coşguner** [1], **Yücel Fidan** [1]

[1]Pamukkale University, Faculty of Education, Kınıklı Campus, 20070, Denizli, Turkey

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Abstract: This study aimed to develop mathematics teaching anxiety scale for prospective primary school teachers. It was designed based on survey method and conducted with four sampling group consisting of 956 prospective primary school teachers at Education Faculties in Turkey. First sampling group was consisted of 404 prospective primary school teachers and 96 out of it were involved in the application of open-ended questions and 308 were involved in exploratory factor analysis. 305 prospective primary school teachers in the second sampling group participated in the confirmatory factor analysis, 108 prospective teachers in the third group were involved in criterion validity and 139 prospective teachers in the fourth one participated in the test-retest reliability analysis. As a result of the principal component analysis of the Mathematics Teaching Anxiety Scale (MTAS), it was found that the scale indicating single factor structure and consisting of 31 items (47.43% of the total variance). After suggested modifications, the scale MTAS was constructed with 19 items. 12 items were removed from the scale and the confirmatory factor analysis (CFA) was carried out with 19 items. According to CFA results ($0 \leq X2 / df = 1.483 \leq 2$, RMSEA = 0.040, RMR = 0.050, AGFI = 0.908, TLI = 0.972, CFI = 0.976, IFI = 0.976, GFI = 0.928, NFI = 0.930 and RFI = 0.919), it was confirmed that the scale structure was consisting of 19 items and one dimension. The Cronbach's alpha coefficient of the final form of Mathematics Teaching Anxiety Scale was calculated as 0.93.

1. INTRODUCTION

A global improvement in Information and Communication Technology (ICT) and being an interconnected world cause differences in not only individuals' social lives but also their school lives. The rapid change in the world enables individuals to share their knowledge effortlessly and this situation results in being aware of improvements and innovations around the world. Due to these changes, the content of education in terms of disciplines and teaching strategies and styles of them are also changing (Voogt & Roblin, 2010; Trilling & Fadel, 2009).

Students of new world need to gain a set of competencies that would help them better coping with the compulsive demands of 21st century. In this sense, it could be said that mathematics is crucial for 21st century skills in that it enables to think analytically, critically and creatively which then enable to gain problem solving and reasoning skills. This means mathematics helps thinking analytically, having better problem-solving skills and having better reasoning abilities.

CONTACT: Vesile ALKAN ✉ vesile@pau.edu.tr Pamukkale University, Faculty of Education, Kınıklı Campus, 20070, Denizli, Turkey

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These skills are significant in providing individuals to find out the way of solving problems and looking for solutions in their lives. Therefore, learning and teaching mathematics in schools has become even more significant in today's world.

As emphasized by Tobias (1978) learning mathematics is intellectual but also emotional. Learning mathematics is related with how students can solve mathematical operations, how they can comprehend mathematical literacy and how they are competent in mathematics. However, it should be also noted that learning mathematics is also related with how students use their cognitive intelligences on how to succeed. On the one hand this suggests cognition and emotion are intertwisted in learning mathematics. On the other hand, even though mathematics and mathematical knowledge are used not only in schools but also regularly in everyday lives, students may avoid learning mathematics due to negative emotional reactions.

Many studies (Aiken, 1970; Alkan, 2009; 2010; 2011 & 2013; Ashcraft, 1995; Baloğlu, 1999; Bessant, 1992; Bourne, 1995; Campbell & Evans, 1997; Chipman, Krantz & Silver, 1992; Dowker, Sarkar, & Looi, 2016; Gierl & Bisanz, 1995; Hembree, 1990; Izard, 1972; Kitchens, 1995; Ma & Xu, 2004; Peker & Ertekin, 2011; Posamentier & Stepelman, 1986; Richardson, 1980; Skiba, 1990; Şahin, 2004; Tobias, 1978; Tobias, 1990; Vukovic, Kieffer, Bailey & Harari, 2013; Wu, Willcutt, Escovar & Menon; 2014; Zettle & Houghton, 1998; Zettle & Raines, 2000) indicated that some students at different grades of schools have negative attitudes towards mathematics which in turn cause feeling anxiety in mathematics. As suggested by given studies, it can be said that there is a lack in considering affective features of students in mathematics. In addition to this, it is suggested that students' anxiety in mathematics is attributable to such reasons like personality, parents, peers as well as teachers along with their teaching strategies and styles.

It can be accepted that teachers are one of the most powerful influences on students' learning of mathematics. Bandura (1993) emphasized that *"teachers' beliefs in their personal efficacy to motivate and promote learning affect the types of learning environments they create and the level of academic progress their students achieve"* (p. 117). From this point, it can be said that self-efficacy can be the predictor of teachers' effectiveness in mathematics (Hashmi & Shaikh, 2011; Swackhammer, Koellner, Basile, & Kimborough, 2009). Additionally, a wide body of studies (Alkan, 2009; 2011; Fiore, 1999; Geist, 2010; Sheilds, 2006; Sloan, 2010; Stuart, 2000) determined that teachers can cause, increase or reduce students' anxiety in mathematics at all levels of schooling on account of their attitudes and behaviours along with the teaching methods and the instructional strategies they use.

Swars, Daane & Giesen (2006) stated that there was a negative relationship between self-efficacy for teaching and mathematics anxiety. This means teacher with high level self-efficacy can convey their confidence in mathematics to students (Mji & Arigbabu, 2012) whereas those with low self-efficacy can cause students to feel negative attitudes towards mathematics. It was found in studies that teachers who are mathematics anxious fail in conveying important mathematical concepts and in allocating enough time for teaching these important concepts (Alkan, 2009; Dunkle, 2010; Fiore, 1999; Hembree, 1990 and Stuart, 2000). It can be also assumed that mathematics anxious teachers can transfer their negative attitudes in mathematics to their students.

Learning mathematics and teaching mathematics can be affected not only by the level of students' anxiety but also by the level of teachers' mathematics anxiety along with their teaching anxiety in mathematics (Alkan, 2009, 2011 and Baloğlu, 2001). The results of some studies indicated that there was a strong relation between teachers' mathematics anxiety and mathematics teaching anxiety (Bursal & Paznokas, 2006; Gresham, 2008; Swars et al., 2006). Furthermore, it was found that teachers' negative feelings and attitudes in teaching mathematics can create anxiety and increase the level of anxiety of students in mathematics (Alkan, 2009,

2011; Baloğlu, 1999; Beilock & Willingham, 2014; Finlayson, 2014; Furner & Berman, 2003; Sparks, 2011; Uusumaki & Nason, 2004; Vinson, 2001).

Mathematics teaching anxiety can be define as teachers' feeling negative reaction to mathematics, feeling under pressure to teach mathematics and being frustrated with the lack of progress in mathematics. Teachers who feel anxiety in teaching mathematics might have fear of explaining concepts, formulae and operations in mathematics. However, it should be noted that mathematics is cumulative; there is a relation between prior knowledge, current and further knowledge in mathematics. This means the teacher needs to clarify each topic in mathematics in order not to cause students to fall behind. In addition to this, the teacher needs to help students to comprehend each concepts and operations in mathematics clearly.

Ölmez and Cohen (2018) emphasized that teachers are expected to provide supportive classroom setting in which lessening students' negative feelings towards mathematics. Furthermore, teachers are expected to enhance students' involvement in mathematics by helping to build connections with real-life situations and also building their self-confidence in mathematics. Although these expectations are specified, it should be considered that teachers having negative attitudes towards mathematics and teaching mathematics can fail in meeting these. Therefore, it is crucial to find out the level of mathematics teaching anxiety of teachers to deal with their anxieties in teaching mathematics.

As given in many studies above, there is an association between students' negative feelings in mathematics and teachers' anxiety and teaching anxiety in mathematics. It should be noted that feeling anxiety in mathematics can be started at primary school and raise at other levels of schooling and can transfer to the professional life. Like teachers, prospective teachers' teaching efficacy and self-confidence in mathematics can have an impact on their learning mathematics and then their teaching process (Hudson, Kloosterman& Galindo, 2012). Levine (1993; 1996) claimed that prospective teachers have difficulties in teaching mathematics due to their teaching anxiety. Hence, mathematics anxious prospective teachers may avoid mathematics and mathematics related courses which in turn cause teaching in a way that unconsciously leading their students to feel anxiety in mathematics.

Prospective teachers especially for primary schools are significant resources for future mathematics lessons in schools and for improving future students' self-efficacy in mathematics. For this reason, it is needed to improve their teaching efficacy in mathematics in order to help these future teachers to be successful in their teaching in mathematics (Ryang, 2012). Gurin and et al, (2017) stated that there was a slight increase on studies conducted to find out the relation between teachers' mathematics anxiety and students' mathematic anxiety. Moreover, it is seen that there is a few studies focusing on prospective teachers' teaching anxiety in mathematics. These situations show that there is a need to investigate teachers' and prospective teachers' mathematics teaching anxiety in order to find out the ways of diminishing their and students' anxiety in mathematics. It is assumed that the results of studies focusing on mathematics teaching anxiety can contribute to the area of teaching mathematics. On the other hand, there is also need to find out the level of prospective teachers' mathematics teaching anxiety in order to help them to reduce or overcome this anxiety. Consequently, this study aimed to develop a scale for mathematics teaching anxiety based on prospective primary school teachers' perceptions.

2. METHOD

This study was designed in terms of quantitative approach to construct a scale for mathematics teaching anxiety for prospective teachers. To this view, a scale development steps were used.

2.1. Sampling

The participants of this study consisted of 956 prospective primary school teachers at Education Faculties in Turkey. These participants were included in four different sampling groups. The first group of this study was consisted of 404 prospective primary school teachers and 96 prospective teachers from this group were used in the application of open-ended questions and 308 of them ($\overline{X}$= 21.87, Sd = 1.83; female = 233, male = 75) were used for exploratory factor analysis. A total of 305 ($\overline{X}$= 21.95, Sd = 1.31; Female = 234, Male = 71) prospective primary school teachers in the second sampling group were used for confirmatory factor analysis, 108 prospective primary school teachers in the third group ($\overline{X}$= 21.80, Sd = 1.01; Female = 91, Male = 10) were used for criterion validity studies. Lastly, 139 prospective primary school teachers in the fourth sampling group (female = 111; male = 28) were included in test-retest reliability studies.

2.2. Assessment Measures

During the development of the Turkish version of Mathematics Teaching Anxiety Scale (MTAS), the steps proposed by De Vellis (2014), Tavşancıl (2006) and Erkuş (2014) were followed. In order to develop the scale, first of all, the literature and assessment tools were reviewed and examined. After that, the form including open-ended questions was given to prospective primary school teachers and based on their answers 57 items were prepared for the scale within the conceptual frame. Then, the draft scale form was sent to the experts who worked on such topics as mathematics teaching, anxiety and mathematics anxiety. This supported the content-related validity of the scale. In line with the recommendations of these experts, 5 items were removed from the form and suggested corrections were done. After the scale's items were clarified according to the views, the original form of the scale consisting of 52 items was designed.

Items were rated on a 5-point Likert type ranging from 1 to 5. The ranges of the scale were 1 (Strongly disagree), 2 (Slightly agree), 3 (Partially agree), 4 (Mostly agree), and 5 (Completely agree). Volunteer prospective primary school teachers were involved in data collection process. Before the data collection the participants were informed about the study and the data collection tool.

In order to perform confirmatory factor analysis, the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) was used. This instrument was used to measure prospective teachers' efficacy beliefs in teaching mathematics. The original scale was developed by Enochs, Smith & Huinker (2000). Its first adaptation to Turkish was carried out by Çakıroğlu (2000), and the second one was by Hacıömeroğlu & Şahin - Taşkın (2010). The current adapted version of the scale was used in the present study. This instrument was consisted of 17 items and 7 out of these items were scored reversely.

2.3. Data Analysis

SPSS 22.00 package program and AMOS 18.00 program were used to analyse the data. The principal component analysis within the scope of exploratory factor analysis (EFA) was performed using the Kaiser Criteria (eigenvalue> 1). After finding by the exploratory factor analysis that the scale was uni-dimensional, the Cronbach Alpha coefficient was calculated to determine the internal consistency of the scale. Confirmatory factor analysis was done with the help of AMOS 18.00 program (Byrne, 2009). For the criterion validity of the scale, Pearson product moment correlation coefficient was measured between the Mathematics Teaching Efficacy Belief Instrument (MTEBI) and the scale. In the analysis phase, whether the data had a univariate normal distribution in each study group was examined at first. It was determined that the data obtained from all study groups had a univariate normal distribution and the skewness and kurtosis values were between -1 and +1 (Muthén & Kaplan, 1985).

3. RESULTS

3.1. Exploratory Factor Analysis

While doing the Exploratory Factor Analysis (EFA), primarily the data gathered from the study group with whom MTAS consisting of 52 items applied was investigated. In this context, the chi-square value of the Bartlett Sphericity Test was found to be significant with 8973.88 (p <0.000), and the Kaiser-Meyer-Olkin value (0.949) was found to be sufficient. In the light of these results, it was determined that the data obtained from the first study group was suitable for factor analysis (Albayrak, 2006; Şencan, 2005). In order to determine the factor structure of the MTAS, a single-factor structure consisting of 31 items was determined as a result of the principal components analysis carried out based on the criteria of screen-plot and eigenvalue> 1.0 and it was revealed that this structure explained 47.43% of the total variance (Kline, 1994).

The Cronbach Alpha coefficient was preferred in the calculation of the reliability coefficient of the MTAS, since it yielded consistent results in determining the reliability of the assessment tools with a single factor structure (Tan, 2009). In this respect, the lowest acceptable value for Chronbach Alpha coefficient was determined to be ≥ 0.70. The reliability value of the MTAS was found to be 0.96, which is a high value (Hair, Anderson, Tatham & Black, 1998; Nunnally & Bernstein, 1994). The test-retest reliability coefficient of the MTAS was calculated to be 0.703 and this value was considered equal to the acceptable limit value. The factor loadings of the items on the MTAS, common variance and Cronbach Alpha coefficient for the single-factor structure of the scale is given in Table 1.

Table 1. *Results of the Exploratory Factor Analysis of Mathematics Teaching Anxiety Scale (N = 308)*

Item No	Item	Factor 1	Common Variance
M29	When a student does not understand mathematical operations, I get anxious about how to explain them. *Matematiksel işlemleri öğrenci anlamadığında nasıl açıklayacağım endişesi yaşarım.*	0.770	0.613
M27	A rise in the level differences among my students while teaching mathematics worries me. *Matematik dersini işlerken öğrencilerim arasında düzey farklılıklarının artmasından endişelenirim.*	0.747	0.591
M40	Until I gain experience in teaching, I feel fear about my lack of conveying mathematical concepts on time. *Deneyim kazanana kadar matematik kavramlarını zamanında kazandıramamaktan korkarım.*	0.737	0.631
M44	I feel worry about not being able to teach in mathematics according to my students' level. *Matematik dersini öğrencilerimin düzeylerine göre anlatamayacağım endişesi yaşarım.*	0.732	0.539
M23	The thought that I cannot concretize the abstract concepts in mathematics frightens me. *Matematik dersinde soyut kavramları somutlaştıramama düşüncesi beni korkutur.*	0.730	0.599
M35	I feel anxious while considering students' individual differences in teaching mathematics. *Matematik öğretirken bireysel farklılıkları göz önünde bulundurma zorunluluğu beni endişelendirir.*	0.729	0.646
M43	I feel worry that I do not know how to teach mathematical concepts to students. *Matematik kavramlarını kazandırırken nasıl öğreteceğimi bilmediğim için tedirgin olurum.*	0.726	0.605
M46	I feel anxious that I may fail in bringing my students having different readiness levels to the same level in mathematics. *Matematik dersinde hazırbulunuşluk düzeyi farklı olan öğrencilerimi aynı düzeye getiremeyeceğim endişesi yaşarım.*	0.724	0.559
M26	I feel anxious about not relating the content of mathematics with students' daily lives. *Matematik dersinde işlenecek konuyu günlük yaşamla ilişkilendiremeyeceğim endişesi yaşarım.*	0.722	0.635

Table 1. *Continues*

Item No	Item	Factor 1	Common Variance
M31	I feel anxious that I cannot finish the outcomes of the mathematics curriculum on time. *Matematik programındaki kazanımları zamanında bitiremeyeceğim endişesi yaşarım.*	0.722	0.525
M50	I'm afraid of losing my classroom control if I cannot solve the problems in mathematics. *Matematik dersinde problemleri çözemezsem sınıftaki hâkimiyetimi kaybetmekten korkarım.*	0.719	0.752
M52	I feel anxious about how I'm going to teach the subjects that I feel incompetent in mathematics. *Matematik dersinde kendimi yeterli hissetmediğim konuları öğrencilerime nasıl kazandıracağım endişesi yaşarım.*	0.705	0.587
M25	I'm worried about not using the appropriate method and technique in mathematics. *Matematik dersine uygun yöntem ve tekniği kullanamama endişesi yaşarım.*	0.697	0.589
M41	I'm worried about not enabling my students' to engage in mathematics actively. *Öğrencilerimin matematik dersine aktif katılımını sağlayamama endişesi yaşarım.*	0.696	0.630
M22	The thought that the student cannot comprehend when I turn a concept into a mathematical sentence (e.g. 2 + 3) makes me anxious. *Bir kavramı matematiksel cümleye (ör: 2+3) dönüştürdüğümde öğrencinin anlayamayacağı düşüncesi beni tedirgin eder.*	0.696	0.586
M34	I get anxious about designing activities that are appropriate for my students' level in mathematics. *Matematik dersinde öğrencilerimin düzeyine uygun etkinlik hazırlama endişesi yaşarım.*	0.695	0.554
M49	The thought that the level differences of the students in mathematics may reduce the interest of attending the lesson disturbs me. *Matematik dersinde öğrencilerin düzey farklılıklarının derse olan ilgiyi azaltacağı düşüncesi beni rahatsız eder.*	0.692	0.561
M39	I feel uneasy with the thought that I cannot enable my students to like mathematics. *Matematiği sevdiremeyeceğim düşüncesi beni huzursuz eder.*	0.679	0.671
M18	I am afraid that the level differences of the students in mathematics may affect my teaching pace. *Matematik dersinde öğrencilerin düzey farklılıklarının ders işleme hızımı etkilemesinden korkarım.*	0.674	0.558
M21	I am afraid that students with fewer interests in mathematics may reduce the interest of other students. *Matematik dersine ilgisi az olan öğrencilerin diğer öğrencilerin ilgisini azaltmasından korkarım.*	0.674	0.608
M37	I am afraid that families will criticize me if I cannot catch up with the mathematics curriculum. *Matematik programını yetiştiremezsem ailelerin beni eleştirmesinden huzursuz olurum.*	0.672	0.495
M33	I am afraid that school administrators will criticize me if I cannot catch up with the mathematics curriculum. *Matematik programını yetiştiremezsem okul yöneticilerinin beni eleştirmesinden korkarım.*	0.659	0.509
M19	The fact that my students have different readiness levels in mathematics frightens me in the early years of my professional life. *Meslek yaşantımın ilk yıllarında öğrencilerimin matematik dersindeki hazırbulunuşluk düzeylerinin farklı olması beni korkutur.*	0.656	0.621
M28	I am anxious since I believe that I do not have sufficient knowledge about teaching mathematics. *Matematik öğretimine yönelik yeterli bilgiye sahip olmadığımı düşündüğümden endişelenirim.*	0.651	0.634
M48	I feel fear of being humiliated by the students if I cannot solve problems in mathematics. *Matematik dersinde problemleri çözemezsem öğrencilerin gözünde küçük düşmekten korkarım.*	0.648	0.636
M24	It makes me uncomfortable to know that the next lesson I will teach is mathematics. *İşleyeceğim bir sonraki dersin matematik olduğunu bilmek beni huzursuz eder.*	0.647	0.693

Table 1. *Continues*

M15	I feel anxious if the differences in the level of the students in mathematics affect my classroom management. *Öğrencilerin matematik dersindeki düzey farklılıklarının sınıf hâkimiyetimi etkilemesinden endişelenirim.*	0.630	0.599
M30	I feel insecure about the thought that my students having level differences in mathematics can isolate themselves from the class eventually. *Matematik dersinde düzey farklılıkları olan öğrencilerimin zamanla kendilerini sınıftan soyutlayabilecekleri düşüncesi beni huzursuz eder.*	0.606	0.615
M3	I'm worried that I cannot motivate the students due to my prejudices against mathematics. *Matematiğe yönelik önyargılarımdan dolayı öğrencileri motive edemeyeceğim endişesi yaşarım.*	0.585	0.455
M13	I feel uncomfortable in mathematics since I do not have enough experience. *Yeterli deneyime sahip olmadığım için matematik dersinde kendimi huzursuz hissederim.*	0.585	0.414

Chronbach's Alpha Coefficient: 0.96

3.2. Confirmatory Factor Analysis

AMOS 18.00 program was used in order to perform the confirmatory factor analysis (CFA) of the MTAS and maximum likelihood method was opted for the estimation of model parameters (Tezbaşaran, 1997). The structure consisting of 31 items and one dimension as a result of exploratory factor analysis was tested via confirmatory factor analysis. The result of the analysis indicated that some of the items exhibited a high correlation with each other.

In this respect, the items exhibiting correlations were removed from the scale. Yet, after suggested modifications, the scale MTAS was constructed with 19 items and one dimension. The confirmatory factor analysis values of the MTAS and the suggested are illustrated in Figure 1.

It is stated that there are three types of fit that are practical for all fit measures and can be represented as absolute, incremental and restricted fit in the CFA (Schumacker and Lomax, 2010). In this study, X^2, RMSEA, GFI and RMR were used to evaluate the absolute fit. AGFI, NFI, TLI, CFI, RFI and IFI were used as incremental fit measures. The fit values for CFA are shown in Table 2.

Table 2. *Goodness of Fit Indices in the Confirmatory Factor Analysis*

X^2	X^2/df	*p*-value	RMSEA	GFI	RMR	AGFI	NFI	TLI	CFI	RFI	IFI
220.963*	1.483	0.000	0.040	0.928	0.050	0.908	0.930	0.972	0.976	0.919	0.976

* $p<0.01$

When Table 2 is examined, it is seen that X^2 value (X^2 = 220.963; df = 126, p <0.01) is significant (Timm, 2002). However, this statistic is considered to be a weak absolute fit (Timm, 2002). When the relevant literature is reviewed, it is observed that X^2 value is significant in large samples (Byrne, 1989). For this reason, X^2/df, which is another proposed statistic, was calculated and it was found that this statistic ($0 \leq X^2/df = 1.483 \leq 2$) showed good fit (Kline, 2011; Sümer, 2000). When the other fit indices were examined, it was observed that RMSEA (0.040), RMR (0.050), AGFI (0.908), TLI (0.972), CFI (0.976) and IFI (0.976) showed a good fit. The indices with acceptable fit values included GFI (0.928), NFI (0.930) and RFI (0.919) (Hair, Black, Babin & Anderson, 2014; Browne & Cudeck, 1993; Baumgartner & Homburg, 1996; Bentler, 1980; Bentler & Bonett, 1980; Marsh, Hau, Artelt, Baumert & Peschar, 2006; Schermelleh–Engel & Moosbrugger, 2003; Kline,1991). When these values are examined, it can be stated that the MTAS has a good fit. Table 3 shows the 19-item MTAS, standardized factor loadings and standard error values of this scale.

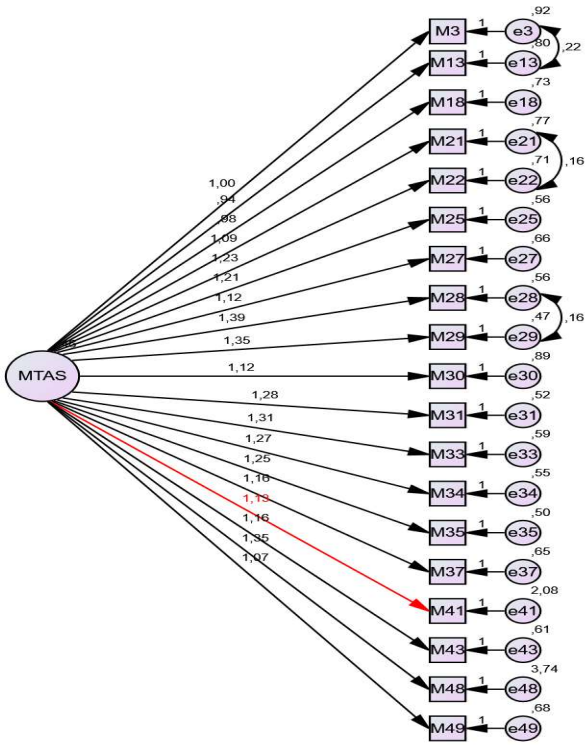

Figure 1. Results of the Confirmatory Factor Analysis of MTAS

Table 3. *Confirmatory Factor Analysis Item Statistics*

Item No		Standardized Factor Loadings	S.E.
M3	I'm worried that I cannot motivate the students due to my prejudices against mathematics. *Matematiğe yönelik önyargılarımdan dolayı öğrencileri motive edemeyeceğim endişesi yaşarım.*	0.577	
M13	I feel uncomfortable in mathematics since I do not have enough experience. *Yeterli deneyime sahip olmadığım için matematik dersinde kendimi huzursuz hissederim.*	0.580	0.096
M18	I am afraid that the level differences of the students in mathematics may affect my teaching pace. *Matematik dersinde öğrencilerin düzey farklılıklarının ders işleme hızımı etkilemesinden korkarım.*	0.614	0.111
M21	I am afraid that students with fewer interests in mathematics may reduce the interest of other students. *Matematik dersine ilgisi az olan öğrencilerin diğer öğrencilerin ilgisini azaltmasından korkarım.*	0.647	0.119
M22	The thought that the student cannot comprehend when I turn a concept into a mathematical sentence (e.g. 2 + 3) makes me anxious. *Bir kavramı matematiksel cümleye (ör: 2+3) dönüştürdüğümde öğrencinin anlayamayacağı düşüncesi beni tedirgin eder.*	0.705	0.127
M25	I'm worried about not using the appropriate method and technique in mathematics. *Matematik dersine uygun yöntem ve tekniği kullanamama endişesi yaşarım.*	0.740	0.120
M27	A rise in the level differences among my students while teaching mathematics worries me. *Matematik dersini işlerken öğrencilerim arasında düzey farklılıklarının artmasından endişelenirim.*	0.684	0.117

Table 3. *Continues*

Item No		Standardized Factor Loadings	S.E.
M28	I am anxious since I believe that I do not have sufficient knowledge about teaching mathematics. *Matematik öğretimine yönelik yeterli bilgiye sahip olmadığımı düşündüğümden endişelenirim.*	0.783	0.134
M29	When a student does not understand mathematical operations, I get anxious about how to explain them. *Matematiksel işlemleri öğrenci anlamadığında nasıl açıklayacağım endişesi yaşarım.*	0.800	0.129
M30	I feel insecure about the thought that my students having level differences in mathematics can isolate themselves from the class eventually. *Matematik dersinde düzey farklılıkları olan öğrencilerimin zamanla kendilerini sınıftan soyutlayabilecekleri düşüncesi beni huzursuz eder.*	0.628	0.125
M31	I feel anxious that I cannot finish the outcomes of the mathematics curriculum on time. *Matematik programındaki kazanımları zamanında bitiremeyeceğim endişesi yaşarım.*	0.770	0.124
M33	I am afraid that school administrators will criticize me if I cannot catch up with the mathematics curriculum. *Matematik programını yetiştiremezsem okul yöneticilerinin beni eleştirmesinden korkarım*	0.757	0.129
M34	I get anxious about designing activities that are appropriate for my students' level in mathematics. *Matematik dersinde öğrencilerimin düzeyine uygun etkinlik hazırlama endişesi yaşarım.*	0.757	0.125
M35	I feel anxious while considering students' individual differences in teaching mathematics. *Matematik öğretirken bireysel farklılıkları göz önünde bulundurma zorunluluğu beni endişelendirir.*	0.767	0.122
M37	I am afraid that families will criticize me if I cannot catch up with the mathematics curriculum. *Matematik programını yetiştiremezsem ailelerin beni eleştirmesinden huzursuz olurum.*	0.701	0.120
M41	I'm worried about not enabling my students' to engage in mathematics actively. *Öğrencilerimin matematik dersine aktif katılımını sağlayamama endişesi yaşarım.*	0.469	0.157
M43	I feel worry that I do not know how to teach mathematical concepts to students. *Matematik kavramlarını kazandırırken nasıl öğreteceğimi bilmediğim için tedirgin olurum.*	0.709	0.119
M48	I feel fear of being humiliated by the students if I cannot solve problems in mathematics. *Matematik dersinde problemleri çözemezsem öğrencilerin gözünde küçük düşmekten korkarım.*	0.427	0.203
M49	The thought that the level differences of the students in mathematics may reduce the interest of attending the lesson disturbs me. *Matematik dersinde öğrencilerin düzey farklılıklarının derse olan ilgiyi azaltacağı düşüncesi beni rahatsız eder.*	0.660	0.115

Chronbach's Alpha: 0.93

3.3. Criterion Validity

Within the scope of the criterion validity studies of the MTAS, prospective primary school teachers in the third group were asked to fill in the Mathematics Teaching Efficacy Belief Instrument and the Mathematics Teaching Anxiety Scale in order to measure the Pearson

product moment correlation coefficient. It was found that the correlation coefficient showed a moderately negative (r = –0.43) and significant (p <0.01, n = 108) relationship (Büyüköztürk, 2012; Field, 2009). In the light of these results, it can be said that the MTAS has concurrent validity.

4. CONCLUSION

This study aimed to develop and examine a scale for measuring mathematics teaching anxiety (MTAS) for prospective primary school teachers. To this aim, 956 prospective primary school teachers were involved in this study in order to construct and to prove the validity and reliability of the scale. At the beginning of the study, a scale was designed with 57 items and sent to experts for content-related validity. After their judgements, the scale was structured with 52 items.

Before the factor analysis process, it was found that the chi-square value of the Bartlett Sphericity Test was significant with 8973.88 (p <0.000), and the Kaiser-Meyer-Olkin value was sufficient (0.949). According to the results of the exploratory factor analysis, it was found that the scale indicates single factor structure and consisting of 31 items. The reliability value of the scale with 31 items was found to be 0.96, which is a high value. In addition to this, the test-retest reliability coefficient was calculated to be 0,703 was considered equal to the acceptable limit value.

Confirmatory factor analysis was also used to determine the correlations among items. In this analysis, it was found that some items were exhibiting high correlations; therefore, those items were removed from the scale. As a result, the structure of the scale was constructed with 19 items. In terms of CFA results (0≤X2 / df = 1.483≤2, RMSEA = 0.040, RMR = 0.050, AGFI = 0.908, TLI = 0.972, CFI = 0.976, IFI = 0.976, GFI = 0.928, NFI = 0.930 and RFI = 0.919), it was confirmed that the scale structure was consisting of 19 items and one dimension. Thereafter, the criterion validity was measured and found that the scale has concurrent validity.

In conclusion, the final form of Mathematics Teaching Anxiety Scale (MTAS) for prospective primary school teachers was consisting of 19 items and the Cronbach's alpha coefficient of this scale was 0.93. It is believed that this MTAS can contribute to the area by helping to measure the level of prospective teachers' mathematics teaching anxiety. Furthermore, this scale could be one of the measurements in the area which can help other research to construct new scales and to focus on mathematics teaching anxiety in various ways.

ORCID

Vesile ALKAN https://orcid.org/0000-0002-8630-3357

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APPENDIX

Mathematics Teaching Anxiety Scale (MTAS-Turkish version)
for Prospective Primary SchoolTeachers

1	I'm worried that I cannot motivate the students due to my prejudices against mathematics. *Matematiğe yönelik önyargılarımdan dolayı öğrencileri motive edemeyeceğim endişesi yaşarım.*
2	I feel uncomfortable in mathematics since I do not have enough experience. *Yeterli deneyime sahip olmadığım için matematik dersinde kendimi huzursuz hissederim.*
3	I am afraid that the level differences of the students in mathematics may affect my teaching pace. *Matematik dersinde öğrencilerin düzey farklılıklarının ders işleme hızımı etkilemesinden korkarım.*
4	I am afraid that students with fewer interests in mathematics may reduce the interest of other students. *Matematik dersine ilgisi az olan öğrencilerin diğer öğrencilerin ilgisini azaltmasından korkarım.*
5	The thought that the student cannot comprehend when I turn a concept into a mathematical sentence (e.g. 2 + 3) makes me anxious. *Bir kavramı matematiksel cümleye (ör: 2+3) dönüştürdüğümde öğrencinin anlayamayacağı düşüncesi beni tedirgin eder.*
6	I'm worried about not using the appropriate method and technique in mathematics. *Matematik dersine uygun yöntem ve tekniği kullanamama endişesi yaşarım.*
7	A rise in the level differences among my students while teaching mathematics worries me. *Matematik dersini işlerken öğrencilerim arasında düzey farklılıklarının artmasından endişelenirim.*
8	I am anxious since I believe that I do not have sufficient knowledge about teaching mathematics. *Matematik öğretimine yönelik yeterli bilgiye sahip olmadığımı düşündüğümden endişelenirim.*
9	When a student does not understand mathematical operations, I get anxious about how to explain them. *Matematiksel işlemleri öğrenci anlamadığında nasıl açıklayacağım endişesi yaşarım.*
10	I feel insecure about the thought that my students having level differences in mathematics can isolate themselves from the class eventually. *Matematik dersinde düzey farklılıkları olan öğrencilerimin zamanla kendilerini sınıftan soyutlayabilecekleri düşüncesi beni huzursuz eder.*
11	I feel anxious that I cannot finish the outcomes of the mathematics curriculum on time. *Matematik programındaki kazanımları zamanında bitiremeyeceğim endişesi yaşarım.*
12	I am afraid that school administrators will criticize me if I cannot catch up with the mathematics curriculum. *Matematik programını yetiştiremezsem okul yöneticilerinin beni eleştirmesinden korkarım*
13	I get anxious about designing activities that are appropriate for my students' level in mathematics. *Matematik dersinde öğrencilerimin düzeyine uygun etkinlik hazırlama endişesi yaşarım.*
14	I feel anxious while considering students' individual differences in teaching mathematics. *Matematik öğretirken bireysel farklılıkları göz önünde bulundurma zorunluluğu beni endişelendirir.*
15	I am afraid that families will criticize me if I cannot catch up with the mathematics curriculum. *Matematik programını yetiştiremezsem ailelerin beni eleştirmesinden huzursuz olurum.*
16	I'm worried about not enabling my students' to engage in mathematics actively. *Öğrencilerimin matematik dersine aktif katılımını sağlayamama endişesi yaşarım.*
17	I feel worry that I do not know how to teach mathematical concepts to students. *Matematik kavramlarını kazandırırken nasıl öğreteceğimi bilmediğim için tedirgin olurum.*
18	I feel fear of being humiliated by the students if I cannot solve problems in mathematics. *Matematik dersinde problemleri çözemezsem öğrencilerin gözünde küçük düşmekten korkarım.*
19	The thought that the level differences of the students in mathematics may reduce the interest of attending the lesson disturbs me. *Matematik dersinde öğrencilerin düzey farklılıklarının derse olan ilgiyi azaltacağı düşüncesi beni rahatsız eder.*

Chronbach's Alpha Coefficient: 0.93