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Abstract

The purpose of the study is to develop a scale that determines the attitudes of secondary school students towards distance mathematics education, and to examine the attitudes of the students by certain variables. The study included 271 secondary school students studying in Sivas province during the 2020-2021 academic year. Exploratory and confirmatory factor analyses were performed on the data obtained from the scale to examine the psychometric structure of the scale. A t-test and an analysis of variance were performed to determine the differences among secondary school students' attitudes towards distance education in mathematics by gender, school type, and grade level. It was found that the attitudes of secondary school students towards receiving distance mathematics education were negative. Gender does not constitute a significant difference in the attitude scores of secondary school students towards receiving distance mathematics education. In terms of the type of school in which students studied, a significant difference was found in favor of public schools in secondary school students' attitude scores towards distance mathematics education. In terms of grade levels, a statistically significant difference was found in favor of the 5th, 6th, and 7th grades regarding their attitudes towards distance mathematics education, among 5th, 6th, 7th, and 8th grade students.

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Research Article

A Scale Development Study Determining the Attitudes of Secondary School Students towards Distance Education of Mathematics*

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Abstract

The purpose of the study is to develop a scale that determines the attitudes of secondary school students towards distance mathematics education, and to examine the attitudes of the students by certain variables. The study included 271 secondary school students studying in Sivas province during the 2020-2021 academic year. Exploratory and confirmatory factor analyses were performed on the data obtained from the scale to examine the psychometric structure of the scale. A t-test and an analysis of variance were performed to determine the differences among secondary school students' attitudes towards distance education in mathematics by gender, school type, and grade level. It was found that the attitudes of secondary school students towards receiving distance mathematics education were negative. Gender does not constitute a significant difference in the attitude scores of secondary school students towards receiving distance mathematics education. In terms of the type of school in which students studied, a significant difference was found in favor of public schools in secondary school students' attitude scores towards distance mathematics education. In terms of grade levels, a statistically significant difference was found in favor of the 5th, 6th, and 7th grades regarding their attitudes towards distance mathematics education, among 5th, 6th, 7th, and 8th grade students.

Keywords: Distance mathematics education, attitude, scale development

1. INTRODUCTION

Distance education, which originated in the 1700s as mail correspondence education, has evolved and become increasingly popular in recent times. Today, education is delivered online and planned remotely at all levels (Yamamoto & Altun, 2020). In the most general sense, distance education is the organization, presentation and evaluation of the teaching processes of teachers and students in different environments from a distance and from a center (Sönmez, 2009). The most distinctive feature that distinguishes distance education from face-to-face education is the independence between the learner and the teacher in terms of time and space (Ağır, 2007). Thanks to distance education, the individual's ability to learn independently can be developed, and the course contents can be easily changed. In addition, by eliminating the opportunity gap between students, education can be provided in line with students' needs. In this way, traditional education processes can be enriched, and it could be possible to benefit from them at all stages of education in various disciplines (Uşun, 2006). However, the fact that it is not possible to implement some courses that require practice and that it is more difficult to provide learning and teaching motivation in distance education than in traditional education are among its disadvantages (Ağır, 2007). Distance education

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can cause asociality as it limits face-to-face interaction and communication. In cases where the technological infrastructure is insufficient, learning activities may lose their efficiency (Uşun, 2006).

Distance education is highly related to developments in the technology field. Therefore, distance education is carried out online thanks to internet technology (Okur, 2012). In parallel with these developments and the fact that technology is further embedded in education and training, the idea of individual learning is gaining importance. The idea that an effective and efficient learning environment can be provided with the concomitant use of the constructivist learning approach and technology has become widespread, and a new perspective on the use of technology in education has been gained (Erbaş & Demirer, 2015).

There are four principles proposed by Heid (1997) for technology-enriched learning environments. According to the first principle, student-centered teaching is valuable, and technology is a powerful alternative for student-centered learning environments. According to the second principle, the student should have a working/studying experience just like a mathematician. The third principle states that learning can be strengthened by deep thinking, and technology can play a strong thought-provoking role. In the fourth principle, epistemological authority is redefined in conjunction with technology. It is possible to say that these principles can also provide guidance on how mathematics courses can be conducted through distance education. In other words, according to Heid's principles, technology becomes a source of information that has a decisive effect on the formation of the students' knowledge. This student-centered approach is supported by individuals' work and experiences. From this point of view, it is seen that technology aims to improve mathematical understanding and thinking by supporting the environment of learning and teaching of mathematics. Accordingly, in mathematics education given by distance education, technology should be considered just a presentation tool, and students should be provided with learning environments where they can interact with mathematics software at various levels.

When the literature is reviewed, it is seen that there are studies examining the views, perceptions and beliefs of teachers and/or students on distance education (Arslan, Kutluca & Özpınar, 2011; Boz, 2019; Bozkurt, 2020; Erfidan, 2019; Mercan, 2018; Özer, 2011; Özyurt & Kısa, 2021). These studies show that while there is a positive opinion in terms of flexibility of time and space, there are also negative views expressing that it is not possible to have direct communication and interaction in distance education. It is stated that some instructors define distance education as a system that is inefficient, with hardships and difficulties (Şeren, Tut & Kesten, 2020), and that they have a more negative view than the students in terms of the processes and the evaluation (Özer, 2011). Moreover, it is also observed that instructors have a low level of knowledge and awareness about distance education and have a more positive stance towards traditional education (Erfidan, 2019). Mercan (2018) stated that most of the undergraduate students evaluated distance education positively. Students were examined in the context of learning, environment and technology about the positive aspects of distance education. Additionally, students expressed that the lack of active participation, technical problems, lack of obligation to attend and low interaction compared to formal education are the negative aspects of distance education (Mercan, 2018).

Literature contains studies that reveal teachers' and students' attitudes to distance education. According to Ülkü (2018), primary school teachers generally have negative attitudes towards distance education, but there are no significant differences between classroom and branch teachers working in primary schools. However, Ağır (2007) stated that primary teachers had a positive attitude towards distance education and that the Internet was preferred as a technique of distance education. The common conclusion found in the studies of Ülkü (2018) and Ağır (2007) is that teachers who have a master''s degree have more positive attitudes towards distance education. While Sipahi (2019) studied the attitudes of high school students towards distance education, Gürkan (2017) and Uslusoy (2017) examined the attitudes of higher education students. Uslusoy (2017) compared the attitude of students

studying in Turkey and the United States towards distance education. The sample of the study conducted by Uslusoy (2017) consists of students studying in Turkey and the USA. According to the study results, students at the higher education level were found to have a negative attitude towards distance education in Turkey compared to students in the United States. It was stated that a significant portion of the students from Turkey were not able to benefit from the distance education courses that they had taken previously. This brings up the limitations of distance education. The results of the study conducted by Sipahi (2019) show that students encounter significant problems and obstacles online. Similarly, Horzum (2003) stated that students experience socialization problems with distance education, that there are some problems in applied lessons conducted with distance education, and that learning cannot be carried out properly. Özdemir Baki and Çelik (2021) identified the problems experienced by mathematics teachers working in secondary schools who were faced with the distance education process for the first time due to Covid-19. It has been determined that teachers have difficulties due to lack of infrastructure, lack of tools such as computers, tablets, phones because of financial impossibilities among students, and difficulties in accessing the internet. The study reveals that mathematics subjects are interrelated, and therefore, the fact that students cannot attend one class and attend the next, that is, not being able to attend every live lesson, negatively affects the learning of the subjects covered in the lessons. Similar results were obtained in literature research, in which teachers and parents decided on distance education during the pandemic period (Erdemci & Elçiçek, 2022; Gören, Gök, Yalçın, Görgen & Çalışkan, 2020; Oflaz & Adalar, 2020).

Due to the Covid-19 pandemic, billions of learners around the world had to continue their education with distance education (Bozkurt, 2020). The experiences and gains achieved with early widespread digital learning, which was rapidly adapted as a result of the Covid-19 pandemic, contributed to the development of this method all over the world. It is expected that digital learning, whose functionality will increase with the contribution of new technologies and systems in the near future, will become the main learning structure (Yamamoto & Altun, 2020). In this case, it becomes important to determine the relationship between technology and mathematics learning and teaching environments, as the attitudes of the students are shaped accordingly. This is true because the teaching methods employed while teaching mathematics are also effective factors determining the interest in and attitudes towards mathematics (İrmak & Çelik 2021; Şengül & Dereli, 2013). In other words, attitude is influenced by math learning experiences. In the literature, there are studies examining the attitudes of the teachers and the students who do not receive distance education except for mandatory courses. However, no study was found to measure the attitudes of secondary school students who spent this period of education taking mathematics courses through mandatory distance education. The aim of this study was to develop a scale of attitudes of secondary school students who had previously undertaken compulsory distance education in mathematics and to study their attitudes from the perspective of various variables. In the study, it is thought to be important in terms of developing a valid and reliable scale for middle school students to take mathematics courses via distance education.

For this purpose, answers to the following sub-problems were sought.

1. Is the scale developed to determine the attitudes of secondary school students toward distance mathematics education a valid and reliable scale?
2. What is the level of attitudes of secondary school students towards distance mathematics education?
    a. Is the difference between the attitude scores towards distance mathematics education statistically significant in terms of the differences in gender, school types, and grade levels of the secondary school students?.

2. METHOD

2.1. Research Model

This study used a survey model to develop a valid and reliable tool to determine students' attitudes to distance mathematics education in secondary schools. Survey models are research models aimed at describing past or present situations in their own conditions (Karasar, 2005).

2.2. Study Group

The study group for the research consists of students studying in secondary schools that were identified in Sivas province during the 2020-2021 academic year. Criterion sampling, one of the techniques of purposeful sampling, was preferred in the study as the participants of the study group needed to get more information about the situation investigated. According to the study, the criteria are that students are studying in secondary school and taking mathematics courses through distance education. This study was conducted with two separate study groups. The study was carried out with one of the groups during the development of the attitude scale towards distance mathematics education and with the other group at the stage where the attitudes of the students were determined by applying the scale that had just been developed. The demographics of the study groups are provided in Table 1 and Table 2.

Table 1. Demographics of the group participating in the development of the attitude scale regarding distance mathematics education

		f
Gender	Female	159
	Male	151
School type	State school	310
	Private School	0
Grade Level	5th Grade	70
	6th Grade	78
	7th Grade	71
	8th Grade	91
Total		310

As can be seen from Table 1, 159 of the 310 students who participated in the scale development part, which is the first stage of the research, are female, and 151 are male students. The entire study group is studying at a public school. The study group consists of 70 students studying in the 5th grade, 78 students in the 6th grade, 71 students in the 7th grade, and 91 students in the 8th grade.

Table 2. The demographics of the group where the students' attitudes were determined by applying the scale that had been developed.

		f
Gender	Female	154
	Male	117
School type	State school	204
	Private School	67
Grade Level	5th Grade	56
	6th Grade	60
	7th Grade	58
	8th Grade	97
Total		271

Table 2 shows that 154 of the 271 students who participated in the second stage, in which the students' attitudes were determined by applying the attitude scale developed, were female and 117 were male students. In this study group, there are 204 students studying at a public school and 67 students studying at a private school. 56 students from 5th grade, 60 students from 6th grade, 58 students from 7th grade and 97 students from 8th grade participated in the study.

In the scale development study, the sample size of 50 participants is considered to be very low, 100 low, 200 medium, 300 good, 500 very good. In addition, the size of the sample depends on the number of factors and population correlation coefficients (Tavşancıl, 2010). In this context, as seen in Table 1 and Table 2, it can be concluded that the sample size is sufficient for both stages of the study.

2.3. Data Collection

The "Attitude Scale of Secondary School Students towards Distance Mathematics Education" developed by the researchers, was used as a data collection tool in the research. The Personal Information Form created by the researchers was used to determine the independent variables taken into account in determining the attitudes of the students towards distance mathematics education.

2.3.1. Personal information form

The "Personal Information Form" which constitutes the first part of the data collection tool, consists of items that allows to get to know the students who constitute the study group and to obtain the necessary information to determine their attitudes towards distance mathematics education according to some variables. In this section, the gender, class, and school type of the students were requested. Students were asked to write down their thoughts, experiences, opinions, and suggestions in relation to taking a mathematics course through distance education.

2.3.2. Attitude scale of secondary school students towards distance mathematics education

Literature reviews examined various measurement tools used to develop attitudes scales to determine attitudes of secondary school students to distance education and mathematics courses. In order to determine the items on the scale, 34 students attending 8th grade and 6th grade in a secondary school in central Sivas were asked to write a composition in which they shared their experiences about distance education, stated the positive and negative characteristics, and presented suggestions, if any. The scale items were prepared as a result of the evaluation of the compositions written by the students and the examination of the attitude scales towards distance education that already exist in the literature. The statements that can be used as sentences expressing attitudes from these prepared scale items were selected and arranged in a way so that they can express attitude in accordance with the item writing rules.

The content validity is an indication whether the items in the content of the test are sufficient in terms of quality and quantity to measure the behavior to be measured. Taking into account the expert opinion is one of the logical ways to test content validity (Büyüköztürk, 2005). The scale, which consists of 46 items, was examined by 2 experts working in the field of mathematics education and 1 expert working in the field of measurement, and their opinions were taken into account. It was checked to see whether each question sufficiently explained the situation it aimed to explain, and the necessary corrections were made in this direction. Then, the study was presented to a Turkish teacher to get his/her opinion for language validity. In order to determine whether a respondent understood each item in the same way, the scale was applied to a group of 15 students and then finalized.

The 46 items created were distributed on a draft scale, paying attention to the ordering of positive and negative items and not creating any bias in participants. Positive items on the 5-point Likert scale were scored as 5, 4, 3, 2, and 1 from the "Completely Agree" option to the "Strongly

Disagree" option. The negative items were scored as 1, 2, 3, 4, 5 from the "Strongly Disagree" option to the "Strongly Agree" option. Thus, the highest score that can be obtained from the scale is 230 and the lowest score is 46.

Within the scope of the research, the scale that was created was applied to secondary school students studying in 1 provincial central public school, 1 district public school, and 1 private school in the center of the Sivas province in March of the 2020-2021 academic year. 203 students completed the questionnaire online, and the questionnaires were distributed physically to 150 students. Out of the 150 questionnaires sent, 100 were returned, and 32 were invalidated and hence excluded from the study. In total, 271 questionnaires were answered.

2.4. Data Analysis

Different analysis techniques were used in the scale development part of the study and in the application part of the developed scale. Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were performed respectively for the construct validity of the scale. SPSS 22.0 software was used for EFA and LISREL 8.7 software was used for CFA. In addition, the reliability calculations of the scale were interpreted according to the Cronbach Alpha Coefficient.

With the completion of scale development, students' attitudes towards distance mathematics education were determined according to various variables. SPSS 22.0 software was used for this purpose. Kolmogorov-Smirnov Test $\left|\frac{\text{skewness}}{\text{standart error}}\right|$ techniques were used to determine the normality of the measurements. According to the results of the Kolmogorov-Smirnov Test (p=0.085), it can be said that the scores are normally distributed. In addition, when the skewness coefficient is divided by its standard error and the value is smaller than 1.96, it is decided that the distribution is normal (Bursal, 2017). Since the result of the measurement is within the specified range, it can be said that the data shows a normal distribution. Independent sample t-test and variance analysis were performed to determine the differentiation of secondary school students' attitudes towards distance education in mathematics according to gender, school type, and grade level. In addition, calculations of the standard deviation and arithmetic mean were performed to determine the attitudes of secondary school students towards distance mathematics education.

3. FINDINGS

In this part of the study, first the findings of the studies made on the validity and reliability of the scale were reported, and then the results of the analysis on whether the attitudes of secondary school students towards distance mathematics education differ according to various variables were reported.

3.1. Is the scale developed to determine the attitudes of secondary school students toward distance mathematics education a valid and reliable scale?

To determine the reliability of the scale, the Cronbach Alpha internal consistency coefficient was calculated. The Cronbach Alpha value of the 46-item attitude scale related to the attitude of the secondary school students towards distance mathematics education was found to be 0.91. Values above 0.80 are described as highly reliable in the literature (Tavşancıl, 2010). In order to ensure content validity, the opinions of three faculty members, who are experts, on the 46-item scale were obtained, and the necessary corrections were made by examining whether each question explained the situation it aimed to explain in line with their opinions. Then, the study was presented to a Turkish teacher, and his/her opinion was obtained for language validity. In order to determine whether each item was understood in the same way by each participant, the scale was applied to a group of 15

students and finalized. The 46 items created were distributed on a draft scale, paying attention to the ordering of positive and negative items so as not to create any bias in the participant.

Factor analysis technique was used to test the construct validity of the scale. Factor analysis explains the measurement with a small number of factors by gathering the variables that measure the same structure or quality (Büyüköztürk, 2005). In factor analysis, two general approaches are used: exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). The repeatability of EFA results and the reliability of the results obtained are directly related to various factors. The size of the dataset affects the strength of the analysis and the accuracy of the results (Uyumaz, Dirlik &Çokluk, 2016). In this study, 310 participants were studied. Therefore, it can be said that the sample size is "good" (Tavşancıl, 2010).

Table 3. Results of Kaiser-Meyer-Olkin (KMO) test and Bartlett's test for sphericity

Measurement of Kaiser-Meyer-Olkin Sampling Competence		.91
Bartlett Sphericity Test	Approximately Chi-Square	2888,224
	Df	210
	Sig.	.00

In order to perform factor analysis, the normality assumption must be met. In Table 3, it is seen that the KMO test is 0.91 and the Bartlett's test has a significance level (sig<0.05) for the scale of "determining the attitudes of secondary school students towards distance mathematics education". As these values were significant, factor analysis techniques were applied to determine the construct validity.

The scale initially consists of 11 factors with eigenvalues greater than 1. These factors explain 59.418 of the variance. After the scale was rotated with the Varimax rotation technique, items with a load value less than 0.4 were removed from the scale (Çokluk, Şekercioğlu & Büyüköztürk, 2010). Table 4 shows the total variance values explained regarding the attitude scores of the scale applied.

Table 4. Total variance values

Component	Initial Eigenvalues			Subtotals of Quadratic Loads			Rotation Totals of Square Loadings		
	General	Percentage	ofCumulative	Total	Percentage	ofCumulative	Total	Percentage	ofCumulative
1	6.60	31.44	31.44	6.60	31.44	31.44	5.12	24.36	24.36
2	3.66	17.42	48.86	3.66	17.42	48.86	4.19	19.96	44.32
3	1.14	5.42	54.27	1.14	5.42	54.27	2.09	9.96	54.27
4	.95	4.51	58.78						
5	.81	3.89	62.67						
6	.77	3.65	66.32						
7	.72	3.43	69.74						
8	.68	3.26	72.99						
9	.67	3.18	76.17						
10	.65	3.09	79.27						
11	.59	2.84	82.11						
12	.54	2.55	84.66						
13	.51	2.45	87.11						
14	.51	2.40	89.51						
15	.42	1.99	91.50						
16	.40	1.92	93.42						

17	.34	1.61	95.03
18	.33	1.57	96.59
19	.29	1.41	98.00
20	.24	1.14	99.15
21	.18	.85	100.00

In Table 4, it is seen that the variance explanation rate of 3 factors is 54.27%. The variance values explained by the factors in the scale were determined as 24.36% for factor 1, 19.96% for factor 2 and as 9.96% for the factor 3. On the other hand, the total variance explanation value of all 3 factors was found to be 54.27%. Excessive variance can be stated as evidence that the relevant structure or concept is well-measured (Çokluk et al. 2010).

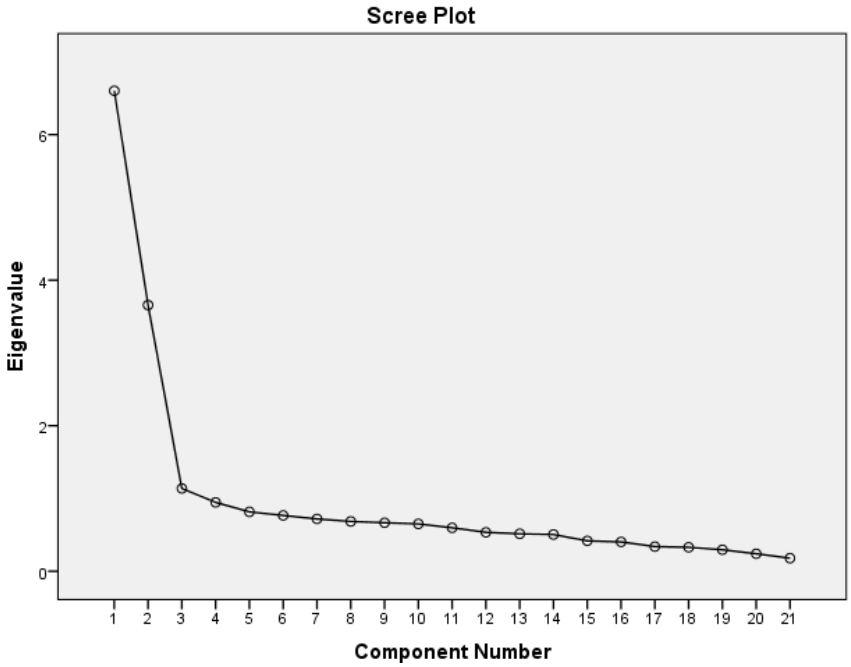

Figure 1. Scree plot

While determining on how many factors the data are collected, "eigenvalue statistics" are examined with the "scree plot" graph. When Figure 1 is examined, it is seen that the line graph follows a horizontal path after the third factor. This shows that it is appropriate to gather the items under 3 factors.

Table 5. Factors and load values in the scale

Factors and items	**Explained Variance**	**Factor Load**
Factor : Satisfaction factor	24.36%	
i19		.88
i15		.87
i34		.80
i8		.76
i23		.73
i9		.66
i11		.64
i45		.63

i6		.62
Factor 2: the Factor for Reservations and Difficulties	19.96%	
i24		.77
i31		.75
i33		.73
i35		.71
i30		.68
i14		.67
i28		.63
i3		.49
Factor 3: Factor for Impact on Learning	9.96%	
i27		.72
i41		.69
i18		.59
i39		.55

The distribution of the items decided to be included in the scale according to factor loadings and dimensions is shown in Table 5. It is observed that the load values of the items in the scale vary between 0.49 and 0.88. It is seen that the load value of the items in the first factor varies between 0.62 and 0.88. It is seen that the load value of the items in factor 2 varies between 0.49 and 0.77, and the load value of the items in factor 3 varies between 0.55 and 0.72. In line with the literature review and expert opinions, the first factor was named the "satisfaction factor," the second factor was named the "reservations and difficulties factor," and the third factor was named the "effect on learning factor."

The data of 271 people, who were not included in the first sample, were used in the structure consisting of 21 items and 3 factors obtained after EFA, and then CFA was performed. The indices of CFA are given in Table 6.

Table 6. Item dimensions fit model values

Criterion	Perfect Fit Value	Compliance value obtained from the scale	Degree of matching
Chi-Square	-	356.89	
Df	-	186	
Chi-square/df	0≤x2/df<2	1.92	Perfect fit
RMSEA	≤0.05	0.06	Good fit
SRMR	≤0.05	0.06	Good fit
GFI	0.90 ≤ GFI	0.90	Good fit
CFI	0.95≤CFI	0.97	Perfect fit
NFI	0.90 ≤ NFI	0.94	Good fit
NNFI	0.95≤NNFI	0.97	Perfect fit

When Table 6 is examined, the fit values of the model are seen. When we look at each of the fit indices in the Fit Statistics, it is understood that the Chi-Square value is calculated as 356.89 and it is statistically significant (p<.00). The fact that the ratio of x^2 /df is 2.5 or less for the confirmatory factor analysis indicates that it is a perfect fit. When Table 6 was examined, the ratio of x^2 /df was calculated as 1.92, and thus, it was determined that it was a perfect fit. It was determined that RMSEA

value (0.06), SMRM value (0.06), GFI value (0.90), NFI value (0.94) showed good fit; CFI value (0.97), NNFI value (0.97) showed perfect fit (Çokluk et al., 2010).

The significance levels of the t values of the variables observed in the model were examined.

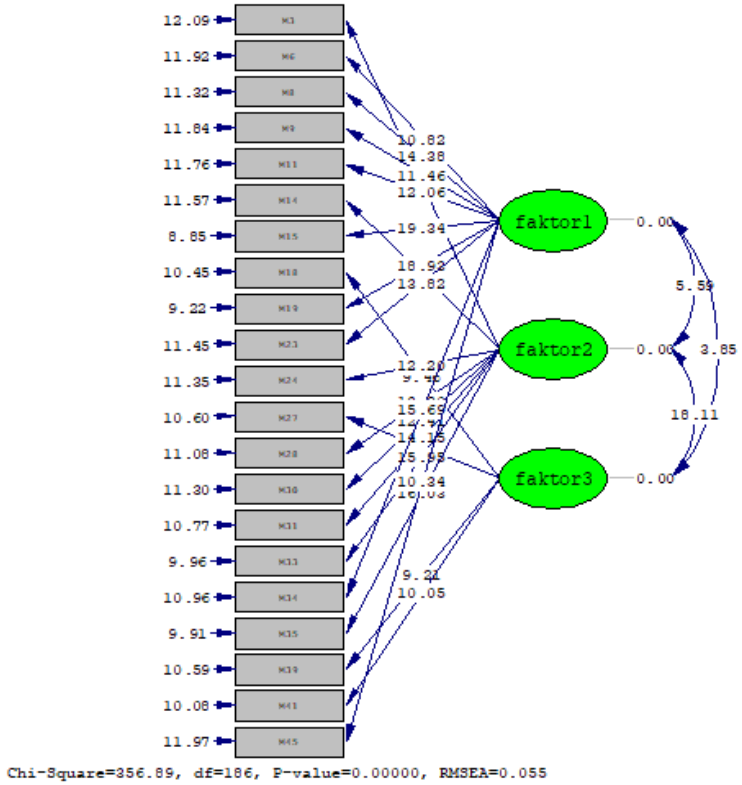

Figure 2. The significance level of the rates of explanation of latent variables by the observed variables for the three-factor model of the attitude scale

Figure 2 shows the t values of the latent variables explaining the observed variable. If the t values exceed 1.96, it can be said that the parameter estimates are significant at the level of 0.05 (Çokluk et al., 2010). As seen in Figure 2, t values are significant at the level of 0.05.

Cronbach's alpha value was used to determine the reliability of the scale. The Cronbach's alpha value of the scale was to be 0.91. This value shows that the scale is highly reliable (Tavşancıl, 2010).

Table 7. Cronbach's Alpha values of the determined factors

Factors	Number of Items	Cronbach's Alpha
Satisfaction Factor	9	.90
Reservations and Difficulties Factor	8	.86
Impact on Learning Factor	4	.66
Total Scale	21	.91

As can be seen in Table 7, the reliability values of the developed scale are quite good. Therefore, developed scale can be considered a reliable tool for determining the attitude of secondary school students towards distance education.

3.2. Is the difference between secondary school students' attitude scores towards distance mathematics education in terms of gender, school types and grade levels statistically significant?

In this section, descriptive statistics on the attitude scale applied are presented first. Then, the students' attitudes towards distance mathematics education were examined according to gender, school type and grade level variables.

According to Table 7 the reliability coefficient of the attitude scale regarding distance mathematics education was determined to be 0.91. This value shows that the reliability of the developed scale is at a very good level.

Table 8. Overall mean and standard deviation results based on factors

	N	Mean	Sd
Satisfaction Factor	264	2.09	.94
Reservations and Difficulties Factor	264	3.16	.1
Impact on Learning Factor	264	3.02	1.06
Total	264	2.65	.72

According to the descriptive analysis data. the mean value for the scale was determined as 2.65. With this value, it is seen that the scale mean is low. In general, it is seen that almost all the students gave negative answers to the items related to the satisfaction factor. When Table 8 is examined, the mean satisfaction factor item (x=2.09) also shows a similar situation. This leads to the conclusion that the students participating in the study are not satisfied with taking the mathematics course through distance education. In other words, it can be said that students have a negative attitude with regard to the satisfaction they get from distance education. When the item means of the reservation and difficulties factor (x=3.16) are examined, it can be said that they have an indecisive attitude towards the relevant items. When the item means of the impact on learning factor (x=3.02) are examined, it is seen that the students are undecided about the effect of the mathematics course taken with distance education on learning.

Table 9 shows whether there is a significant relationship between the attitudes of secondary school students towards distance mathematics education and their gender.

Table 9. Comparison of attitudes towards distance mathematics education by gender

Gender	N	Mean	Sd	Sd	t	p
Female	154	2.67	.75	.06	0.42	0.67
Male	110	2.63	.68	.07		

Levene's test determines whether the variances are equally distributed. As a result of the Levene test (p=0.301), it can be said that the variances are equally distributed as the p is >0.05. Accordingly, since the significance value calculated as a result of the independent sample t test (p=0.67) is p>0.05, there is no significant difference between the attitude scores of female and male students. According to Table 9. Although the mean attitude score of female students is higher than that of male students. This difference is not significant (t(264) = .42;p = 0.67).

Table 10 shows the extent to which there is an important relationship between attitudes towards distance education among secondary school students and the type of school.

Table 10. Comparison of attitudes towards distance mathematics education by school type

School type	N	Mean	Sd	Sd	t	p
Public	198	2.72	.70	.05	2.76	0.01
Private	66	2.44	.75	.09		

As a result of the Levene's test conducted to determine whether the variances are equally distributed (p=0.826). it can be said that the variances are equally distributed since p>0.05.

As shown in Table 10, the significance value calculated by independent sample t-tests (p=0.01) is p<0.05, so there is a significant difference in attitudes of students studying at public schools and private schools. It is seen that the mean of the attitude scores of the students studying at the public school is higher than the mean of the attitude scores of the students studying at the private school. According to the test results, it can be said that this difference between attitude scores is significant ($t_{(264)}$ = 2.76;p=0.01).

ANOVA was used to determine whether the difference between secondary school students' attitude scores towards distance mathematics education was significant according to grade level.

Table 4. The results of the one-way analysis of variance for the attitude scores regarding distance mathematics education according to grade level

	Sum of Squares	Sd	Mean of Squares	F	p
Between groups	10.32	3	3.44	7.13	.00
Within groups	125.43	260	.48		
Total	135.76	263			

As seen in Table 11, it can be said that there is a significant difference between the attitude scores of at least two grade levels ($F_{(3.260)}$ =7.13;p=0.00). In cases where the variances are equal, Scheffe or Tukey HSD test is often used to understand among which groups the differences are in terms of grade levels. A Tukey HSD test was performed to determine between which classes the difference occurred in terms of attitude scores.

Table 12. Tukey HSD test results

Grade	(J) Grade	Difference between means (I-J)	P
5	6	.09	.91
	7	.03	.99
	8	.45*	.00
6	5	-.09	.91
	7	-.04	.98
	8	.37*	.01
7	5	.04	.99
	6	-.05	.98
	8	.41*	.00
8	5	.45*	.00
	6	.37*	.01
	7	-.41*	.00

As seen in Table 12, there is a significant difference between the attitudes of 5th (p= 0.00), 6th (p = 0.01) and 7th (p = 0.00) grades and 8th grades. A statistically significant difference was found between the attitudes of 5th, 6th and 7th grade students towards distance mathematics education and the attitudes of 8th grade students. This difference benefits students in the 5th, 6th and 7th grades. There were no statistically significant differences between the other groups.

4. DISCUSSION, CONCLUSION AND RECOMMENDATIONS

In this study, a scale was developed to measure the attitudes of secondary school students towards distance mathematics education. The prepared scale was applied to 5th grade, 6th grade, 7th grade and 8th grade students studying in secondary school. As a result of the analyses, it can be said that the scale developed is a valid and reliable scale that will determine the attitudes of secondary school students towards receiving distance mathematics education. Similarly, Deniz (2021) developed a valid and reliable scale to determine and evaluate teachers' attitudes towards distance education program. Ağır (2017) developed a scale to determine the teachers' thoughts about distance education.

As a result of the study, it was concluded that secondary school students had a negative attitude towards receiving distance mathematics education. Similarly, Akpolat (2021), Gören et al. (2020), Kaynar, Kurnaz, Doğrukök and Barışık (2020), Oflaz and Adalar (2020) conclude that students prefer face-to-face education than distance education. They think effective education requires direct interaction. Therefore, they believe that direct education is more beneficial than distance education. In their studies conducted with students in high school and higher education, Sipahi (2019), and Uslusoy (2017), stated that students have a negative attitude towards distance education. Distance education is no longer seen as an aid to face-to-face education but as a substitute for it (Yamamoto & Altun. 2020) and as a part of education (Bozkurt, 2017). However, it is seen that students have a negative attitude towards distance education, which is expected to be a part of education in the future. Similarly, it was stated that attitudes of male students towards mobile learning were higher than female students since they were more motivated by fast learning, easy access, and multimedia factors in learning (Gürkan, 2017).

In line with the results obtained from the findings, there is no statistically significant difference between male and female students' attitudes towards distance mathematics education. A similar result is supported by other studies (Deniz, 2021; Kaynar et al., 2020; Uslusoy, 2017; Tevetoğlu, 2021). As the reason for this situation, it was stated that students are in similar and equal opportunities by drawing attention to the equality of opportunity and possibility. This reason is thought to be valid for our study as well. Sipahi (2019), stating that the students' distance education attitudes did not change according to gender, found that as the social interactions increased, the attitudes of the students also increased. In contrast, Sarıbıyık (2022) found a significant gender difference in secondary school students' opinions on distance education mathematics courses during the Covid-19 period. In this context, it was stated that the opinions of male students were more positive than female students. Akpolat (2021) stated that there are perceptual differences between male and female students regarding distance education. While female students describe distance education as more demanding, non-interactive and inefficient, male students perceive it as providing easy accessibility, creating more diversity and causing loneliness. However, it was stated that female students had a more negative approach than male students. Boz (2019) stated that as the technology acceptance level of male students is higher than female students, distance education perception level of male students is higher. Similarly, it was stated that attitudes of male students towards mobile learning were higher than female students since they were more motivated by fast learning, easy access, and multimedia factors in learning (Gürkan, 2017; Mercan, 2018). In our study, the reason why there is no significant difference in students' attitudes towards distance mathematics education according to the gender variable is thought to be that there is no difference between male and female students in terms of motivation with factors such as fast learning and easy access.

According to the results obtained, there was a statistically significant difference between private and public schools in the attitudes of secondary school students to distance mathematics education. Similarly, Sarıbıyık (2022) stated that students studying at public schools have a more positive attitude than students studying at private schools. The reason for this was associated with the

higher educational expectations of students from private schools than those from public schools. Kaynar et al. (2020) concluded that students studying in public schools had more difficulties accessing the necessary equipment, so the secondary school students studying in private schools had more positive opinions about distance education than their peers studying in public schools. In addition, Deniz (2021) stated that teachers in private schools have a positive attitude than those in public schools. It is stated that the reason for this is that private school students and teachers have better access and participation in classrooms and better technological opportunities. Ağır (2007) examined the attitudes of primary school teachers working in public and private schools towards distance education and found no statistically significant difference. However, in a way similar to this study, he stated that teachers working in public schools had a more positive attitude. In conclusion, it is thought that the fact that private schools are more convenient than public schools in terms of some opportunities increases the desire of students to receive face-to-face education in private schools, and therefore their attitudes towards distance education are lower than those of students studying in public schools. In addition, it is thought that the education expectations of the students studying in private schools may be higher than those in public schools.

When examined in terms of grade levels, a statistically significant difference was found in terms of attitudes towards distance mathematics education between 5th, 6th, and 7th grade students on the one hand, and 8th grade students on the other. This difference is in favor of the 5th, 6th, and 7th grades. The reason for this difference is thought to be that 8th grade students prefer face-to-face education, which they are used to because they are preparing for high school exams. Similarly, Gören et al., (2020) stated that satisfaction in the distance education process decreases as the grade of education increases. Akpolat (2021) stated that 5th and 6th grade students used both positive-negative metaphors about distance education in-half, and 7th and 8th grade students used more negative metaphors. Similarly, Sarıbıyık (2022) found that 5th and 6th grade students approached distance education more positively than 7th and 8th grade students. The reasons for this situation were explained as follows: the 7th and 8th grade math subjects were more abstract and difficult, and the 5th and 6th grade math subjects were more entertaining and less challenging. Unlike our study, Tevetoğlu (2021) stated that there was no significant difference between students' expectations and readiness for the distance education process in terms of grade levels. He pointed out that the reason for this situation is that training programs are presented appropriately for each grade level. Gürkan (2017) stated that university students'' attitudes towards distance education and mobile learning were not statistically significant according to their grade levels. However, since it was determined that students had a positive attitude in the study, it is thought that students generally adapted to and used technology for each grade level. In conclusion, in our study, the reason for the significant difference in attitudes towards taking distance mathematics education in favor of the 5th, 6th, and 7th grades between the 5th, 6th, 7th, and 8th grades is thought to be the increase in the level of anxiety as the grade level increases and the expectations from education due to the central exam.

In this study, a valid and reliable scale was developed for assessing the attitudes of secondary school students towards distance mathematics education. By applying this scale to a larger sample, it will be possible to determine their attitudes towards taking mathematics lessons through distance education. Valid and reliable measurement tools can be developed to determine students' attitudes towards taking other courses through distance education. Hence, it could be possible to investigate the attitudes of students studying at different school types and grade levels toward distance education. If the data collected by qualitative research methods are included in determining the attitudes of students towards taking a course through distance education, student attitudes can be examined in more detail.

When evaluated in the context of attitudes towards the factors constituting the scale, learning environments in which students interact with mathematics software at various levels can be offered by making more use of the richness of the internet and computer instead of the direct lecture technique in

distance education. Lessons can be taught using a constructivist approach with a view to ensuring more active student participation in the lesson during the distance education process and reducing learning losses. In distance education, students can be guided to develop individual study methods to control their own learning. Work can be carried out to enable students to learn more about distance education and to ensure and develop the use of related technologies.

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