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THE DEVELOPMENT OF THE MATHEMATICAL RESILIENCE SCALE: VALIDITY AND RELIABILITY STUDY

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Abstract: In this study, the aim was to develop a measurement tool that would provide a valid and reliable assessment of secondary school students' mathematical resilience skills. The research was conducted with a sample of 229 students. To ensure the content and face validity of the scale, expert opinions were initially sought, and the scale was revised based on their suggestions. The scale was then administered to the student group, to evaluate the construct validity of the measurements, both Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) were performed. The EFA results indicated that the scale comprised 14 items grouped into four sub-dimensions, labeled as 'value,' 'struggle,' 'growth,' and 'culture.' These factors accounted for 57.667% of the total variance. Regarding reliability, the Cronbach's alpha coefficient was calculated as .704. Additionally, CFA confirmed the four-factor structure of the scale. These results indicate that the developed scale is a valid and reliable tool for measuring students' mathematical resilience skills.

Key words: Mathematical resilience, Secondary school, Scale development

Introduction

There are many definitions of resilience in literature. According to Grotberg (1995), resilience is characterized as a human capability that allows individuals to confront challenges in life, overcome them, and potentially emerge from these experiences with greater strength. Walsh (2006) defines resilience as "an active process that enables one to come out of a difficulty in a stronger way, to develop in a crisis situation and to be resilient". In mathematics education, the importance of resilience skills is increasingly emphasised. Mathematical resilience skill is a fundamental factor affecting the motivation and achievement of students who face mathematical difficulties (Sarıçam & Çakıcı, 2019). Mathematical resilience refers to the determination of certain students to engage with mathematics confidently, persist through challenges, and actively participate in discussions, reflection, and research (Johnston-Wilder & Lee, 2010).

Mathematical resilience empowers learners to navigate and overcome challenges they may encounter in mathematics.Students study, Johnston-Wilder and Lee (2010) argue that the whole learning process requires resilience, but that the resilience required to learn mathematics often emerges as a result of various factors such as the teaching approach used, the nature of mathematics and common beliefs about mathematical ability, and that students may experience failure and difficulties in the learning process, but for students with mathematical resilience skills, negative effects can be eliminated.

Students who have developed mathematical resilience will be capable of understanding what an exam question is asking of them. Additionally, they will have the ability to apply mathematical concepts in real-life situations beyond school and will be motivated to continue their mathematical growth when necessary. The development of mathematical resilience also encourages students to adopt a more reflective and critical approach to learning mathematics. Resilient students know that they can handle seemingly complex ideas and problems by thinking carefully, engaging in discussions with others, and reflecting on their knowledge (Johnston-Wilder & Lee, 2010).

It is emphasised that resilience skills help students build a strong academic background in mathematics education and forms a fundamental basis for their future success. Research shows that resilience skill plays a critical role in increasing students' success in mathematics (Mert, 2018). In this context,

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resilience skill encourages students to seek solutions instead of giving up when faced with mathematical difficulties, which helps to enhance their problem-solving skills (Kılıç, 2017).

Mathematical resilience has been the issue of many scientific studies, especially in the field of educational psychology and teaching methods. Most of these studies focus on the ability to cope with mathematical difficulties and to increase students' mathematical confidence. In addition, how mathematical resilience influences students' achievement and how it leads to educational processes are also among the research topics. Stipek (2002) investigated the effects of mathematical resilience on students' learning motivation and academic achievement. In his study, Dweck (2006) focused on the relationship between growth mindset and fixed mindset. Boaler (2007) examined the origins of mathematical resilience and students' misconceptions about their mathematical abilities. Salmela-Aro and Upadyaya (2014) investigated how mathematical resilience relates to school burnout and student attachment levels, while Duckworth (2016) highlighted the connection between mathematical resilience and traits such as patience and perseverance.

Mathematical resilience is important in respect of developing children's problem-solving skills and giving them the ability to find solutions when faced with mathematical problems. This includes the skills necessary to solve problems they will encounter in real life (Attami, Budiyono, & Indriati, 2020). Mathematical resilience can help children gain mathematical self-confidence by overcoming mathematics- related difficulties. This can reduce negative attitudes towards mathematics and positively affect the learning process (Farooq & Shah, 2008; Johnston-Wilder & Lee, 2010).

There are important studies that educators and researchers have taken into consideration to understand the concept of mathematical resilience and to improve students' mathematics performance. Shanna, George, and Mei-Lin (2015) developed an academic resilience scale in mathematics in a study conducted with 7th and 8th grade students. Kooken, Welsh, McCoach, Johnston-Wilder, and Lee (2016) developed a scale to measure university students' mathematical resilience skills. Muntazhimah and Syafika (2020) tried to determine the mathematical resilience levels of prospective teachers. Attami, Budiyono, and Indriati (2020) sought to define the mathematical problem-solving abilities of 8th-grade students in relation to their mathematical resilience. Nevertheless, research focused on assessing the mathematical resilience skills of secondary school students remains relatively scarce in the literature. When the studies are examined, the sample group mostly includes adults and university students (Shanna, George, & Mei-Lin, 2015; Gürefe & Akçakın, 2018; Muntazhimah & Syafika, 2020).

In the mathematical resilience scale development study (Kooken et al., 2016), mathematical resilience skill includes three related factors: value, struggle and growth. After the scale development study (Kooken, et al., 2016), which revealed all these factors, an adaptation study of this scale into Turkish was conducted (Gürefe & Akçakın, 2018).

The factors emerging in the Mathematical Resilience Scale are explained as follows:

1. Value: The value factor, often referred to as the mathematical resilience factor, represents students' perception of the significance of mathematics lessons in helping them reach their current or future objectives. This factor is linked to both intrinsic and extrinsic motivation, as well as self-regulation.

2. Struggle: Struggle factor refers to the student's belief that because mathematics is a difficult discipline to learn, it is necessary to overcome difficulties in the learning process.

3. Growth: The growth factor of mathematical resilience skill refers to the belief that the level of mathematical knowledge is an attribute that can be developed and shaped (Kooken et al., 2016).

In their longitudinal study, Werner and Smith (1992) examined how individuals exposed to adverse life conditions in childhood show resilience and achieve positive results and revealed the resilience factors in children. Masten (2001) examined resilience processes in the context of child development and discussed how positive adaptation occurs. If we specialise the concept of resilience in the field of mathematics, mathematical resilience involves children's resistance to mathematics-related difficulties and their success in this field. This can affect their academic success and support the process of developing mathematical skills (Kooken et al., 2016).

All these studies emphasise the importance of the concept of mathematical intimidation in childhood. For this reason, due to the need for research to be carried out with different sample groups due to the scarcity of studies on the concept of mathematical intimidation with children, the study was decided to be conducted with the hypothesis that different factors would emerge from the sub-factors revealed in the studies. For this reason, it was thought that the development of a measurement tool that allows the examination of mathematical resilience of secondary school students and the contribution of the factors that may emerge to the literature are important and it was decided to carry out this study.

2. Method

This study intends to develop a measurement tool with established validity and reliability to evaluate the mathematical resilience skill levels of secondary school students.

2. 1. Participants

The study was conducted with 229 students continuing their education in Balıkesir. The study group consisted of 51.5% (n=118) male and 48.5% (n=111) female students. In the selection of the sample, it was aimed to find secondary school students with multiple different demographic characteristics. Care was taken to ensure that the class in which the application would be made was a homogeneous class in terms of academic achievement, and it was selected with the guidance of the guidance unit. Of the participating students, 53.3% (n=122) were 6th grade students, 31.4% (n=72) were 7th grade students and 15.3% (n=35) were 8th grade students. While determining the number of participants, the number of items in the draft scale was taken into account. Responses with missing data and multiple responses to the same question were considered invalid and were not included in the analysis. By reaching 229 secondary school students who gave valid responses, more than 5 times the number of participants required for the draft scale with 26 items was reached.

2. 2. The Process of Developing Mathematical Resilience Scale

The following steps were followed in the development of the "Mathematical Resilience Scale (MRS)":

The first step involved conducting a comprehensive literature review on the concepts of "resilience" and "mathematical resilience," as well as examining relevant studies in this area. Based on this review, a pool of 103 potential questions was developed. Before finalizing the scale, a wide and detailed collection of candidate items was created, ensuring a thorough representation of the constructs (Devellis & Thorpe, 2017). To guarantee both content and face validity, a language specialist was consulted to assess the clarity and wording of the items. Furthermore, input was collected from four field-specific academicians to refine and enhance the overall quality of the scale. For this purpose, expert opinions were obtained through an expert evaluation form which included options such as "appropriate," "suitable with revisions," and "not appropriate" for each item in the pool. prepared for assessment purposes. Following the feedback, some items were removed, while others were revised. As a result, a draft scale comprising 26 items was developed based on expert opinions. The positive items on the scale were evaluated using a five-point Likert scale, varying from "strongly disagree (1)" to "strongly agree (5)." For the negative items, the scoring was reversed. To calculate the MRS scores, the sum of participants' responses was divided by the total number of questions. The final scale interpretation was as follows: 1.00–1.80 represented "strongly disagree," 1.81–2.60 represented "disagree," 2.61–3.40 represented "neutral," 3.41–4.20 represented "agree," and 4.21–5.00 represented "strongly agree." Since the scale scores varied from 1.00 to 5.00, higher scores indicated higher mathematical resilience, while lower scores indicated reduced resilience. In Likert-type scales, respondents are presented with statements and asked to indicate their level of agreement, with 50% of the items reflecting positive attitudes and the remaining 50% capturing negative attitudes (Hogg & Vaughan, 2014).

Since attitudes have both positive and negative dimensions, items were designed to measure both reactions in the draft scale. Of the 26 items included, 14 represented positive attitudes and 12 negative. Care was taken to avoid a fixed order of presenting positive and negative statements. When developing Likert-type scales, responses to negative items must be adjusted, as half the items are positive, and half are negative (Tavşancıl, 2018). During the data preparation phase for factor analysis, negative item scores were reversed and recalculated. Finally, the draft scale was piloted with a group of 30 students, who were not part of the main study, using Google Forms. Based on the students' responses to the items, it was concluded that no further revisions to the items were necessary.

2. 3. Data Collection

The objective of the study was explained to the participants, and the research was carried out with those who voluntarily agreed to participate. It was explained to the students that this study was not a written, exam or graded study, but only aimed to reveal students' thoughts about their mathematical resilience skills. It was shared with the students before the application that no names would be written on the papers and the collected papers would remain only with the researcher.

2.4. Analysing the Data

Prior to data analysis, the collected tools were carefully reviewed. A total of 62 responses, where items were either incomplete or where multiple responses were given to the same question, were excluded from further analysis. The remaining valid data from 229 students were analyzed to assess the validity and reliability of the scaleExploratory Factor Analysis (EFA) was performed in SPSS to assess the construct validity of the scale. The relevance of the data for factor analysis was first checked using the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's Test of Sphericity. To confirm construct validity, the Varimax rotation technique was applied, which helps simplify the factor structure for clearer interpretation. The resulting factors were named and interpreted based on existing literature. Cronbach's alpha coefficients were intended to identfy the reliability of both the individual sub-dimensions and the entire scale, while item-total correlations were analyzed to verify the validity of each item. Additionally, Confirmatory Factor Analysis (CFA) was performed using AMOS to validate the theoretical factor structure identified by the EFA. SPSS was used for conducting EFA, calculating Cronbach's alpha, analyzing item-total correlations, and comparing item score differences between the top and bottom 27% groups. For CFA, the AMOS software was utilized to evaluate the model fit in light of the EFA results. A summary of the procedures undertaken to ensure the scale's validity and reliability is provided in Table 1.

Table 1. *Steps Followed Regarding Validity and Reliability Process*

Procedures related to validity and reliability	
1. Content validity	Expert opinion and literature review.
2. Compliance with principal component analysis	Application of KMO coefficient and Barlett Sphericity test
3. Construct validity (EFA)	Performing exploratory factor analysis (SPSS)
4. Item validity	Calculation of item-test correlations
5. Internal consistency reliability	Calculation of Cronbach's Alpha value
6. Construct validity (CFA)	Performing confirmatory factor analysis (AMOS)
7. Internal consistency	Independent t test for the difference between the item scores of 27% lower and 27% upper groups (SPSS)

3. Findings

The results of the study are structured and presented under the following sections: findings from the exploratory factor analysis, findings from the findings related to reliability and confirmatory factor analysis.

3. 1. Findings Related to EFA of the Scale

To evaluate the construct validity and identify the factor loadings of the items, Principal Component

Analysis was utilized. The Kaiser-Meyer-Olkin (KMO) measure and Bartlett's Test of Sphericity were computed to determine the adequacy of the data for principal component analysis. The results of these tests, including the KMO coefficient and Bartlett's Test of Sphericity, are shown in Table 2.

Table 2. *KMO and Bartlett Sphericity Test Results*

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.812
Bartlett's Test of Sphericity	Approx. Chi-Square	731,103
	df	91
	Sig.	.000

As a result of the analysis, the KMO value was calculated as 0.812, indicating that the sample is adequate for factor analysis. Additionally, the chi-square test statistic from Bartlett's test of sphericity was found to be significant, confirming that the data is suitable for factor analysis ($\chi 2$= 731,103; df=91; p<.000). KMO value of .90 and above is an excellent level in terms of suitability for factor analysis, .80 is a valuable level, .70 is a medium level (Kaiser, 1974). The KMO value obtained as a result of the analysis is at a very good level with .812. In exploratory factor analysis, the goal is to explain a theoretical structure that is not yet fully understood using data gathered from the measurement tool developed for this purpose (Kan, 2019). In the initial exploratory factor analysis, attention was given to ensuring that the eigenvalues of the items were at least 1, as recommended by Shevlin and Lewis (1999), when selecting items for inclusion in the scale. The results of the EFA indicated that the items clustered under six factors, each with eigenvalues exceeding 1. However, within this six-factor model, some items were found to load on multiple factors, and several items had factor loadings below .40. Büyüköztürk (2014) stated that in a multi-factor structure, an item with a high loading value on more than one factor is referred to as an overlapping item, and it may be considered for removal from the scale to improve its clarity and ensure that each item distinctly represents a single factor. A factor loading value of 0.45 or higher is a good criterion, and a difference of at least 0.10 between items is considered a criterion for being included in more than one factor (Tavşancıl, 2018). In scale development and adaptation studies, it may be recommended to keep the item loading value at least .30. However, if a stronger structure is desired to be created, it is recommended that the factor load should take a higher value (Seçer, 2015). In this study, .40 was taken as the factor loading value. Items that overlapped or had a factor loading below .40 were detached from the scale, and EFA was re-run. As a consequence of these analyses, 12 items were eliminated from the original 26-item draft, leaving a total of 14 items. The EFA findings showed that these 14 remaining items were organized into four distinct factors. The eigenvalues of the four-factor structure are presented in Figure 1.

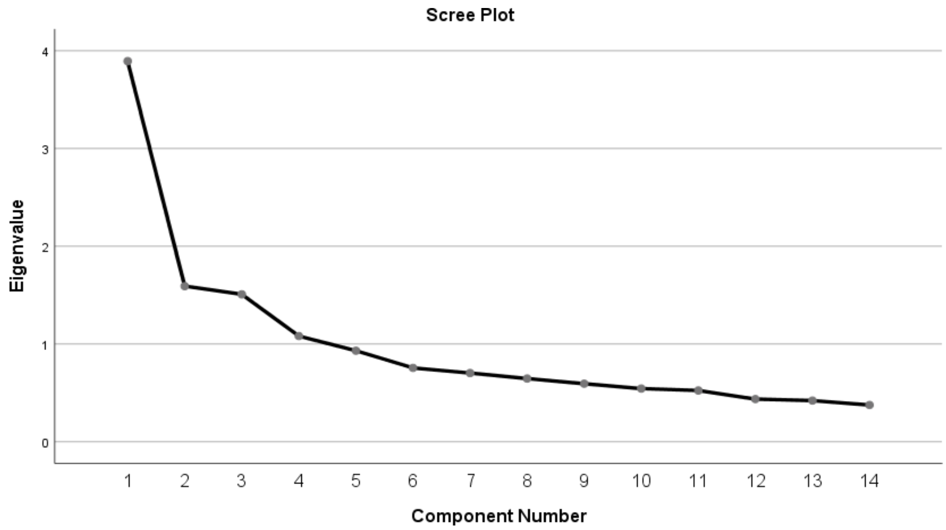


Figure 1. *Eigenvalues Related to Factors*

The eigenvalues, which indicate the significance and contribution of each factor, were identified as 3.893 for the first factor, 1.592 for the second, 1.508 for the third, and 1.081 for the fourth. A factor loading cut-off of .40 was applied. The EFA results for the 14 remaining items are shown in Table 3.

Table 3 *Findings Related to EFA of the Scale (MRS)*

Article No	Factor Covariance	Factor Loadings After Rotation				Corrected Item Total Correlation
		Factor 1	Factor 2	Factor 3	Factor 4	
m22	1,588	,758				,575
m17	1,020	,732				,462
m5	1,582	,710				,520
m1	2,251	,707				,602
m9	1,868	,618				,456
m13	,835		,702			,464
m23	1,154		,693			,509
m12	,742		,609			,200
m2	,875			,782		,194
m10	1,192			,731		,245
m6	1,369			,660		,361
m20	1,032				,798	,226
m4	,701				,674	-,085
m25	1,611				,664	,326
Kaiser Meyer Olkin (KMO) scale validity						.812
Barlett Sphericity test Chi-Square						731,103
p value						.000

The EFA results revealed that the loading values for the first factor ranged between .758 and .618, for the second factor between .702 and .609, for the third factor between .782 and .660, and for the fourth factor between .798 and .664. Based on both the literature and the feedback from three field experts, the factors were labeled as follows: "value" for the first factor, "struggle" for the second, "growth" for the third, and "culture" for the fourth. The variance explained by these factors, along with the items corresponding to each factor, is displayed in Table 4.

Table 4. *Nomenclature of the Factors of the Scale (FMQ)*

Factor Name	Articles	Factor Name	Explanatory Factor
Value	m22	I think that knowing maths well will increase my working opportunities.	20,772
	m17	Mathematics will be encountered everywhere in life.	
	m5	Knowing maths will help me achieve my goals.	
	m1	Maths is necessary for my future.	
	m9	Having a good knowledge of mathematics positively affects my thinking power in many areas.	

Struggle	m13	Mathematics is one of my favourite subjects.	12,843
	m23	If I can't solve a difficult problem in maths, I don't give up.	
	m12	Even if I am not successful in maths, my family always supports me.	
Growth	m2	Even good mathematicians can find it difficult to solve problems.	12,644
	m10	Difficulties are normal when learning maths.	
	m6	When doing maths, everyone makes mistakes from time to time.	
Culture	m20	My family has high expectations for me to be successful in maths.	11,408
	M4	If I fail maths, my parents will be upset.	
	m25	My family thinks maths is important.	
		Total variance	57,667

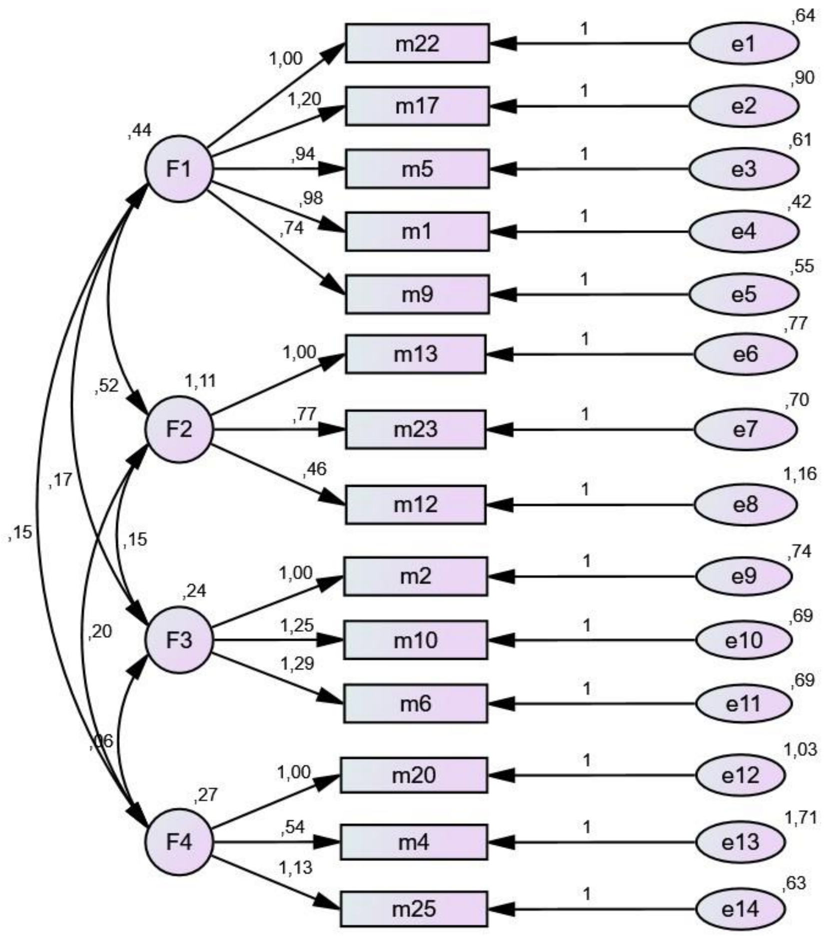
In Table 4, the factor loadings from the EFA are presented in descending order for each factor. The table clearly shows that the developed scale consists of 14 items, divided into 4 distinct factors. The first factor includes 5 items, while the second, third, and fourth factors each contain 3 items. The factors were labeled as follows: the first factor "value," the second "struggle," the third "growth," and the fourth "culture." The first factor accounted for 20.772% of the variance, the second 12.843%, the third 12.644%, and the fourth 11.408%, with the combined factors explaining 57.667% of the total variance. The final version of the scale, with 14 items, yields a minimum score of 14 and a maximum score of 70. Lower scores on the scale indicate a lower level of mathematical resilience skills, while higher scores reflect a higher level of these skills. If the scores obtained from the scale are evaluated at three different levels from very low to very high, the group interval coefficient [(70-14)/3] was 18.67 according to the formula proposed by Kan (2019). This number was rounded to 19 and group intervals were determined. Therefore, the score between 14 and 32 can be considered as having low level mathematical resilience skills, the score between 32 and 51 can be considered as having mathematical resilience skills, and the score between 51 and 70 can be considered as having high level mathematical resilience skills.

3.2. Findings Related to CFA of the Scale

CFA was performed to evaluate the suitability of the four-dimensional structure revealed by the EFA. The resulting model of the scale is depicted in Figure 2.

The compliance criteria for model fit indices are for RMSEA, a value between 0 and 0.05 indicates a good fit, while values between 0.05 and 0.10 suggest acceptable fit, with the obtained RMSEA being 0.056. The NFI ranges from 0.95 to 1 for a good fit and from 0.80 to 0.95 for acceptable fit, with an NFI of .846 in this analysis. The CFI falls within 0.97 to 1 for a good fit and 0.90 to 0.97 for acceptable fit, where the value obtained was .916. For GFI, values between 0.95 and 1 indicate a good fit, and values from 0.90 to 0.95 reflect acceptable fit, with a GFI of .940. The AGFI is considered a good fit between 0.90 and 1, and acceptable between 0.85 and 0.90, with an AGFI of .905. Finally, the χ^2/df ratio was found to be 1.884, indicating a good fit, as it falls below the threshold of 3. Upon reviewing the fit indices in Table 5, the χ^2/df value for this study is found to be 1.884, which, being below 3, suggests a strong fit, confirming that the CFA results are both statistically significant and well-fitted. The GFI value, which ranges between 0 and 1, indicates a good fit when it exceeds .90. Similarly, a CFI value of .90 or higher also reflects a good fit, while an AGFI value above .85 is considered an acceptable fit. The NFI, ranging from 0 to 1, is deemed acceptable when it falls between .80 and .94 (Byrne, 2011). RMSEA values between 0.05 and 0.10 also represent an acceptable fit (Sümer, 2000). Additionally, the IFI value, which is not shown in the table and adjusts for sample size, is acceptable between .90 and .95 (Şimşek, 2007).

In this study according to the goodness of fit indices, the RMSEA, GFI, AGFI, NFI, and CFI values are all within acceptable ranges. Based on these indices, the four-factor structure containing of the dimensions "value," "struggle," "culture," and "growth," identified through EFA, was confirmed by CFA. The reliability of the mathematical resilience scale was evaluated using Cronbach's Alpha for internal consistency, and the reliability coefficients for each factor are listed in Table 5.



CMIN=133,764; DF=71; CMIN/DF=1,884; p=,000; RMSEA=,056; CFI=,916; GFI=,940

Figure 2. *Factors and Loadings in CFA*

Table 5. *Reliability Coefficients of the Scale (MRS)*

Factor	Factor name	Articles	Cronbach's Alpha (α)
Factor 1	Value	m22	.790
		m17	
		m5	
		m1	
		m9	
Factor 2	The Struggle	m13	.704
		m23	
		m12	
Factor 3	Growth	m2	.702
		m10	
		m6	
Factor 4	Culture	m20	.621
		m4	
		m25	
Cronbach's Alpha for the Overall Scale			.704

The Cronbach's Alpha coefficient for all items in the scale was calculated as .704, with the first factor 'value' having an alpha of .790, the second factor 'struggle' .704, the third factor 'growth' .702, and the fourth factor 'culture' .621. A Cronbach's Alpha value above .70 generally indicates that the scale is reliable (Büyüköztürk, 2014; Durmuş, Yurtkoru, & Çinko, 2013), though in exploratory studies, a value of .60 or higher suggests adequate reliability (Muttalib, Danish, & Zehri, 2023).

These results suggest that the scale is reasonably reliable in both its sub-dimensions and overall. To further study the internal consistency of the scale, an independent samples t-test was conducted to compare the item scores between the top 27% and bottom 27% of respondents. The process of item selection, based on this internal consistency criterion, was applied to the data from students in the top and bottom 27% of the score distribution. This method allowed for the evaluation of the item score distribution for each item, and the t-test was employed to evaluate the significance of the differences between the mean scores of students in the upper and lower groups. This test helps determine whether the observed differences in their mean scores are statistically significant. (Tezbaşaran, 2008). The results of this analysis are presented in Table 6.

Table 6. *Independent t Test Results Regarding the Difference Between the Item Scores of 27% Lower and 27% Upper Groups*

Article	Group	$\bar{x}$	s	p
m1	Top group	4,7705	2,62293	,000
	Subgroup	3,3934	6,76878	,000
m2	Top group	4,3443	,42401	,000
	Subgroup	3,8689	1,17301	,000
m4	Top group	3,3934	,77212	,007
	Subgroup	3,2459	1,10265	,007
m5	Top group	4,7705	1,39378	,572
	Subgroup	3,2623	1,47937	,572
m6	Top group	4,7869	,49644	,000
	Subgroup	3,9016	1,25036	,000
m9	Top group	4,3934	,52009	,000
	Subgroup	3,2787	1,33797	,000
m10	Top group	4,4918	,73663	,000
	Subgroup	3,6721	,95098	,000
m12	Top group	4,3934	,86839	,000
	Subgroup	3,4754	1,28739	,000
m13	Top group	4,3934	,98790	,000
	Subgroup	2,0492	1,49004	,000
m17	Top group	4,4098	,88088	,000
	Subgroup	2,7377	1,24400	,000
m20	Top group	4,4098	,86366	,000
	Subgroup	3,3115	1,22341	,000
m22	Top group	4,7541	,98956	,000
	Subgroup	3,0492	1,29796	,000
m23	Top group	4,7049	,50516	,000
	Subgroup	2,6885	1,16084	,000
m25	Top group	4,7541	,61493	,000
	Subgroup	4,0492	1,17673	,000
Total	Top group	62,7705	2,62293	,001
	Subgroup	45,9836	6,76878	,001

The difference between the item scores of 61 students with the lowest item total score (27% lower group) and 61 students with the highest item total score (27% upper group) for each question was analysed by independent samples t test. It was found out that the difference between each item scores of the 27% lower and 27% upper groups of the research group was significant ($p<.05$). The fact that the differences observed in the desired direction between the groups are significant shows that the test has internal consistency. (Büyüköztürk, 2014).

4. Conclusions

The purpose of this study was to design a scale aimed at assessing the Mathematical Resilience skills of secondary school students. In the scale development process, an item pool was generated through a comprehensive review of the relevant literature. Following the collection of expert feedback to ensure both content and face validity, a draft version of the scale was constructed, which was then subjected to a preliminary application for testing. After removing invalid and incomplete responses for validity and reliability, the responses of the remaining 229 students were analysed. Firstly, EFA was conducted for construct validity and CFA was performed to validate the found structure. As a result of EFA, the scale was found to have a four-factor structure. If there is no unresponsiveness towards an object, it can be thought that the tendencies of individuals will be in the direction of approaching or moving away, positive or negative. In this context, after reviewing other attitude scales in the literature and incorporating feedback from three subject matter experts, the first factor, comprising seven items, was labeled 'value,' the second factor with three items was named 'struggle,' the third factor, also containing three items, was labeled 'growth,' and the fourth factor, consisting of three items, was designated as 'culture.' The final version of the scale includes a total of 14 items. The first factor explained 20.772% of the variance, the second 12.843%, the third 12.644%, and the fourth 11.408%, with the entire scale accounting for 57.667% of the total variance. Given that a variance explanation ratio between 40% and 60% is considered sufficient in social science research (Başol, 2020), the scale demonstrates an acceptable level of explanatory power. In order to test the accuracy of the structure found with EFA, the fit index values in the CFA result were examined and it was seen that the model was in harmony with the data. According to the findings obtained from EFA and CFA analyses for construct validity, it can be said that this four-factor scale is valid. For reliability, Cronbach-Alpha coefficients were calculated and the consistency between 27% lower and 27% upper groups was examined. According to the findings, it was concluded that the scale was valid and reliable. The outcomes of the validity and reliability of the scale developed to measure mathematical resilience skills show that it can be used to determine the mathematical resilience skills of secondary school students. In line with mathematical resilience skills, the ability of students' attitudes towards mathematics to predict their behaviours in this field has been the focus of many studies (Ajzen, 2001). Determining the attitude towards an object also allows us to know the behaviours of individuals towards that object. In the field of mathematics education, determining the mathematical resilience skill and attitudes towards mathematics courses can predict students' behaviours towards these courses. In this context, it is thought that this scale, whose validity and reliability have been ensured, will enable secondary school students to predict their attitudes towards mathematics course and the behaviours determined by these attitudes by determining their mathematical resilience skills. In the development of this scale, only secondary school students were included as the study group. If the scale is to be applied to assess the mathematical resilience skills of groups beyond secondary school students, validity and reliability analyses should be conducted on the data obtained from those groups. The scale can also be utilized in research exploring the relationships between students' mathematical resilience skills and other factors, such as learning styles, academic performance in different subjects, and motivation toward mathematics. This scale development study was conducted with secondary school students in Balıkesir city centre. As a suggestion for future research, the scale should be applied to students with different socioeconomic levels living in different regions and the results can be compared with the current scale by conducting validity and reliability analyses.

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