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EXAMINING THE MATHEMATICS ATTITUDES OF PRIMARY SCHOOL STUDENTS: A LONGITUDINAL ANALYSIS IN THE CONTEXT OF TURKEY

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Abstract: This study was conducted with the aim of tracking the mathematics attitudes of primary school students from the year they started school until they graduated from primary school and transitioned to middle school, covering a four-year period. The research involved a longitudinal method and was carried out with the participation of primary school students in Istanbul, Turkey. The data collection instruments utilized in this study were the "Student Information Form" prepared by the researchers and the "Mathematics Attitude Scale" developed by Aşkar (1989). Statistical analysis of the data was performed using SPSS 25.0, incorporating the Mann Whitney U test, Kruskal Wallis H test, and Spearman Correlation data analysis methods. In the study, it was observed that students had a 'moderate' mathematics attitude in the first grade, a 'very high' attitude in the second grade, and an overall 'high' attitude in the third and fourth grades. As students progressed through the grades, their mathematics attitudes decreased. Although there was a trend favoring males in scores over the years based on gender, this difference was not statistically significant. Finally, a significant relationship was found between mathematics attitude and students'mathematics grades in both the first and fourth grades

Key words: Primary, attitude, mathematics, mathematics attitudes.

1. Introduction

According to Bloom (1998), affective traits account for 25% of students' achievements and contribute to 25% of the learning outcome. Considering the extensive research conducted since the early 1960s, it is observed that among the affective traits, attitude holds the longest historical significance (Ernest, 1989; Van der Sandt, 2007). Allport (1935) notes that attitude first entered the literature of social psychology in the early nineteenth century, along with research on the predictability of voter preferences and consumer product choices in selections (Tabuk, 2018).

The concept of attitude is defined in various ways in literature. Some use this term similarly to beliefs, while others employ it in a less cognitive sense, leaning more towards emotions (McLeod, 1992). According to Aiken (1970, p. 551), attitude is defined as "an individual's predisposition to respond positively or negatively to an object, situation, concept, or another person." Attitude represents "a person's basic liking or disliking state towards a familiar target" (Hannula, 2002, p25). The theoretical framework for attitude is formed by Bandura's Social Learning Theory. Bandura (1997) emphasizes a close relationship between individuals' self-efficacy beliefs, attitudes, and behaviors towards any domain, asserting that this relationship plays a determinant role in the learning process. Therefore, changes in attitudes and beliefs lead to alterations in an individual's behaviors. When a student begins their school life, attitudes towards school and learning also start to form. The experiences encountered in school contribute to the development of attitudes, either positively or negatively (Davies & Brember, 2001; Lumsden, 1994). Negative attitudes cause students to experience shame and lack self-confidence in the classroom, school environment, and their surrounding community. Consequently, students may experience learned helplessness (Boz & Büyükalan Filiz, 2020). In general, attitudes, beliefs, and emotions constitute the fundamental aspects of the affective domain in mathematics education (McLeod, 1992). The societal image and significance of mathematics can play a crucial role in influencing students'attitudes (Prendergast, Hongning & Block, 2016).

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Mathematics attitude is defined as a comprehensive measure formed by the combination of liking or disliking mathematics, the tendency to participate or avoid activities related to mathematics, and beliefs about whether mathematics is good or bad, and whether mathematics is beneficial or useless (Ma & Kishor, 1997). Additionally, it can be defined as a long-term positive or negative emotional tendency towards mathematics (Kiwanuka et al., 2017). According to Işık (2018), once an attitude is acquired in a mathematics class, it is nearly impossible as well as difficult to change. If a student harbors a negative attitude towards the course, the class becomes challenging to succeed in, does not easily dissipate, and may carry over into their future experiences (Filiz & Gür, 2020; Kocakaya et al, 2018). Attitude in the mathematics class influences cognitive learning (Ma & Kishor, 1997; Nicolaidou & Philippou, 2003; Yücel & Koç, 2011), mathematical performance (Guo et al., 2015; Lipnevich, Preckel & Krumm, 2016; Passolunghi et al., 2016; Smetackova, 2015), and conceptual learning (Markovits & Forgasz, 2017). The positive impact of positive attitudes also has neurological implications, strengthening the relationship between attitude and mathematical success. It is suggested that learning-memory systems rooted in the hippocampus contribute to this relationship. Consequently, positive attitudes may lead to increased utilization of the hippocampus for more effective encoding and retrieval, resulting in enhanced learning ability (Chen et al., 2018). Students with a positive attitude towards mathematics tend to develop a liking for mathematics, perceive it as a valuable subject, and exhibit confidence in the topic (Mullis et al., 2020). Attitude influences achievement, and achievement also reciprocally affects attitude in a bidirectional manner (Aiken, 1970). The academic success and failure of students in mathematics classes are believed to be influenced by their attitude towards mathematics (Aiken, 1972; Cantürk-Günhan, Topuz & Bedir, 2019; Hemmings, Grootenboer & Kay, 2011; Kara & Özkaya, 2022; Ryan & Pintrich, 1997; Sullivan, 2008). Additionally, it is thought that a positive attitude towards mathematics also positively affects mathematical achievement (Choi & Chang, 2011; Dowker, Cheriton, Horton & Mark, 2019; Dwinell & Higbee, 1991; Ganley & Vasilyeva, 2011; Hwang & Son, 2021; Kiwanuka et al., 2020; Ma, 1997; Ma & Kishor, 1997; Ma & Xu, 2004; Makur, Prahmana & Gunur, 2019; Lipnevich, Preckel & Krumm, 2016; Poçan, İlhan & Gemcioğlu, 2022; Siskandar, 2013; Yücel & Koç, 2011).

It is evident that many individuals, including both children and adults, harbor negative attitudes towards mathematics, and these attitudes hinder mathematical learning and engagement (Garden, 1997; McLeod, 1992). Simultaneously, the relationship between attitude, belief, and behavior varies according to fields such as mathematics and is influenced by other variables (cultural characteristics, etc.) (Bandura, 1997). The reason for students developing positive or negative attitudes towards mathematics may stem from the experiences they have in this subject (Akdemir, 2006). The formation of this situation is influenced not only by teachers but also by the attitudes and thoughts of families (Cain-Caston, 1993). Exposure to the attitudes of parents and teachers towards mathematics during early childhood has an impact on the development of negative attitudes towards mathematics in later years (Gunderson, Ramirez, Levine & Beilock, 2012; Mata, Monteiro & Peixoto, 2012). The influence of parents' and teachers' expectations on children's attitudes towards mathematics and their achievement is significant (Eccles et al., 1990 Jacobs et al., 2005; Jacobs & Eccles 1992; Uchida & Mori, 2018). The expectations of parents and teachers have a significant impact on children's attitudes and success in mathematics (Aiken, 1972; Cain-Caston, 1993; Gunderson, Ramirez, Levine & Beilock, 2012; Mata, Monteiro & Peixoto, 2012; Mohr-Schroeder et al., 2017; Mulhern & Rae, 1998; Papanastasiou, 2000; Ryan & Patrick, 2001; Simmons et al., 2024). The attitudes of teachers towards the subject, their instructional techniques, and the way they organize the content they teach ultimately influence their students' attitudes towards the subject (Fennema et al., 1990; Pajares 1992). According to Piht and Eisenschmidt (2008), in order for students to develop positive attitudes, teachers should implement teaching methods and tasks that actively engage students in the process, embrace differentiated learning, and are structured in connection with everyday life. Creating a dynamic learning environment where students are actively engaged in the instructional process and utilizing various methods and techniques are effective in enhancing students' attitudes (Soric & Palekcic, 2009).

The primary education years have been identified as a crucial period in the process of developing students' attitudes towards mathematics (Eskici & Ilgaz, 2019). The foundation of students' attitudes towards mathematics is laid during the primary school period (Cevahir Batmaz & Toptaş, 2021). The

continuation of students' negative attitudes developed during the primary education levels into higher grades hinders the teaching and learning of mathematics (Cantürk-Günhan, Topuz & Bedir, 2019). Children with negative attitudes in primary school tend to dislike this subject, and this, in turn, affects their academic success in the course (Baltayeva, 2021; Baykul, 2021). It is observed that students' attitudes become more negative as they transition from primary school to middle school (McLeod, 1994). The perceived likelihood of withdrawing from any task perceived as resulting in failure, giving up on mathematics education, and subsequently adopting a widespread negative attitude become prevalent (Chinn, 2012).

According to Cüceloğlu (1991), the long-term nature of attitude implies the prolonged observation of a tendency in an individual. Thus, momentary and temporary inclinations are not considered attitudes. Therefore, the primary school phase is seen as a critical stage when considering students' attitudes. Turkey has a 4+4+4 education system, comprising four years of primary school, four years of middle school, and four years of high school. In Turkey, pre-school education and primary school are structured as fundamental education under the Ministry of National Education (Ministry of Education, 2012). In Turkey, the primary school program aims for students to exhibit a confident approach to mathematics and simultaneously develop positive attitudes towards it (Ministry of Education, 2018). However, in two national exams conducted in Turkey, students scored an average of 4.24 out of 20 questions in the LGS-Turkish Abbreviation (High School Entrance Exam), 6.93 out of 40 questions in the YKS-Turkish Abbreviation (Higher Education Institutions Exam) Basic Competency Test, and 7.24 out of 40 questions in the YKS-Turkish Abbreviation (Higher Education Institutions Exam) Field Competency Test in mathematics (Central Examination for Secondary Education Institutions, 2022; Higher Education Institutions Examination Numerical Data, 2022). According to data from the 2018 Programme for International Student Assessment (PISA), among 79 participants, Turkey is ranked 42nd in mathematics (Emin, 2019). Additionally, Turkey has not achieved an average score above the OECD countries'average in the field of mathematical literacy (OECD, 2020). According to another international assessment tool, TIMSS 2019 (Trends in International Mathematics and Science Study), Turkey has gradually increased its average performance in mathematics over time. However, based on the TIMSS assessments, Turkey has demonstrated performances below or at the scale midpoint (500 points), which is considered a reference point in TIMSS evaluations (TIMSS 2019 Turkey Preliminary Report, 2020). As observed, the below-average results in both national and international exams in Turkey underscore the importance of examining the attitudes of Turkish students. Revealing the affective factors that influence mathematical achievement is of great importance, as it enhances success in mathematics education (Schweinle & Mims, 2009).

In this context, the relevant literature has been reviewed, and numerous studies have investigated the attitudes of primary school students towards mathematics (Akdemir, 2006; Aktan & Budak, 2021; Cvencek, Brečić, Gacesa & Meltzoff, 2021; Çiner & Kılıç, 2022; Ekinci & Bal, 2019; Geesa et al., 2019; Markovits & Forgasz, 2017; Tuncer & Şahinkaya, 2021; Yücel & Koç, 2011; White & McCoy, 2019); meta-analyses (Boz & Büyükalan Filiz, 2020; Cantürk-Günhan, Topuz & Bedir, 2019; Cevahir Batmaz & Toptaş, 2021; Geçici & Bayırlı, 2022; Ma & Kishor, 1997; Tabuk, 2018); and longitudinal (Anttonen, 1969; Beattie, Deichmann & Lewis, 1973; Elmore et al., 1985; Geary et al., 2019; Geary et al., 2023; Kim, 2020, 2021; Metsämuuronen & Tuohilampi, 2014; Sherman, 1982; Ursini & Sa´nchez, 2008) researches have been conducted.

The assumption that there has not been a longitudinal study examining the attitudes of primary school students in Turkey over the years, and as mentioned earlier, the low national and international exam scores of the country, led to the consideration that conducting such research would contribute to the field. Therefore, this research aims to investigate the attitudes of primary school students towards mathematics over a four-year period from the year they start primary school until graduation. The research questions are provided below:

1. How do the attitudes of primary school students towards mathematics vary across classes?
2. How has there been a change over time (grades) in the attitudes of primary school students towards mathematics?

3. How has there been a change over time in the attitudes of primary school students towards mathematics based on 'gender'?
4. Is there a relationship between the changing attitudes towards mathematics of primary school students over time and their achievements?

2. Method

2.1. Model of Research

The research utilized a 'longitudinal method' to collect data from the same sample group at different situations and times (Lynn, 2009). Longitudinal surveys involve scanning procedures that allow data collection on changes in trends within a panel group consisting of the same individuals to measure the tendencies of the same group (Creswell, 2017). The same group of students is examined longitudinally over four years. Starting from the first grade when primary school students begin school, repeated measurements were taken at each grade level to examine the changes in students' attitudes towards mathematics.

2.2. Research Group

The research group consists of students selected from Turkey, Istanbul, using a simple random sampling method. Considering the belief that the diversity among teachers could potentially alter the course of the research, the sample was specifically chosen as a single classroom, and all students in that class were included in the study. The participants in the study consist of 44.4% boys (N:8), and 55.6% girls (N:10) from primary school.

2.3. Data Collection Tools

The data collection tools used in the study include the "Student Information Form" and the "Mathematics Attitude Scale (MAS)".

Student Information Form: This form, developed by the researcher, consists of information related to the students. The questions include 'Gender' and 'Mathematics grade on the year-end report card.' 'Gender' is categorized as "female" and "male." Year-end report card grades are as follows in Turkey:

In the first three grades, exams are not conducted, and grades are given based on teacher evaluations in the three-point system: (1): Needs Improvement (2): Good (3): Very Good

In the fourth grade, which is the final year of primary school in Turkey, exams are conducted for the mathematics course, and students receive grades on a five-point scale (1, 2, 3, 4, 5).

Mathematics Attitude Scale (MAS): To measure students' attitudes towards the mathematics lesson, a scale developed by Aşkar (1986) was used. In Turkey, there are numerous scales related to mathematical attitude. However, Aşkar's scale (1989) is still the most widely used scale despite its age (Tabuk, 2018). Attention has been paid to this in the selection of the scale to be used. The scale consists of 20 items, ten of which (1, 4, 5, 8, 11, 13, 14, 17, 18, 20) are positive, and the remaining ten (2, 3, 6, 7, 9, 10, 12, 15, 16, 19) are negative. Examples of positive and negative items are as follows:

Positive Item 1: "I enjoy mathematics; it is a subject I like."

Positive Item 4: "I enjoy discussing mathematics with my friends."

Negative Item 2: "I feel a great deal of distress when entering the mathematics class."

Negative Item 3: "Life as a student would be more enjoyable without mathematics class."

The feelings, thoughts, and behaviors expressed in the items of the Mathematics Attitude Scale (MAS) were rated based on the impact of these expressions on individuals'attitudes, ranging from "completely appropriate (5)" to "appropriate (4)," "undecided (3)," "inappropriate (2)," and "completely inappropriate (1)." For negative items, the scoring was reversed to calculate the total

score, which represents the student's attitude towards the mathematics lesson. Accordingly, scores range from a minimum of 20 to a maximum of 60 on the scale. The reliability coefficient of the Mathematics Attitude Scale is 0.89, and in this study, the reliability coefficient was found to be 0.81.

2.4. Analysis of Data

The data collection process adhered to ethical principles, and participation was based on voluntarism. SPSS 25.0 was used for the data analysis. Prior to the analyses, normality tests were conducted, and the assumptions were examined. According to the results of the Kolmogorov-Smirnov test (p=.20>.05) and Shapiro-Wilk normality analysis (p=.01<.05), it was determined that the data did not follow a normal distribution. Additionally, skewness and kurtosis values were found to be within the range of -1.5 and +1.5 (Skewness: -.843; Kurtosis: .914), but visual inspection of the histogram graphs revealed non-normality. Following all these examinations, due to the sample size being less than 30 (Tanrıöğen, 2009), non-parametric tests were employed for the analyses. These tests include the Mann Whitney U test, Kruskal Wallis H test, and Spearman Correlation analysis.

3. Findings

The findings of the study are presented in the order of the sub-problems of the study. Accordingly, the findings of the first sub-problem are given in Table 1.

Table 1. *Descriptive Analysis of Changing Attitudes Within Classes Among Primary School Students*

Grade	***N***	***M***	***S.s.***
1st Grade	18	3.29	.70
2nd Grade	18	4.56	.26
3rd Grade	18	3.94	.20
4th Grade	18	3.85	.66
Total	18	3.91	.67

When looking at the changing attitudes of primary school students within classes, it is observed that in the first grade, the attitude is 3.29, in the second grade, it is 4.56, in the third grade, it is 3.94, and in the fourth grade, it is 3.85. Additionally, the average for the group is found to be 3.91 (Table 1). To determine the levels based on the scores obtained from the scales, the scale's range width was calculated using the formula "range width/number of groups to be created" (4/5=0.80) (Tekin, 1993). The arithmetic mean intervals of the scale are determined as follows: 1.00-1.79 'Very Low', 1.80-2.59 'Low', 2.60-3.39 'Moderate', 3.40-4.19 'High', 4.20-5.00 'Very High'. According to this, it can be stated that in the first grade students' math attitudes are at an average level, in the second grade at a 'very high' level, and in the third and fourth grades, as well as overall, at 'high' levels. Additionally, there has been an increase in attitudes only in the second grade, while in the other grades, attitudes have decreased compared to the previous year.

The findings of the second research question are presented in Table 2.

Table 2. *Examination of Students' Mathematics Attitude by Classes*

Grade	**N**	**Mean Rank**	**χ2**	**p**	**Significant Difference Groups**
(1): 1st Grade	18	18.42	35.548	**0.00****	2,3,4>1
(2): 2nd Grade	18	59.39			2>3,4
(3): 3rd Grade	18	34.97			
(4): 4th Grade	18	33.22			

To determine whether there is a difference in the mathematics attitudes of primary school students each year based on their classes, the Kruskal-Wallis H Test was conducted. According to the test,

there is a statistically significant difference in mathematics attitudes across classes (χ^2=35.548, p<.01). Following this procedure, complementary comparison techniques were employed to determine which groups contributed to the identified significant difference after the Kruskal-Wallis H test. Since there was no specific test technique used for this purpose, the Mann-Whitney U test was applied for pairwise comparisons. The analyses revealed that the differences occurred in favor of the second grade when comparing the second grade with the first grade (U=6.500; z=-4.927; p<.01), in favor of the third grade when comparing the third grade with the first grade (U=57.000; z=-3.325; p<.01), and in favor of the fourth grade when comparing the fourth grade with the first grade (U=97.000; z=-2.058; p<.01). Additionally, the differences were in favor of the second grade when comparing the second grade with the third grade (U=10.000; z=-4.817; p<.01), and finally, in favor of the second grade when comparing the second grade with the fourth grade (U=57.500; z=-3.313; p<.01). According to this, primary school students' attitudes towards mathematics were low in the first grade and increased in the subsequent grades, reaching the highest level in the second grade. However, in the third and fourth grades, these attitudes decreased. (Table 2)

The findings of the third research question are presented in Table 3.

Table 3. *The Change of Mathematics Attitude Over Time Based on the 'Gender' Variable*

	Gender	***N***	Mean Rank	***U***	***Z***	***p***
1st Grade	Girl	10	7.80	23.000	-1.513	0.13
	Boy	8	11.63			
2nd Grade	Girl	10	9.85	36.500	-.313	0.75
	Boy	8	9.06			
3rd Grade	Girl	10	8.20	27.000	-1.160	0.24
	Boy	8	11.13			
4th Grade	Girl	10	8.30	28.000	-1.068	0.28
	Boy	8	11.00			

According to the Mann-Whitney U Test conducted to examine the difference in the change of the "Mathematics Attitude Scale" over time based on the gender variable, there is no statistically significant difference in the first grade (U = 23.000, p>.05), second grade (U = 36.500, p>.05), third grade (U = 27.000, p >.05), and fourth grade (U = 28.000, p>.05) (Table 3). However, when evaluated in terms of scores, it can be observed that only in the second grade, girls have a more positive attitude than boys, while in all other grades, boys have a more positive attitude than girls.

The findings of the fourth research question are presented in Table 4.

Table 4. *The relationship between students' mathematics grades and math attitudes*

MAS	***N***	***r***	***p***
1st Grade	18	.723	.00**
2nd Grade	18	.321	.19
3rd Grade	18	.160	.52
4th Grade	18	.692	.00**

According to the Spearman Correlation Analysis conducted to examine the relationship between the Mathematics Attitude Scale and students' end-of-year mathematics grades, a moderately positive relationship was found in the first grade (r=.723, p<.01), and a moderately positive relationship was also observed in the fourth grade (r=.692, p<.01). Thus, there is a positive correlation between achievement and mathematics attitude. However, in the second grade (r=.321, p>.05) and third grade (r=.160, p>.05), no significant relationship was identified (Table 4).

4. Discussion, Conclusion and Recommendations

The first result of this research, which examines primary school students' attitudes towards mathematics over a four-year period, from the start of primary school to graduation and transition to middle school, indicates that student' math attitudes are at an 'average' level in the first grade, at a 'very high' level in the second grade, and at 'high' levels in the third and fourth grades, and 'high' level overall.

Another noteworthy result from examining attitudes towards mathematics at each grade level over the four-year period is that there is an increase only in the second grade, while in the other grades, attitudes have decreased compared to the previous year. In a study conducted by Çiner and Kılıç (2022) examining the mathematics achievements and attitudes of fourth-grade primary school students, it was observed that students have above-average attitudes.

When examining how students' attitudes toward mathematics change in relation to their respective grades, it was found that in comparison to the first grade, second-grade students had a more positive attitude, third-grade students had a more positive attitude compared to the first grade, and fourth-grade students had a more positive attitude compared to the first grade. Additionally, second-grade students had more positive attitudes compared to third-grade students, and finally, second-grade students had more positive attitudes compared to fourth-grade students. Thus, the attitudes of primary school students towards mathematics were lowest in first grade, increased in subsequent grades, with the most significant increase occurring in second grade. However, these attitudes gradually decreased in each subsequent grade, reaching their lowest point in the fourth grade. According to Hannula (2002), students' math (?) attitudes decrease from primary to secondary education. Norman (1977) also found, in his research, a decrease in attitudes towards mathematics as grade level ~~increased~~ specifically for 2^{nd}, 6^{th}, 8^{th}, 9^{th}, and 10^{th} grade students. Ursini and Sa´nchez (2008) monitored 430 students using technology and 109 students not using technology for mathematics in Mexico, for three years. Over this period, no observed increase in attitudes and confidence was noted. In a longitudinal study such as this one in which Geary et al (2019) followed students for two years, it has been determined that the mathematics attitudes of students in the seventh grade are lower than those in the sixth grade. Geary et al (2023), in their longitudinal studies tracking students from the seventh to the ninth grade, similarly found that as mathematics achievement increased across grades, attitudes became less positive. Metsämuuronen and Tuohilampi (2014) followed students in Finland from the beginning of school (age 7) until the end of compulsory education (age 16) and observed a similar decline in mathematics attitudes over the years, consistent with the results of this research. In the study conducted by Şimşek, Şahinkaya, and Aytekin (2017) with a total of 437 students selected from the 4^{th} and 7^{th} grades, it was also observed that positive attitudes towards mathematics decreased as the grade level increased. In many studies, as the grade level increases, mathematics attitudes tend to decrease (Cantürk-Günhan, Topuz & Bedir, 2019; Eskici & Ilgaz, 2019; Kocakaya et al., 2018). There are various factors contributing to the decrease in positive attitudes towards mathematics as children progress through grades. Although the inherent difficulty of mathematics increases with each grade level, schools and teachers also play a crucial role in shaping these attitudes, whether positively or negatively (Aiken & Dreger, 1961; Aiken, 1972; Gunderson, Ramirez, Levine & Beilock, 2012; Boz & Büyükalan Filiz, 2020; Mulhern & Rae, 1998). The positive contribution of teachers using methods that allow students to enjoy mathematics (Van De Walle, Karp & Bay-Williams, 2016), as well as their attitudes towards mathematics, has a significant impact on students' attitudes towards mathematics (Aiken, 1970; Gresham, 2007). The influence of peers also has a positive effect on enjoying mathematics. In classes where the focus is on enjoyment, it has been observed that students encourage each other to appreciate the subject. However, if most students do not value mathematics, this situation can negatively affect the overall attitude of the entire class (Kiwanuka et al., 2017). A positive attitude towards mathematics also means that students with higher levels of "valuing mathematics," "enjoyment," and "confidence" will likely be more willing to engage in mathematics study and demonstrate perseverance when faced with challenges, which could lead to greater success in mathematics (Cho & Hwang, 2019; Guo et al., 2015). In the formation of this situation, the attitudes and thoughts of not only teachers but also families play a significant role (Cain-Caston, 1993). Elmore et al. (1985) tracked changes in the mathematics attitudes of eighth and twelfth-grade students over a four-year period based on parental mathematics attitudes and career interests. They found a relationship between parents' mathematics attitudes and their children's mathematics attitudes. Many studies have shown positive relationships

between parents' and students' attitudes toward mathematics (Gunderson, Ramirez, Levine & Beilock, 2012; Mata, Monteiro & Peixoto, 2012; Mohr-Schroeder et al., 2017).

When primary school students' scores were examined by their gender from the year, they started school to the year they graduated from primary school, no statistically significant difference was observed. Like the study conducted by Herbert and Stipek (2005), this longitudinal study indicated that gender is not a significant factor in students' mathematics achievements. Lawsha and Hussain (2011) conducted a study examining the attitudes toward mathematics among students in a secondary school in the Maldives. Like the results of this research, they did not find a significant difference in mathematics attitudes based on gender. Despite the absence of a statistically significant difference in this study, when looking at the scores, it can be observed that in each class level, girls had more positive attitudes than boys only in the second grade, while in all other grades boys had more positive attitudes than girls. Middleton (1999) suggests that low self-confidence in mathematics among girls may negatively impact their attitudes. In a longitudinal study conducted by Beattie, Deichmann & Lewis (1973) with 120 fourth-grade students, tracking their mathematics achievement and attitudes over three years, they found that the correlation value for gender and attitudes toward mathematics increased each year for boys, while for girls the value decreased each year, approaching zero. In another longitudinal study, Ursini and Sánchez (2008) conducted research in Mexico, following 430 students who used technology for mathematics and 109 students who did not over three years. They observed differences in attitudes in favor of male students over the three years. Another longitudinal study by Geary et al (2019) tracked students over two years, assessing mathematics anxiety and attitudes based on gender differences. The study found that girls with low mathematics achievement were at a higher risk of developing mathematics anxiety and weak attitudes toward mathematics compared to boys with low achievement. In the longitudinal study conducted by Geary et al (2023), it was observed that males had stronger spatial abilities, more positive attitudes toward mathematics, and less anxiety compared to females. However, there was no gender difference in mathematics achievement. The finding that females tend to have more negative mathematical attitudes (Gunderson, Ramirez, Levine & Beilock, 2012), and this tends to increase with age, is a topic that needs attention, as it may limit girls' participation in mathematics and their learning capacities (Hyde et al., 1990). There is existing literature indicating that gender does not make a difference in mathematics attitudes (Aktan & Budak, 2021; Pierce, Stacey & Barkatsas, 2007; Yücel & Koç, 2011).

The study examined whether there is a relationship between students' changing attitudes toward mathematics by grades and their mathematics grades at the end of the year. The result of the research indicates a positively moderate significant relationship in the first grade and a positively moderate significant relationship in the fourth grade. Therefore, at these grade levels, there is a positive correlation between academic achievement and mathematics attitude. In other words, students who perform well in mathematics also tend to have a positive attitude towards the subject. However, in the second and third grades, there appears to be no correlation between attitude towards mathematics and academic success in the subject. A longitudinal study conducted by Anttonen (1969) over a span of six years, from the end of primary school to the end of high school, revealed a significant positive correlation between attitude scores in mathematics at the primary school level and those at the high school level among 607 students. Another investigation, examining changes in attitudes towards mathematics over a three-year period in relation to factors such as mathematics achievement, gender, reading proficiency, and IQ among 120 fourth-grade students, found no significant alterations in mathematics attitudes as classes progressed. Across all three years, a positive correlation was consistently observed between mathematics achievement and attitudes towards mathematics (Beattie, Deichmann & Lewis, 1973). Kim (2020) conducted a study in Seoul, tracking changes in achievement and attitudes towards mathematics over the years among second-grade middle school and second-grade high school students. The findings revealed that students with high academic achievement in mathematics tended to have a higher positive attitude towards the subject in their respective math classes. According to research examining the results of the Trends in International Mathematics and Science Study (TIMSS) in various countries and focusing on the relationship between mathematics attitudes and achievements, Saatçioğlu's (2023) study on TIMSS 2019 data for 8th grade students in Turkey indicates that students who exhibit a positive attitude towards mathematics have higher mathematics achievements compared to those with a negative attitude towards the subject. Berger et

al. (2020), in another study examining the TIMSS 2015 data for 8th grade students in Austria, found a relationship between mathematics attitudes and achievement. Similarly, Hwang and Son (2021), based on the TIMSS 2019 data for Singapore, categorized students' attitudes towards mathematics into four profiles: very negative (5.44%), negative (41.38%), neutral (38.77%), and positive (14.41%). Their research revealed a positive relationship between students' attitudes towards mathematics and their mathematics achievement. Geesa et al. (2019) conducted a study using the TIMSS 2015 data, examining the mathematics attitudes of fourth-grade students in South Korea, Turkey, and the United States, and found that mathematics attitudes significantly influenced the mathematics achievements of these students. The study identified a positive association between attitude and achievement. Additionally, it concluded that Turkish students had higher mathematics attitudes compared to students in South Korea and the United States, but their mathematics achievement scores were lower. Ma and Kishor's (1997) meta-analysis revealed a statistically significant but low correlation between attitude towards mathematics and mathematics achievement across 113 studies. In a meta-analysis study examining 19 articles and theses conducted in Turkey between 2003-2017, it was found that attitudes towards mathematics had a moderately positive impact on mathematics achievement (Cantürk-Günhan, Topuz & Bedir, 2019). Lijie, Zongzhao, and Ying (2020) explored the impact of students' mathematics attitudes on academic achievement and noted a positive and direct effect of students' mathematics attitudes on their mathematics academic performance. Numerous studies have consistently found that students' attitudes towards mathematics significantly predict their mathematics achievement (Choi & Chang, 2011; Çiner & Kılıç, 2022; Moenikia & Zahed-Babelan, 2010; Rabab'h & Veloo, 2014).

In this research, which tracked the changes in the mathematics attitudes of primary school students in Turkey over a four-year period, it was found that students had a 'medium' level of mathematics attitude in the first grade, a 'very high' level in the second grade, and a 'high' level in the third and fourth grades and overall. As they moved from a lower class to a higher one, students' attitudes towards mathematics decrased. Although there was a trend in favor of males in terms of scores over the years, this difference was not statistically significant. A significant relationship between mathematics attitude and mathematics grades was found in the first and fourth grades. In other words, students who had a positive attitude towards mathematics in these grade levels also had higher mathematics grades. Students' bias towards mathematical activities leads to a negative attitude towards mathematics. In this context, especially during the primary school period, teachers have significant roles in fostering a positive attitude towards mathematics among students. Using different materials, methods, and techniques in mathematics lessons, preparing personalized activities, and making students more active in class, especially by highlighting the practical value of mathematics in everyday life, can positively contribute to students' attitudes towards mathematics. Parents and the environment can also play a role by introducing children to mathematics in daily life, making them aware of its importance, encouraging them to use it in real-life situations, and helping them understand how essential basic mathematical skills are in life skills.

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