



AN INVESTIGATION INTO THE RELATIONSHIPS BETWEEN 8TH-GRADE STUDENTS' MATHEMATICS SELF-EFFICACY PERCEPTIONS AND THEIR MOTIVATION AND ANXIETY LEVELSⁱ

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Abstract:

This study seeks to examine the relationships between 8th-grade students' mathematics self-efficacy perceptions and their motivation and anxiety levels. The correlational survey model was used in the study. The population of the study consists of 9811 8th-grade students studying at 64 public schools in Batman province in the 2020-2021 academic year. The sample consists of 550 students from 10 secondary schools selected via the random method among 9811 students. Personal Information Form, Mathematics Self-Efficacy Scale, Motivation Scale for Mathematics Lessons, and Mathematics Anxiety Scale were used as data collection tools. Independent samples t-test, one-way analysis of variance (ANOVA), and Pearson product-moment correlation analysis were used to analyze the data. The relationship between mathematics self-efficacy perception, mathematics lesson motivation, and mathematics anxiety was calculated by path analysis. As a result, a positive and moderately significant relationship was found between students' mathematics self-efficacy perceptions and their motivation for mathematics lessons while a negative and moderately significant relationship was found between mathematics self-efficacy perceptions and mathematics anxiety. It was also determined that there was a negative and moderately significant relationship between students' motivation for mathematics lessons and their mathematics anxiety. The Path analysis revealed that as 8th-grade students' mathematics self-efficacy perceptions increase, their motivation for mathematics lessons increases, and their mathematics anxiety levels decrease.

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1. Introduction

Mathematics has an important role in life as a field drawn upon in all their activities to unearth talents and guide individuals as well as to bring in a systematic and logical thinking habit (Bulut, 1988). Mathematics is of great importance in every aspect of students' education and career choices. For this reason, mathematics lessons are key to students' current education as well as a good education and career choice in the future (Şentürk, 2010). Accordingly, mathematics is a subject taught from the very beginning of education and training and is generally known to be tough and fearful and causes high levels of anxiety (Eldemir, 2006). Such negative emotions, thoughts, attitudes, and behaviors stem from preconceptions and negative emotions, thoughts, and attitudes towards mathematics, rather than mathematics mathematics being a complex, abstract, and difficult subject (Taşdemir, 2009). Thus, pedagogues believe that students should learn mathematics with love and desire, emphasizing that individuals should feel self-confident and competent in mathematics (İpek, 2019).

It is a narrow point of view to believe that students only need to have good field knowledge to be successful in mathematics, which is a crucial field in education (İpek, 2019). It is significant to reveal the affective factors that have an impact on mathematics success and the relationships between these factors, as they are directly associated with enhancing success in mathematics teaching (İpek, 2019). PISA research, which is an international practice in the relevant field, is aimed at revealing students' knowledge and skills and collecting data about students' motivations, self-opinions, and psychological characteristics related to their learning (MEB, 2020). According to the PISA 2015 national report published by the Ministry of National Education, Turkey ranks 50th among 72 countries with 420 points (MEB, 2020). This indicates that mathematics achievement in Turkey is low and requires some notions to improve in mathematics (İpek, 2019). A great number of affective factors are known to be influential in students' mathematics achievement. Some of these factors are listed as perceived mathematics self-efficacy, motivation towards mathematics lessons, and mathematics anxiety (Ayan, 2014). This study, designed to reveal the relationships between 8th-grade students' mathematics self-efficacy perceptions as well as their motivation and anxiety levels for mathematics lessons, seeks to take into consideration these factors believed to affect success in mathematics lessons and the relationships between these factors.

The idea that students only need to have good field knowledge in order to be successful in mathematics, which has an important place in the education process, stems from a narrow perspective (İpek, 2019). It is important to reveal the affective factors that affect mathematics success and the relationships between these factors, as they are directly related to increasing success in mathematics teaching (İpek, 2019). PISA research, which is an international practice among the studies carried out in this field, aims to

reveal students' knowledge and skills and collect data about students' motivations, opinions about themselves, and psychological characteristics related to their learning processes (MEB, 2020). According to the PISA 2015 national report published by the Ministry of National Education, Turkey ranks 50th among 72 countries with 420 points (MEB, 2020). According to this result, it is seen that the mathematics achievement of students in our country is low and it is thought that there are situations that need to be improved in mathematics education (İpek, 2019). It is known that many affective factors are effective in students' success in mathematics lessons. Some of these factors are mathematics self-efficacy perception, motivation for the mathematics lesson, and mathematics anxiety (Ayan, 2014). In this study, which examined the relationships between 8th-grade students' mathematics self-efficacy perceptions and their motivation and anxiety levels for mathematics lessons, these factors affecting success in mathematics lessons and the relationships between these factors were examined.

According to Bandura (1997), perceived self-efficacy affects individuals' learning, efforts, activity choices, and success. While individuals choose activities that they believe will be successful, they avoid activities that they believe will be unsuccessful. Moreover, individuals with a high sense of self-efficacy are expected to try harder and be more patient and resistant to challenges (Bandura, 1997). Individuals with a high sense of self-efficacy make the most appropriate choice in different situations while also being persistent and resistant to potential obstacles, and exhibit productive behaviors instead of emotional reactions (İnandı *et al.*, 2013). Self-efficacy in mathematics is one's belief in one's ability to accomplish mathematics-related tasks (Güneş *et al.*, 2015). According to Margolis and McCabe (2006), a low sense of self-efficacy hinders course success and impairs the psychological state in the long term, creating a perception of failure. Self-efficacy forms the basis for motivation and success (Pajares, 2002).

It is suggested that motivation is among the crucial factors for success in mathematics teaching (Açıkgöz, 2003; Yavuzer, 1997). Altun (2009) investigated the reasons for the failure of students in primary schools, concluding that students' lack of interest in and motivation towards the lesson were among the sources of failure in mathematics lessons. Since students find mathematics as tough and dull, they tend to develop a negative attitude towards it, even before they are taught (Tahiroğlu and Çakır, 2014). A student biased against mathematics naturally loses self-motivation and therefore, s/he will probably perceive mathematics as a difficult subject and fail to put an effort to be successful in mathematics. Therefore, mathematics lesson motivation affects the student's mathematics success (Üzel *et al.*, 2018). Goldin *et al.* (2016) report that the root of the problem lies not in mathematics content per se and that they do not regard mathematics as more difficult, more complex, or more boring in and of itself than other academic content but rather, the norms, beliefs, and practices that have arisen over the past century and a half related to mathematics teaching, learning, and assessment, have ignored or poorly articulated the role of motivational processes in mathematics learning. Anxiety about the lesson is yet another factor that affects learning. Büyüköztürk (1997) defines anxiety as the state of fear and tension felt under threat, adding that anxiety is a

longer-lasting but less severe emotion than fear. Bekdemir (2009), on the other hand, argues that mathematics anxiety is among the important factors that prevent learning and cause failure. As reported by Tobias (1993), mathematics anxiety manifests itself as a student's feeling of tension, stress, and anxiety when solving mathematical problems and performing calculations with numbers in school and daily life, and mathematics anxiety can cause forgetfulness and loss of self-confidence in the student (Cited in Rossnan, 2006). Hembree (1990) reports that mathematics anxiety causes a decrease in mathematics achievement. Mathematics anxiety encompasses fear and hesitation, and in the case of progress in anxiety, one may feel that s/he will fail (Yenilmez and Özbey, 2006).

The literature review reveals that some studies demonstrate that a high level of mathematics anxiety causes a decrease in success (Ashcraft, 2002; Dursun and Bindak, 2011; Pekdemir *et al.*, 2018; Sarı and Ekici, 2018; Yenilmez and Özabacı, 2003) while some other studies have found that students' motivation for mathematics lessons affects their success in mathematics lessons, concluding that the mathematics success of students with high motivation for mathematics lessons increases (Kılıç, 2011; Uluçay and Güven, 2017). As regards the relationships between students' mathematics motivation and mathematics anxiety, some previous studies found a negative significant relationship between students' motivation for mathematics lessons and their mathematics anxiety (Akyurt, 2019; Kılıç, 2011; Zakaria and Nordin, 2008) while some others found that as the sense of self-efficacy increases, mathematics anxiety decreases (Adal, 2017; Doruk *et al.*, 2016; İpek, 2019; Kurbanoglu and Takunyacı, 2012).

This study has been designed to shed light on the relationships between 8th-grade students' mathematics self-efficacy perceptions, motivation for mathematics lessons, and mathematics anxiety. The present study presupposes that as 8th-grade students' mathematics self-efficacy perceptions become positive in mathematics course success, students' motivation for mathematics lessons could increase while their mathematics anxiety levels could decrease. One of the goals of the present study is to verify the relevant issue and contribute to the relevant literature.

1.1 Objective of the Research

The objective of this research is to examine the relationships between 8th-grade secondary school students' mathematics self-efficacy perceptions and their motivation and anxiety levels for mathematics lessons. For this purpose, the following research questions were addressed.

- 1) What is the level of mathematics self-efficacy perception of 8th-grade students?
- 2) What is the level of motivation of 8th-grade students for the mathematics lesson?
- 3) What is the level of mathematics anxiety of 8th-grade students?
- 4) Is there a significant relationship between 8th-grade students' mathematics self-efficacy perceptions and their motivation and anxiety levels for the mathematics lesson?
- 5) In what direction and level do 8th-grade students' mathematics self-efficacy perceptions affect their motivation and anxiety levels for the mathematics lesson?

2. Literature Review

2.1 The Relationship Between Students' Perceived Mathematics Self-Efficacy and Their Motivation and Anxiety Levels for Mathematics Lessons

Self-efficacy in mathematics is one's self-belief to complete mathematics-related tasks (Ural *et al.*, 2008). Hackett and Betz (1989) defined perceived mathematics self-efficacy as "one's situational or problem-based evaluation of his/her self-confidence in successfully performing a mathematics-related task or problem" (cited in Işıksal and Aşkar, 2003). An individual's mathematics self-efficacy perception affects overall mathematics performance and expectations towards mathematics (Yurt, 2015). It is likely that the mathematics performance of students with a high level of belief in mathematics achievement will increase (Şengül and Gülbağcı, 2013). Students with a high sense of self-efficacy in mathematics are expected to have high self-confidence in mathematics, remain calm and produce logical solutions when faced with complex mathematical problems, feel courageous, and believe that they will be successful in mathematics. On the other hand, students with a low sense of self-efficacy in mathematics are expected to have a shy and timid attitude towards mathematics subjects, feel inadequate in solving problems, and have low self-confidence (Gündoğdu and Kurtuluş, 2016).

It is claimed that individuals with a high sense of mathematics self-efficacy spend more time on mathematical problems, try harder to solve them, and show more patience. Individuals with a low sense of self-efficacy in mathematics have the idea that no matter how hard they study, they will not succeed in mathematics and are likely to receive low grades (İpek, 2019). Since mathematics is an abstract subject, students often have a fear of failing in mathematics. Students have low self-belief in mathematics achievement. To enhance perceived mathematics self-efficacy, activities in which students could feel successful are to be organized along with opportunities. Once mathematics is concretized with an appropriate environment for learning mathematics by doing and experiencing, students' mathematical self-efficacy is likely to enhance (Öztürk and Şahin, 2015).

Mathematics is perceived in schools and society as a difficult and abstract lesson containing unrelated formulas and operations (European Commission, 2011). Individuals' negative attitudes towards mathematics can affect success and determine whether they choose mathematics in their lives outside of compulsory education. Therefore, schools and teachers could play a crucial role in increasing students' interest in mathematics and making teaching mathematics more meaningful (European Commission, 2011). Motivation is of great importance in mathematics teaching because mathematics consists of abstract concepts and is perceived as tough (Kesici, 2018). Mathematics motivation can be defined as students' willingness to learn mathematics and active participation in mathematics activities (İspir *et al.*, 2011).

It is argued that students learn more effectively if what they learn is in their fields of interest. Indeed, students tend to become more successful if they enjoy what they learn (European Commission, 2011). It is reported that the intrinsic motivation of students enjoying the subject in mathematics class increases in learning mathematics (Nicolaidou

and Philippou, 2003). Lepper and Henderlong (2000) suggest that when students are motivated to learn mathematics, they tend to spend more time on mathematical operations and be more persistent in solving problems. On the other hand, Kesici (2018) reports that low levels of mathematics motivation cause students' lack of interest and low participation in actions aimed at learning mathematics. Therefore, this reality causes students to develop negative attitudes towards mathematics lessons.

Students' success in mathematics is associated with their mathematics motivation. Students with high mathematics motivation are likely to be more open to learning mathematics (Bozkurt and Bircan, 2015). Therefore, the Ministry of National Education (MEB, 2009) emphasized the importance of developing students' mathematics motivation by taking into account their differences. However, motivation to achieve mathematics is not a fixed student characteristic, which means that students' mathematics motivation may change. This indicates the importance of the teacher's role in student motivation and a teaching process that supports student motivation, using different teaching strategies (European Commission, 2011).

Mathematics anxiety is a multifaceted anxiety that is intertwined with the concepts of fear, tension, rush, and uneasiness (Baloğlu, 2001; Şahin, 2004). Mathematics anxiety, which affects students' education and thus prevents learning, can be defined as reluctance to deal with numbers, inability to create equations and produce solutions in mathematical operations, or fear of simple four-operation problems used in daily life (Alkan, 2011). Mathematics anxiety is a source of hating mathematics for students since it causes students to be afraid of mathematics, and experience feelings of panic and anxiety, thus causing the learning rate to decrease and constant failure (Alkan, 2010). Mathematics anxiety prevents students from learning mathematics, having positive thoughts about mathematics, feeling comfortable in mathematics lessons, and being comfortable while dealing with mathematical operations (Kurbanoglu and Takunyacı, 2012). Mathematics anxiety is a feeling commonly experienced by all age groups, from primary school students to university students (Peker and Şentürk, 2012). Richardson and Suinn (1972) reported that mathematics anxiety not only hinders students' success in mathematics but also causes non-students to have problems in daily tasks such as counting money and checking the bank account (cited in Peker and Şentürk, 2012).

Although the answer to the question "Does mathematics anxiety result from failure in math class, or is failure in math class the result of mathematics anxiety?" is not clear, mathematics anxiety is not the only reason for failure in mathematics class, and failure in mathematics class is not the only reason for mathematics anxiety. However, it is known that both conditions affect each other (Peker and Şentürk, 2012). Curtin (1999) points out that among the reasons for anxiety at school are teacher authority, time limitation, and the pressure created by expectations on students. In this case, students are likely to feel threatened and develop negative attitudes towards various courses. Repetition and increase of negative attitudes also cause anxiety. Teaching methods can be reviewed to reduce the anxiety experienced by students. For example, students would possibly exhibit favorable attitudes towards mathematics if a student-centered approach

is embraced in mathematics lessons along with more tolerance in the face of failures and appreciation for even small successes. Therefore, students are likely to have more self-confidence and less mathematics anxiety (cited in Adal and Yavuz, 2017). The present study primarily focuses on revealing the relationships between 8th-grade students' mathematics self-efficacy perceptions, motivation for mathematics lessons, and mathematics anxiety. In addition, it seeks to unearth what direction and level the mathematics self-efficacy perceptions of 8th-grade students affect their motivation and anxiety levels towards the mathematics lesson.

3. Material and Method

3.1 Research Model

This study is based on the correlational survey model, one of the general survey models. Survey models refer to approaches aimed at describing a past or present situation as it exists. The research model aimed at determining the existence or degree of change between two or more variables is called the correlational survey model (Karasar, 2009). For this reason, it was deemed appropriate to use a correlational survey model to examine the relationships between 8th-grade students' mathematics self-efficacy perceptions, motivation for mathematics lessons, and mathematics anxiety levels.

As part of the research model, students' perceived mathematics self-efficacy is considered as an independent variable while motivation for the mathematics lesson and mathematics anxiety variables were considered as dependent variables. However, as part of the novel model, motivation for the mathematics lesson is considered both a dependent and independent variable as it has a direct and indirect effect on mathematics anxiety.

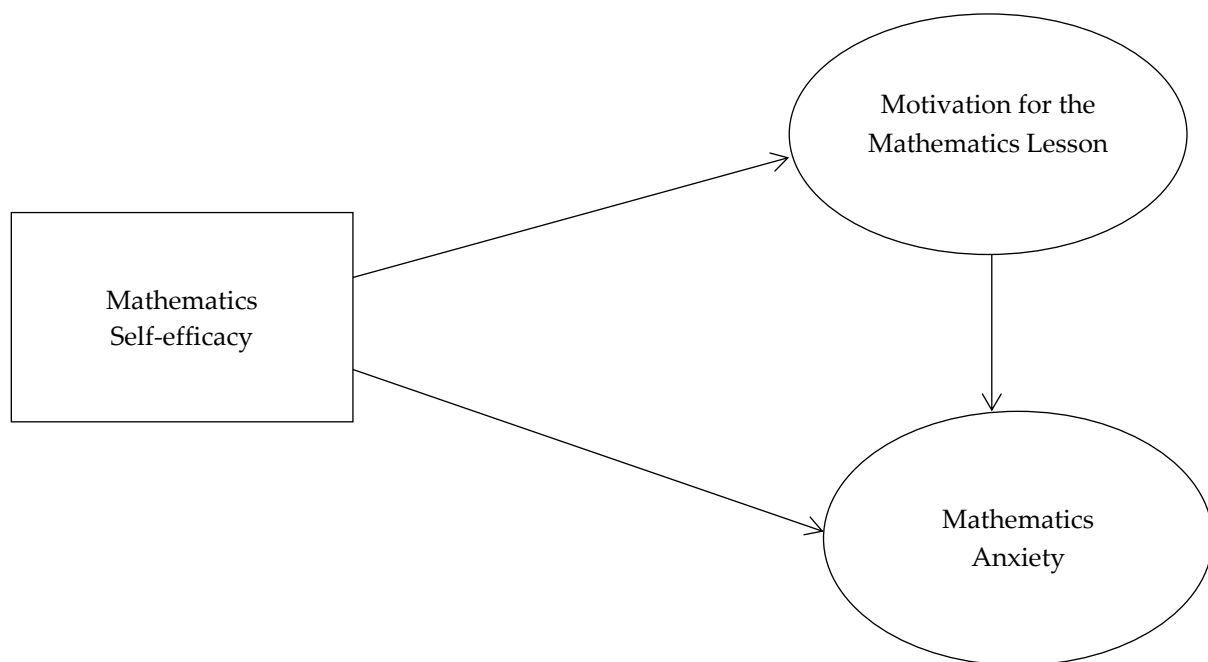


Figure 3.1: Research Model

3.2 Population and Sampling

The population of the present study consists of 9811 8th-grade students studying at 64 public schools in Batman province in the 2020-2021 academic year (Batman Provincial Directorate of National Education, 2021), (see Appendix 1).

The sample consists of 550 8th-grade students studying at 10 secondary schools selected via the simple random method among 64 public schools in Batman province. During the data collection process, the scales were distributed to 600 students, considering situations such as incomplete or incorrect filling of the scales, and as a result of the examinations, the data of 550 students were taken into consideration for analysis. The data belonging to 50 students who failed to meet the analysis criteria were not evaluated. Some of the scales were excluded from the evaluation as they included missing or incorrect coding.

3.2.1 Findings Regarding Demographic Variables of the Sample Group

Table 3.1 below shows the findings regarding the demographic variables of the 8th-grade students participating in the research.

Table 3.1: Findings regarding demographic variables of the sample group

Variable	Category	f	%
Gender	Female	309	56.2
	Male	241	43.8
Mother's educational status	Illiterate	205	37.3
	Elementary School	195	35.5
	Secondary School	96	17.5
	High School	54	9.8
	Undergraduate	-	-
Father's educational status	Illiterate	50	9.1
	Elementary School	169	30.7
	Secondary School	171	31.1
	High School	121	22.0
	Undergraduate	39	7.1
Family income level	Low	176	32.0
	Middle	314	57.1
	High	60	10.9
Participation in mathematics lessons	Yes	262	47.6
	No	288	52.4
Previous semester mathematics report card grade	0-44	15	2.7
	45-54	63	11.5
	55-69	131	23.8
	70-84	143	26.0
	85-100	198	36.0

Table 3.1 shows that 309 (56.2%) of the 8th-grade students participating in the research are female and 241 (43.8%) are male. According to the mother's educational status variable, 205 (37.3%) of the students' mothers are illiterate, 195 (35.5%) are elementary

school graduates, 96 (17.5%) are secondary school graduates, and 54 (9.8%) are high school graduates. According to the father's educational status variable, 50 (9.1%) of the students' fathers are illiterate, 169 (30.7%) are primary school graduates, 171 (31.1%) are secondary school graduates, and 121 (22.0%) are high school graduates. and 39 (7.1%) hold a bachelor's degree. According to the family income level of the students, 176 (32.0%) have a low-income level, 314 (57.1%) have a middle-income level, and 60 (10.9%) have a high-income level. According to the variable of participation in the mathematics lesson at school, 262 (47.6%) students attend the lesson while 288 (52.4%) students fail to attend the lesson. According to the previous semester's mathematics report card grade variable, the mathematics grade of 15 (2.7%) students is in the range of 0-44, the mathematics grade of 63 (11.5%) students is in the range of 45-54, the mathematics grade of 131 (23.8%) students in the range of 55-69, the mathematics grade of 143 (26.0%) students in the range of 70-84, and the mathematics grade of 198 (36.0%) students in the range of 85-100. In other words, the majority of the 8th-grade students participating in the research are female students. The mothers of the majority of the participants are illiterate or elementary school graduates while their fathers are elementary or secondary school graduates. It can be suggested that the family income level of the majority of the 8th-grade students is at a middle level, their participation in the mathematics lesson at school is low, and their mathematics report card grades in the previous semester are high.

3.3 Data Collection Tools

The data collection tool used as part of the study is the "Personal Information Form" prepared by the researcher to determine the demographic characteristics of the students, the "Mathematics Self-Efficacy Scale" developed by Umay (2001) to measure students' perceived mathematics self-efficacy, and the "Mathematics Motivation Scale" developed by Üzel *et al.* (2018) to measure students' motivation levels for the mathematics lesson (2018), and the "Mathematics Anxiety Scale" developed by Erol (1989) to measure students' mathematics anxiety levels.

3.3.1 Personal Information Form

The personal information form (Appendix 2) includes questions about gender, mother, and father education level, family income level, attendance in mathematics lessons, and previous semester mathematics report card grade. While preparing the personal information form, studies in the literature were reviewed and questions expected to contribute to the research were prepared after expert opinions were obtained.

3.3.2 Mathematics Self-Efficacy Scale

The "Mathematics Self-Efficacy Scale" (Appendix 3) developed by Umay (2001) was used to measure the mathematics self-efficacy perceptions of 8th-grade secondary school students. Mathematics Self-Efficacy Scale was drawn upon in many studies (Adal, 2017; Ayan, 2014; Delioğlu, 2017; Karaşan, 2019; Tüzün, 2019). Since it is viewed as a reliable scale, it is preferred in the present study based on expert opinion. Umay reports that the

scale consisting of 14 items as well as 8 positive and 6 negative statements has 3 dimensions. The first dimension is defined as the sense of self in mathematics, the second dimension is awareness of behavior in mathematics subjects, and the third dimension is defined as the transformation of mathematics into life skills. Items 3, 10, 11, 12, and 13 of the scale belong to the first dimension, items 4, 5, 6, 7, 8, and 9 belong to the second dimension, and items 1, 2, and 14 belong to the third dimension. The scale is a 5-point Likert type scale and rated as "Strongly Disagree-1", "Disagree-2", "Undecided-3", "Agree-4", and "Strongly Agree-5" (Reverse scoring was performed for the negative items in the scale). While the Cronbach Alpha reliability coefficient of the scale was found to be 0.88, it was calculated as 0.80 in this study.

3.3.3 Mathematics Motivation Scale

The "Mathematics Motivation Scale" (Appendix 4) prepared by Üzel *et al.* (2018) was used to measure the motivation of 8th-grade secondary school students towards mathematics lessons. The scale, which consists of 26 items and includes 18 positive and 8 negative statements, has three sub-dimensions. The first dimension is defined as motivation for performance, the second dimension is mathematical satisfaction, and the third dimension is amotivation. Items 7, 8, 9, 10, 11, 13, 15, 24, and 26 of the scale belong to the dimension of motivation for performance, items 1, 2, 3, 4, 5, 6, 19, 21, 22, and 25 belong to the dimension of mathematical satisfaction, and items 12, 14, 16, 17, 18, 20, and 23 measure the dimension of amotivation. While the Cronbach Alpha reliability coefficient was found to be 0.88 during the development stage of the scale, it was calculated as 0.91 in this study.

3.3.4 Mathematics Anxiety Scale

The "Mathematics Anxiety Scale" (Appendix 5) developed by Erol (1989) was used to measure the anxiety levels of 8th-grade secondary school students. While developing the relevant scale, the Cronbach Alpha reliability coefficient was found to be 0.91. Erkin *et al.* (2006) conducted a study to test the psychometric properties of the mathematics anxiety scale and to determine its subdimensions. As a result of the factor analysis conducted to determine the sub-dimensions of the scale, the mathematics anxiety scale was found to have four sub-dimensions. The first dimension is defined as mathematics exam and evaluation anxiety, the second dimension is mathematics lesson anxiety, the third dimension is mathematics anxiety in daily life, and the fourth dimension is self-confidence in mathematics. In this study, Cronbach's Alpha was calculated as 0.92. As the Mathematics Anxiety Scale was used in many studies (Akgül, 2008; Ayan, 2014; Aydın *et al.*, 2009; Durmaz, 2012; Yenihayat, 2007) due to its reliability, it was preferred. In this study, the reliability coefficient of the scale was calculated as 0.94.

While the original version of the mathematics anxiety scale, which consists of 45 items, was a four-point Likert type, it was used as a five-point scale to ensure integrity with the other scales used in this study. It was rated as "Strongly Disagree-1", "Disagree-2", "Undecided-3", "Agree-4" and "Strongly Agree-5" (Reverse scoring was performed for the negative items in the scale). 9 of the 45 items (4, 10, 13, 20, 27, 32, 35, 40, and 43) are

reverse items. Items 2, 3, 8, 11, 14, 18, 19, 21, 22, 24, 25, 28, 30, 33, 41, 42, and 44 of the scale indicate the mathematics exam and evaluation anxiety dimension, items 1, 4, 5, 6, 7, 10, 13, 16, 20, 31, 32, 34, 35, 36, 37, 39, and 40 describe the dimension of mathematics lesson anxiety, items 9, 15, 17, 26, 29, 38, and 45 measure the dimension of mathematics anxiety in daily life, and items 12, 23, 27, and 43 measure the dimension of self-confidence in mathematics.

3.4 Data Analysis

AMOS 22 and SPSS 21 statistical packages were used to analyze the data. To test the suitability of the research data for normal distribution, descriptive statistics such as arithmetic mean, mode, median, skewness, and kurtosis values were taken into consideration. To determine whether the data showed a normal distribution, the skewness and kurtosis values of all scales and sub-dimensions of the scales used in the study were calculated. The data obtained are shown in Table 4.1.

Table 4.1: Results of normal distribution compliance analysis of all scales and sub-dimensions

Scales and Sub-Dimensions	N	X̄	SD	Median	Mode	Skewness	Kurtosis
Mathematics Self-Efficacy Scale (Total)	550	3.32	.62	3.36	3.07	-.07	-.22
Mathematics Sense of Self	550	3.54	.81	3.60	3.60	-.32	-.34
Awareness of Behaviors in Mathematics Subjects	550	3.13	.67	3.17	3.17 ^a	-.12	-.30
Transformation of Mathematics into Life Skills	550	3.35	.80	3.33	3.67	-.29	-.12
Motivation for the Mathematics Lesson Scale (Total)	550	3.86	.61	3.88	3.77	-.28	-.40
Motivation for Performance	550	4.26	.63	4.39	4.78	-1.20	1.53
Mathematical Satisfaction	550	3.55	.74	3.60	3.50	-.13	-.48
Amotivation	550	2.22	.83	2.14	1.00	.41	-.25
Mathematics Anxiety Scale (Total)	550	2.58	.70	2.59	2.91	.26	-.35
Mathematics Exam and Evaluation Anxiety	550	2.90	.85	2.82	2.82	.17	-.48
Anxiety About the Mathematics Lesson	550	2.45	.71	2.38	2.12 ^a	.38	-.11
Mathematics Anxiety in Daily Life	550	2.20	.84	2.00	1.00	.54	-.24
Self-confidence in Mathematics	550	2.48	.96	2.38	2.25	.36	-.68

Morgan *et al.* (2004) accept the skewness coefficient ranging between -1 and +1 as a measure of normal distribution (Can, 2020). In addition, if the values obtained by dividing the skewness coefficient and kurtosis coefficient by the standard error of skewness and kurtosis range between -1.96 and +1.96, the distribution is considered normal (Can, 2020). Tabachnick and Fidell (2013) accept that the data are normally distributed when the skewness and kurtosis values range between -1.5 and +1.5. Ak (2008) reported that skewness and kurtosis values ranging between -2.0 and +2.0 are acceptable limits, meaning that they indicate a normal distribution. Table 4.1 shows that

the skewness and kurtosis values of all scales and sub-dimensions of the scales range between -2.0 and +2.0 and show a normal distribution. Therefore, it is concluded that parametric tests can be applied.

Parametric tests were used to analyze normally distributed data. In interpreting arithmetic averages, mean values between 0-1.66 were considered low, mean values between 1.67-3.33 were considered moderate, and mean values between 3.34-5 were considered high. Pearson product-moment correlation coefficients (r) were calculated to determine the relationship between students' mathematics self-efficacy perceptions and their motivation for the mathematics lesson and mathematics anxiety levels. The correlation coefficient can take values between -1 and +1. If the correlation coefficient is positive, it indicates a relationship in the same direction, and if it is negative, then it indicates a reverse relationship (Coşkun *et al.*, 2017). In absolute value, if the correlation coefficient ranges between 0.00-0.30, there is a low level of correlation, a moderate level of correlation if it ranges between 0.30-0.70, and a high level of correlation if it ranges between 0.70-1.00 (Büyüköztürk, 2019). The research model was tested in the AMOS 22 program. The AMOS program provides both the calculation of the value of the path coefficients and the calculation of fit statistics for testing the model. In line with the purpose of the research, a Structural Equation Modeling (SEM) was established and path analysis was conducted. The results obtained in the research were interpreted at the significance level of $p < .05$ and $p < .01$.

4. Findings

4.1. Findings Obtained Regarding the First Sub-Problem

Table 4.1 below shows the results of the descriptive statistics regarding 8th-grade students' mathematics self-efficacy perceptions.

Table 4.1: Descriptive statistics regarding the mathematics self-efficacy scale and its sub-dimensions

Mathematics Self-Efficacy Scale	N	X̄	SS
Mathematics Sense of Self	550	3.54	.81
Awareness of Behaviors in Mathematics Subjects	550	3.13	.67
Transformation of Mathematics into Life Skills	550	3.35	.80
Mathematics Self-Efficacy Scale (Total)	550	3.32	.62

Table 4.1 highlights the mean and standard deviation values for the mathematics self-efficacy scale and the sub-dimensions of the scale. According to the data collected from 550 students, the total average of the mathematics self-efficacy scale was determined to be $\bar{X}=3.32$. Considering the general average of the mathematics self-efficacy scale, it can be implied that the perceived mathematics self-efficacy of 8th-grade students is at a moderate level.

4.2. Findings Obtained Regarding the Second Sub-Problem

Table 4.2 below presents the descriptive statistics results regarding 8th-grade students' motivation for the mathematics lesson.

Table 4.2: Descriptive statistics regarding the motivation for the mathematics lesson scale and its sub-dimensions

Motivation for the Mathematics Lesson Scale	N	X̄	SS
Motivation for Performance	550	4.26	.63
Mathematical Satisfaction	550	3.55	.74
Amotivation	550	2.22	.83
Motivation for the Mathematics Lesson Scale (Total)	550	3.85	.60

Table 4.2 shows the mean and standard deviation values for the motivation for the mathematics lesson scale and its sub-dimensions. According to the data collected from 550 students, it was determined that the total average of the motivation scale for the mathematics lesson was $\bar{X}=3.85$. Considering the general average of the motivation for the mathematics lesson scale, it can be suggested that students' motivation for the mathematics lesson is high.

4.3. Findings Obtained Regarding the Third Sub-Problem

Table 4.3 below shows the descriptive statistics results regarding the mathematics anxiety of 8th-grade students.

Table 4.3: Descriptive statistics regarding the mathematics anxiety scale and its sub-dimensions

Mathematics Anxiety Scale	N	X̄	SS
Mathematics Exam and Evaluation Anxiety	550	2.90	.85
Anxiety About the Mathematics Lesson	550	2.45	.71
Mathematics Anxiety in Daily Life	550	2.20	.84
Self-confidence in Mathematics	550	2.48	.96
Mathematics Anxiety Scale (Total)	550	2.58	.70

Table 4.3 shows the average and standard deviation values of the mathematical anxiety scale and the sub-dimensions of the scale. According to the data collected from 550 students, the total average of the mathematical anxiety scale was found to be $\bar{x} = 2.58$. Considering the general average of the mathematics anxiety scale, it can be suggested that the mathematical anxiety levels of the students are moderate.

4.4. Findings Obtained Regarding the Fourth Sub-Problem

To determine the relationship between 8th-grade students' mathematics self-efficacy perceptions and the levels of motivation for and anxiety about the mathematics lesson, Pearson Moments Correlation coefficients (R) were calculated. The following Table 4.4. presents the correlation results showing the relationship between perceived mathematics self-efficacy and the levels of motivation for and anxiety about the mathematics lesson.

Table 4.4: Correlation results regarding the relationship between perceived mathematics self-efficacy and the levels of motivation for and anxiety about the mathematics lesson

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Mathematics Self-efficacy Perception (total)	1												
1.1. Mathematics Sense of Self	.86	1											
1.2. Awareness of Behaviours in Mathematics Subjects	.85	.55	1										
1.3. Transformation of Mathematics into Life Skills	.75	.52	.51	1									
2. Motivation for the Mathematics Lesson (total)	.58	.52	.42	.51	1								
2.1. Motivation for Performance	.31	.31	.17	.32	.74	1							
2.2. Mathematical Satisfaction	.55	.46	.44	.50	.90	.47	1						
2.3. Amotivation	-.56	-.54	-.42	-.44	-.85	-.44	-.70	1					
3. Mathematics Anxiety (total)	-.66	-.61	-.55	-.44	-.58	-.20	-.56	.65	1				
3.1. Mathematics Exam and Evaluation Anxiety	-.49	-.45	-.47	-.26	-.32	.04	-.36	.45	.89	1			
3.2. Mathematics Lesson Anxiety	-.69	-.64	-.55	-.52	-.701	-.36	-.65	.69	.89	.63	1		
3.3. Mathematics Anxiety in Daily Life	-.54	-.52	-.42	-.38	-.55	-.30	-.47	.60	.82	.61	.72	1	
3.4. Self-confidence in Mathematics	-.54	-.51	-.42	-.38	-.51	-.23	-.49	.53	.78	.60	.68	.62	-

p<.01

Table 4.4, reveals a positive and moderately significant relationship between 8th-grade students' mathematics self-efficacy perceptions and their motivation for the mathematics lesson [$r=.578$, $p<.01$]. In addition, 8th-grade students' mathematics self-efficacy perceptions and motivation for the mathematics lesson are found to have a positive and moderately significant relationship with the sub-dimensions of motivation for performance [$r=.307$, $p<.01$] and mathematical satisfaction [$r=.553$, $p<.01$] while there is a negative and moderately significant relationship with amotivation [$r=-.564$, $p<.01$].

The correlation analysis between the sub-dimensions of 8th-grade students' mathematics self-efficacy perception and the overall sub-dimensions of motivation for the mathematics lesson revealed a positive and moderately significant relationship between the mathematics sense of self sub-dimension and overall motivation for the mathematics lesson [$r=.522$, $p<.01$] as well as between the sub-dimensions of motivation for performance [$r=.305$, $p<.01$] and mathematical satisfaction [$r=.458$, $p<.01$] while it has a negative and moderately significant relationship with amotivation [$r=-.536$, $p<.01$].

There is a positive and moderately significant difference between perceived mathematics self-efficacy and awareness of behavior in mathematics subjects, overall motivation for the mathematics lesson [$r=.423, p<.01$], and mathematical satisfaction [$r=.444, p<.01$] while a negative and moderately significant relationship is found between perceived mathematics self-efficacy and amotivation [$r=-.420, p<.01$]. Accordingly, a positive and low-level significant relationship is found between it and motivation for performance [$r=.167, p<.01$].

A positive and moderately significant difference exists between the transformation of mathematics into life skills and overall motivation for the mathematics lesson [$r=.511, p<.01$] as well as between motivation for performance [$r=.322, p<.01$] and mathematical satisfaction [$r=.496, p<.01$] while there is a negative and moderately significant relationship between it and amotivation [$r=-.442, p<.01$].

On the other hand, a negative and moderately significant relationship is found between 8th-grade students' perceived mathematics self-efficacy and mathematics anxiety [$r=-.655, p<.01$]. In addition, a negative and moderately significant relationship is found between 8th-grade students' perceived mathematics self-efficacy and mathematics anxiety levels and mathematics exam and evaluation anxiety [$r=-.486, p<.01$], mathematics anxiety in daily life, [$r=-.541, p<.01$], mathematics lesson anxiety [$r=-.688, p<.01$], and mathematics self-confidence [$r=-.535, p<.01$].

The correlation analysis between 8th-grade students' perceived mathematics self-efficacy sub-dimensions and the overall and sub-dimensions of mathematics anxiety reveals that a negative and moderately significant relationship exists between mathematics sense of self and overall mathematics anxiety [$r=-.612, p<.01$] as well as between mathematics exam and evaluation anxiety [$r=-.452, p<.01$], mathematics lesson anxiety [$r=-.636, p<.01$], mathematics anxiety in daily life [$r=-.524, p<.01$], and self-confidence in mathematics [$r=-.509, p<.01$].

Also, a negative and moderately significant relationship exists between awareness of behaviour in mathematics subjects and overall mathematics anxiety [$r=-.544, p<.01$] as well as between mathematics exam and evaluation anxiety [$r=-.446, p<.01$], mathematics lesson anxiety [$r=-.544, p<.01$], mathematics anxiety in daily life [$r=-.418, p<.01$], and self-confidence in mathematics [$r=-.424, p<.01$].

A negative and moderately significant relationship exists between transformation of mathematics into life skills and overall mathematics anxiety [$r=-.436, p<.01$] as well as between mathematics lesson anxiety [$r=-.518, p<.01$], mathematics anxiety in daily life [$r=-.383, p<.01$], and self-confidence in mathematics [$r=-.375, p<.01$], and a negative and low-level significant relationship with mathematics exam and evaluation anxiety [$r=-.259, p<.01$].

Finally, a negative and moderately significant relationship is found between 8th-grade students' motivation for the mathematics lesson and their mathematics anxiety [$r=-.576, p<.01$].

4.5. Findings Obtained Regarding the Fifth Sub-Problem

Path analysis was conducted to determine in what direction and level 8th-grade students' perceived mathematics self-efficacy affected their motivation and anxiety levels towards the mathematics lesson. In the conceptual model created within the scope of this research, each path shown by one-way arrows between the variables indicates a cause-effect relationship. Using path analysis, the direct and indirect effects of the predictor variables on the predicted variables were observed. The conceptual model regarding the direction and level at which 8th-grade students' perceived mathematics self-efficacy affected their motivation for mathematics lessons and their mathematics anxiety levels is given in Figure 4.1.

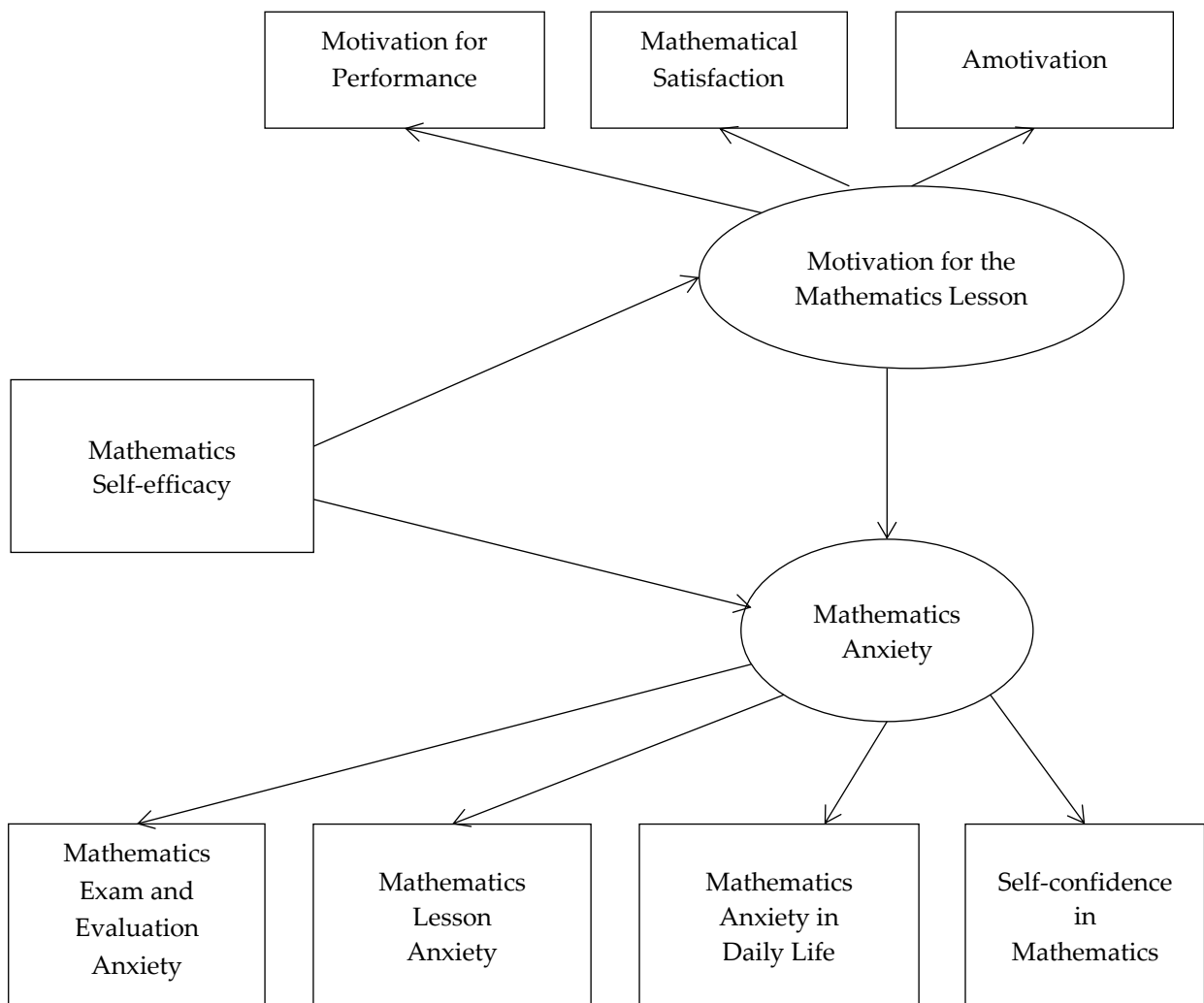


Figure 4.1: Conceptual model

The conceptual model includes 8th-grade students' perceived mathematics self-efficacy as an independent variable. Students' motivation for the mathematics lesson is considered as the mediator variable, and mathematics anxiety is considered as the dependent variable. In the present study, it is assumed that 8th-grade students' perceived

mathematics self-efficacy could directly affect their motivation for mathematics lessons and their mathematics anxiety both directly and indirectly through motivation.

Table 4.5 shows the values related to the fit indices obtained in the path analysis conducted to determine in what direction and level perceived mathematics self-efficacy of 8th-grade students affect their motivation for the mathematics lesson and their mathematics anxiety levels.

Table 4.5: Values for fit indices

Fit Criteria	Fit Values	Acceptable Fit Values	Excellent Fit Values	Result
χ^2/df	$\chi^2/df=197.475/42=4.701$	$3<\chi^2/df<5$	$0<\chi^2/df<3$	Acceptable
RFI	.94	$.90<RFI<.95$	$.95<RFI<1.00$	Acceptable
TLI	.92	$.90<TLI<.95$	$.95<TLI<1.00$	Acceptable
CFI	.96	$.90<CFI<.95$	$.95<CFI<1.00$	Excellent
IFI	.95	$.90<IFI<.95$	$.95\leq IFI<1.00$	Excellent
RMSEA	.074	$.05<RMSEA<.08$	$.00<RMSEA<.05$	Acceptable
p value	.00			

Acceptable fit values, excellent fit values, and fit values obtained in the research for various fit indices are given in Table 4.5. It is observed that close values are generally mentioned in the sources regarding the ranges of fit indices (Bayram, 2010; Meydan and Şeşen, 2011; Okçu, 2011). The χ^2/df ratio included in the fit indices was required to be less than 5. If the χ^2/df ratio is in the range of 3-5, it is an acceptable fit value, and if it is in the range of 0-3, it is an excellent fit value and the $\chi^2/df=4.701$ value calculated as a result of the analysis revealed that the proposed model showed an acceptable fit value with the data (Bayram, 2010). A RMSEA value of less than .05 is considered an excellent fit value (Bayram, 2010; Okçu, 2011). A RMSEA value of .08 and below is considered an acceptable fit value (Tabachnick and Fidell, 2001). As a result of the analysis, the RMSEA value was found to be .074, and this value revealed that the model had an acceptable fit with the data. In addition, for RFI, TLI, CFI, IFI indexes, the range of 0.90-0.95 is an acceptable fit value, and the range of 0.95-1.00 is an excellent fit value (Bayram, 2010; Okçu, 2011; Okçu *et al.*, 2020; Sümer, 2000). As a result of the analysis, RFI (.94) and TLI (.92) values were found to be at an acceptable level of fit, and CFI (.96) and IFI (.95) values were found to be at an excellent fit level.

As a result of the analysis, the standardized path coefficients regarding the direction and level at which 8th-grade students' perceived mathematics self-efficacy affected their motivation for the mathematics lesson, and their mathematics anxiety levels are shown in Figure 4.2 below.

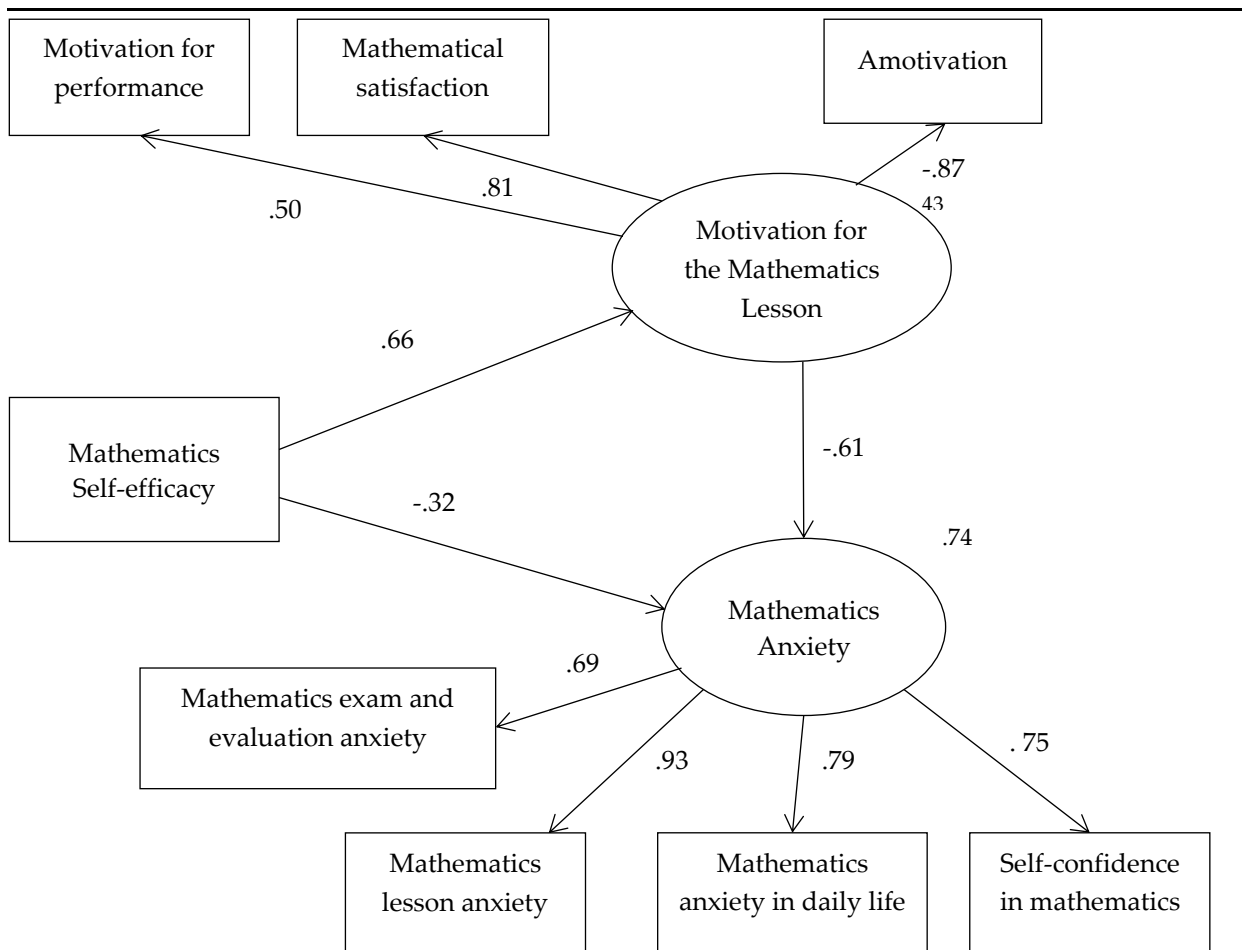


Figure 4.2: Standardized path analysis results

As seen in Figure 4.2, the path coefficients highlight that mathematics lesson anxiety (.93) has more impact on mathematics anxiety than mathematics anxiety in daily life (.79), self-confidence in mathematics (.75), and mathematics exam and evaluation anxiety (.69) while amotivation (-.87) has a greater impact on students' motivation for the mathematics lesson than mathematical satisfaction (.81) and motivation for performance (.50).

The path analysis results regarding 8th-grade students' perceived mathematics self-efficacy, students' motivation for the mathematics lesson, and mathematics anxiety revealed a positive and moderate relationship between students' perceived mathematics self-efficacy and motivation for the mathematics lesson levels ($\beta = .66$). Whereas, a negative and moderate relationship was found between students' perceived mathematics self-efficacy and mathematics anxiety levels ($\beta = -.32$). In other words, it can be suggested that as 8th-grade students' perceived mathematics self-efficacy becomes positive, their motivation for mathematics lessons increases, while their mathematics anxiety levels decrease.

One may notice that a negative and moderate relationship existed between 8th-grade students' motivation for mathematics lessons and mathematics anxiety ($\beta = -.61$).

Accordingly, it can be reported that the increase in the mathematics anxiety levels of 8th-grade students may negatively affect their motivation for mathematics lessons.

In addition, it is observed that 43% of the total change in students' motivation for the mathematics lesson stemmed from students' perceived mathematics self-efficacy. Additionally, 74% of the total change in 8th-grade students' mathematics anxiety levels stemmed from the direct effect of the latent (mediating) variable of students' perceived mathematics self-efficacy and students' motivation for the mathematics lesson, as well as the indirect effect of the students' perceived mathematics self-efficacy variable mediated by the motivation for the mathematics lesson variable. In addition, it can be suggested that a 1-point increase in students' perceived mathematics self-efficacy could cause a .61-point decrease in students' mathematics anxiety. And students' motivation for mathematics lessons had a stronger predictive effect on their mathematics anxiety levels than their perceived mathematics self-efficacy.

As a result, it is concluded that as 8th-grade students' mathematics self-efficacy perceptions become positive, their motivation for mathematics lessons increases while their mathematics anxiety levels may decrease. In other words, both their mathematics self-efficacy perceptions and their motivation for mathematics lessons had a significant impact on reducing the mathematics anxiety levels of 8th-grade students. Perceived mathematics self-efficacy had a significant effect on reducing the mathematics anxiety levels of 8th-grade students (by 74%), and this was mediated by the students' motivation for the mathematics lesson. In addition, students' motivation for mathematics lessons had a stronger predictive effect on their mathematics anxiety levels than their perceived mathematics self-efficacy.

5. Discussion and Conclusion

5.1 Results Regarding Mathematics Self-Efficacy Perception

The research findings revealed that 8th-grade students' mathematics self-efficacy perceptions were generally at a moderate level. In other words, it was observed that 8th-grade students agreed at a moderate level with the statements about the ability to use mathematics effectively in daily life, competence in problem-solving, and self-confidence while studying mathematics. In this context, it is expected and desired that students' self-efficacy perceptions towards mathematics lessons are higher. Along the same lines, Adal (2017) and İpek (2019) concluded in a study with secondary school students that they had a moderate level of perceived mathematics self-efficacy, which means that the results overlap with the results of the present study. Besides, Ergin (2022), Karademir and Yalçın (2019), and Sevgi and Zihar (2020) concluded that secondary school students' perceived self-efficacy in mathematics is high. The moderate or high level of perceived mathematics self-efficacy could arise from differences in sampling.

5.2 Results Regarding Motivation for Mathematics Lessons

The research findings indicated that 8th-grade students highly agreed with the statements about the enjoyment of studying mathematics and answering difficult questions, the desire for mathematics achievement, and openness to new ideas in mathematics. It was also discovered that in general, 8th-grade students had a high level of motivation towards mathematics lessons, which is meant to be favorable in the context of mathematics lesson achievement. Bozkurt and Bircan (2015) found the motivation level for mathematics lessons to be quite high based on the general average of the motivation scale. Süren (2019) reported that the general average of the students' motivation levels for mathematics lessons at a secondary school was high. Kulakaç (2020) also found out that the total motivation score of 5th-grade secondary school students for the mathematics lesson was close to a high level. Kara (2021) conducted a study with 8th-grade secondary school students, concluding that the general average of the students' motivation towards the mathematics lesson was positive. All these studies in the literature support the findings of the present study.

5.3 Results Regarding Mathematics Anxiety

The findings highlighted that 8th-grade students agreed at a moderate level with the statements about panicking while being assigned a task in mathematics, nervousness before the mathematics exam, frustration during the mathematics exam, and lack of courage to ask for feedback when failing to understand anything during the mathematics class. Besides, it was discovered that the mathematics anxiety of 8th-grade students was at a moderate level. Yet, what is desired and expected here is a low or very low level of anxiety. Along the same lines, Adal (2017) concluded that mathematics anxiety of secondary school students was at a moderate level, which means that the finding overlaps with the finding of the present study. However, some studies contradict with the findings of the present study. For example, Dalkılıç (2019) and Taşdemir (2015) found that the mathematics anxiety levels of secondary school students were generally quite low while Süren (2019) found the mathematics anxiety level to be high in a study conducted with 8th-grade students. In a study with primary school students, Medikoğlu (2020) found a high level of mathematics anxiety.

5.4 Results Regarding the Correlation Between Students' Mathematics Self-Efficacy Perceptions and the Levels of their Motivation and Anxiety towards the Mathematics Lesson

A positive and moderately significant relationship was found between 8th-grade students' mathematics self-efficacy perceptions and their motivation for mathematics lessons while a negative and moderately significant relationship was found between 8th-grade students' mathematics self-efficacy perceptions and mathematics anxiety. Reber *et al.* (2018) investigated 7th-grade students' self-efficacy, anxiety, attitude, and mathematics achievement by gender and school type, finding a negative and moderately significant relationship between mathematics self-efficacy perceptions and mathematics

anxiety. Adal (2017) found that the relationship between mathematics self-efficacy and mathematics anxiety was low and negative while İpek (2019) found that students with high self-efficacy perceptions in mathematics class experience low mathematics anxiety while also concluding that a negative and moderately significant relationship was found between 8th-grade students' motivation for mathematics lessons and their mathematics anxiety. In other words, it can be argued that students with high motivation for mathematics lessons have low mathematics anxiety. In this context, Zakaria and Nordin (2008) found a negative and highly significant relationship between students' mathematics anxiety and motivation while Kılıç (2011) found a negative and highly significant relationship between second-stage primary school students' motivation for mathematics lessons and their mathematics anxiety. Along the same lines, Tapia and Marsh (2004) reported that mathematics anxiety has a significant effect on motivation for mathematics lessons, adding that students with low mathematics anxiety have higher motivation for mathematics lessons than students with high mathematics anxiety. In a study conducted with 10th-grade high school students, Durmaz and Akkuş (2016) found a negative, low-level, and significant relationship between mathematics anxiety and intrinsic motivation. The findings of the relevant studies support the findings of the present study. Students experiencing mathematics anxiety are likely to be reluctant to perform mathematics-related tasks, which in return possibly reduces their motivation levels.

5.5 Results on What Direction and Level Students' Mathematics Self-Efficacy Perceptions Affect Their Levels of Motivation and Anxiety towards the Mathematics Lesson

The path analysis results of the study revealed a positive and moderate relationship between students' mathematics self-efficacy perceptions and their motivation levels for mathematics lessons while a negative and moderate relationship was found between students' mathematics self-efficacy perceptions and mathematics anxiety levels. Another finding was that 43% of the total change in 8th-grade students' motivation towards the mathematics lesson was due to the students' perceived mathematics self-efficacy. In addition, 74% of the total change in 8th-grade students' mathematics anxiety levels stemmed from the direct effect of the latent (mediating) variable of students' mathematics self-efficacy perceptions and students' motivation towards the mathematics lesson, as well as the mediation of the motivation variable for the indirect effect of students' mathematics self-efficacy perceptions variable. In other words, it can be argued that mathematics self-efficacy perceptions have a crucial effect on reducing the mathematics anxiety of 8th-grade students, and this is mediated by the students' motivation for the mathematics lesson. Besides, students' motivation for mathematics lessons was found to have a stronger predictive effect on their mathematics anxiety levels than their perceived mathematics self-efficacy. In other words, it can be said that as 8th-grade students' mathematics self-efficacy perceptions become positive, students' motivation for mathematics lessons increases, and their anxiety levels regarding mathematics lessons

decrease. Students feeling competent in mathematics and believing that they are capable of solving mathematical problems and passing mathematics exams may also have high motivation for mathematics lessons. In other words, both mathematics self-efficacy perceptions and motivation for mathematics lessons have a significant impact on reducing the mathematics anxiety levels of 8th-grade students. Furthermore, students' motivation towards the mathematics lesson has a stronger predictive effect on their mathematics anxiety levels than their perceived mathematics self-efficacy. Studies in the literature have demonstrated that there are no path analysis studies that take into consideration the variables of mathematics self-efficacy perception, motivation for the mathematics lesson, and mathematics anxiety. Ayan (2014) conducted a multiple regression analysis and found that perceived mathematics self-efficacy does not have a significant effect on motivation for mathematics lessons. This study does not support the findings of the present study.

However, Ayan (2014) also found that perceived mathematics self-efficacy has a significant and negative effect on mathematics anxiety, which backs up the result of the present study. Yıldırım (2011), on the other hand, examined the relationships between self-efficacy, intrinsic motivation, and anxiety and their effects on mathematics achievement using data from the student survey in the PISA 2003 application in Turkey, Japan, and Finland, concluding that there was a positive relationship between self-efficacy belief and intrinsic motivation in all three countries. and self-efficacy beliefs negatively affected anxiety. In a study conducted with primary school students, Medikoğlu (2020) reported that mathematics anxiety of students with a high perceived mathematics self-efficacy decreases, and accordingly, as the students' motivation for mathematics lessons increases, their anxiety decreases. These studies support the results of this study. Finally, it can be implied that as perceived mathematics self-efficacy increases, students' mathematics anxiety decreases, and as students feel competent in mathematics, their mathematics anxiety decreases. Other studies in the literature generally focus on the relationship between mathematics anxiety, mathematics motivation, and mathematics achievement.

Süren (2019) discussed the effects of 8th-grade students' mathematics anxiety and motivation on their mathematics lesson success, concluding that mathematics anxiety significantly predicted mathematics success compared to mathematics motivation. Along the same lines, Sarı and Ekici (2018) examined the effects of affective variables (attitude, anxiety, and motivation) that have an impact on the mathematics achievement and arithmetic performance of 4th-grade primary school students and the relationships between them, concluding that the variable of students' attitudes towards mathematics positively affected their mathematics success and that there was a negative relationship between students' attitudes towards mathematics and their mathematics anxiety and a negative relationship between mathematics anxiety and mathematics achievement. They determined that mathematics anxiety did not have as great an impact on mathematics achievement as attitude towards mathematics. Finally, the research conducted by Arslan and İnce (2023) revealed that 8th-grade students' attitudes towards the mathematics

lesson have an impact on students' test anxiety. Based on the results of this research, the following recommendations were made:

- 1) This study revealed that students' mathematics self-efficacy perceptions had a very important effect on reducing the mathematics anxiety of 8th-grade students. In this context, in-service training can be organized for teachers to create effective teaching environments to improve students' mathematics self-efficacy perceptions.
- 2) Since increasing motivation for mathematics lessons is expected to reduce mathematics anxiety, effective classroom environments can be created to increase students' motivation. Factors such as students' active participation in the learning process, learning by doing, and experiencing the feeling of accomplishment can help increase student motivation. In this context, educational activities can be organized to raise awareness of teachers.
- 3) Teachers have important duties to reduce students' anxiety. Good communication between the teacher and the student can help reduce the student's anxiety.
- 4) Students can be given training to raise awareness on issues such as ways to cope with math anxiety and lack of motivation.
- 5) Qualitative studies can be conducted on this subject and in-depth analyzes can be made regarding students' self-efficacy perceptions, exam anxiety, and motivation.
- 6) This study is limited to 8th-grade students. To conduct a more comprehensive study, similar studies can be conducted on primary school, secondary school, and high school students.

Author Contributions

Each step of the research was conducted by the authors together, based on an understanding of common responsibility.

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Data Availability Statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Conflicts of Interest Statement

The authors declare no potential conflicts of interest concerning the research, authorship, and/or publication of the article.

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