Yaşadıkça Eğitim, Cilt 39, Sayı 2, Yıl 2025, s.289-301.
Journal of Education for Life, Volume 39, Issue 2, Year 2025, pp. 289-301.
DOI: 10.33308/26674874.2025392820

Investigation of High School 12th Grade Students' Attitudes Towards the Topic of Derivatives

Büşra ATEŞ[1], Neşe DOKUMACI SÜTÇÜ[2]

Abstract: The aim of this study is to examine the attitudes of 12th-grade high school students towards the topic of derivatives. This research, which is descriptive and correlational in nature, involved 223 students. A personal information form and an Attitude Scale Toward the Topic of Derivatives were employed as data collection tools. A second-order confirmatory factor analysis was conducted to validate the three-factor structure of the Attitude Scale Toward the Topic of Derivatives, developed by Kara and Yalçınkaya (2017) for pre-service teachers, for adaption to 12th-grade high school students. Descriptive statistics, independent samples t-test, Pearson, and Spearman-Brown Correlation Coefficient were utilized in data analysis. The study found that students' attitudes toward the behavioral, cognitive, and problem-solving dimensions of the scale were at a moderate levels and did not show a statistically significant difference based on gender. It was determined that Anatolian High School students exhibited significantly higher attitudes toward the behavioral and problem-solving dimensions compared to Imam Hatip High School students. Science track students demonstrated significantly higher attitudes toward each dimension compared to equal weight track students. Additionally, students who participated courses/tutoring centers demonstrated significantly higher attitudes toward the behavioral dimension than those who did not. On the other hand, the study revealed a moderate, positive, and statistically significant relationship between students' first-term mathematics grades, their level of liking mathematics, and their weekly study hours on derivatives, and their attitudes toward the behavioral and problem-solving dimensions. A low, positive, and statistically significant relationship was found between these factors and attitudes toward the cognitive dimension.

Keywords: Mathematics, Derivatives, Attitude

Ortaöğretim 12. Sınıf Öğrencilerin Türev Konusuna Yönelik Tutumlarının İncelenmesi

Öz: Araştırmada, ortaöğretim 12. Sınıf öğrencilerinin türev konusuna yönelik tutumlarını incelemek amaçlanmıştır. Betimsel ve korelasyonel araştırma niteliğinde olan bu çalışmaya 223 öğrenci katılmıştır. Veri toplama aracı olarak kişisel bilgi formu ve türev konusuna yönelik tutum ölçeği kullanılmıştır. Kara and Yalçınkaya (2017) tarafından öğretmen adaylarına yönelik olarak geliştirilen türev konusuna yönelik tutum ölçeğinin üç faktörlü yapısının 12. sınıf ortaöğretim öğrencilerine uyarlanması amacıyla ikinci düzey doğrulayıcı faktör analizi yapılmıştır. Ölçekten elde edilen verilerin analizinde betimsel istatistikler, bağımsız örneklemler için t-testi, Pearson ve Spearman Brown Sıra Farkları Korelâsyon Katsayısı kullanılmıştır. Araştırmada öğrencilerin türev konusuna yönelik tutum ölçeğinin davranışsal, bilişsel ve problem çözme boyutlarına ilişkin tutumlarının orta düzeyde olduğu ve cinsiyete göre istatistiksel olarak anlamlı bir farklılık göstermediği tespit edilmiştir. Anadolu Lisesi öğrencilerinin davranışsal ve problem çözme boyutlarına ilişkin tutumları İmam Hatip Lisesi öğrencilerine göre, sayısal öğrencilerinin her bir boyuta ilişkin tutumları eşit ağırlık öğrencilerine göre, kurs/dershaneye giden öğrencilerin davranışsal boyuta ilişkin tutumları kurs/dershaneye gitmeyen öğrencilere göre anlamlı düzeyde daha yüksek olduğu belirlenmiştir. Öte yandan araştırmada öğrencilerin I. dönem matematik dersi not ortalamaları, matematik dersini sevme düzeyleri ve haftalık türev çalışma saati ile davranışsal ve problem çözme boyutlarına ilişkin tutumları arasında orta düzeyde; bilişsel boyuta ilişkin tutumları arasında düşük düzeyde, pozitif ve istatistiksel olarak anlamlı bir ilişki olduğu ortaya çıkmıştır.

Anahtar Sözcükler: Matematik, Türev, Tutum

Received: 18.09.2024 Accepted: 13.02.2025 Article Type: Research Article

[1] Ministry of National Education, Necati Ceylan Anatolian High School, Diyarbakır, Türkiye, e-mail: b.ates1988@hotmail.com, ORCID: https://orcid.org/0009-0002-4211-8421

[2] Dicle University, Ziya Gökalp Faculty of Education, Department of Mathematics and Science Education, Diyarbakır, Türkiye, e-mail: ndokumaci@dicle.edu.tr, ORCID: https://orcid.org/0000-0003-3279-4194

To cite:/Atıf için
Ateş, B., & Dokumacı Sütçü, N. (2025). Investigation of high school 12th grade students' attitudes towards the topic of derivatives. *Yaşadıkça Eğitim*, *39*(2), 289–301. https://doi.org/10.33308/26674874.2025392820

Mathematics, taught as a fundamental and prominent subject starting from primary education across all school levels, serves as a means to develop problem-solving, problem-posing, expression, systematic thinking, critical thinking, and high-level thinking skills (Aydın & Doğan, 2012). Many mathematical concepts taught during the education and teaching process are inherently abstract, and students sometimes face difficulties in learning these concepts (Altun & Yılmaz, 2016). The reason for this is that mathematical concepts and rules are very closely interrelated, and what is learned earlier forms the foundation for topics to be learned later (Aydın & Doğan, 2012). Due to its abstract nature and concept misconceptions, mathematics has been a nightmare for many students from the early years of primary education to the final years of higher education. As a result, it has often become a subject that is disliked and where students face failure (Yıldız, 2006). Students' perceptions of this subject are shaped by their previous learning experiences and the challenges they encounter. Therefore, the teaching process should be planned in a way that supports students' conceptual understanding, prevents misconceptions, and encourages meaningful learning.

Mathematics learning and teaching activities should be planned by first determining the prior knowledge and skills that students are expected to have. Their readiness in relation to this knowledge and skills should be assessed, and if there are any gaps or misconceptions, appropriate actions should be planned to address them. Considering students' readiness is crucial for establishing connections between their prior knowledge and new learning, as well as for relating what is learned to everyday life. This process should also be seen as a necessity to ensure that students are socially and emotionally prepared. Indeed, to achieve these goals, the Secondary Education Mathematics Curriculum aims to develop teaching strategies appropriate to students' current levels of knowledge (Ministry of National Education [MoNE], 2024).

The Secondary Education Mathematics Curriculum aims to make the process of learning and teaching mathematics engaging and interactive within the framework of the adopted model and approach, thereby increasing students' interest in learning, meeting the needs of individuals and society, and making mathematics a part of everyday life experiences. Additionally, the program emphasizes the development of high-level skills such as critical thinking, problem-solving, and decision-making (MoNE, 2024). Just as it is important to develop cognitive characteristics in education, it is equally important to develop affective characteristics. This is because elements of the affective domain, such as interest, attitude, motivation, anxiety, and self-perception, also affect the cognitive domain (Akdemir, 2006). One of the characteristics addressed in the context of affective characteristics is attitudes (Oral, 2004).

An attitude is a learned tendency to respond positively or negatively toward a particular object, situation, institution, concept, or other people (Tezbaşaran, 1997). It is the individual's mental, emotional, and behavioral tendency developed based on their experiences, knowledge, feelings, and motivations towards themselves, an object in their environment, a social issue, or an event (İnceoğlu, 2000). Individuals often assign specific meanings to events occurring around them and reflect these meanings through their personal experiences. As a result of these experiences, beliefs and approaches are formed. These beliefs and approaches are referred to as attitudes (Yenilmez & Özabacı, 2003). Attitudes can vary in intensity, from the most positive to the most negative. Negative attitudes can manifest as holding negative beliefs about an object or idea, rejecting it, disliking it, or acting against it. Positive attitudes, on the other hand, can be reflected by having positive beliefs about an object or idea, accepting and liking it (Demirhan & Altay, 2001). The experiences a student has with mathematics can lead them to develop either positive or negative attitudes toward the subject. Considering the impact of attitudes on guiding behaviors, it can be said that there is a relationship between attitudes toward mathematics and success in mathematics (Akdemir, 2006).

A review of the literature shows that several studies (Çavdar & Şahan, 2019; Dowker et al., 2019; Elalmış et al., 2023; Kara & Özkaya, 2022; Kiwanuka et al., 2020; Tabuk, 2019) have found a significant and positive relationship between attitudes toward mathematics and mathematical success. According to Saracaoglu (2016), many students are afraid of mathematics, think that they cannot succeed in mathematics and have a negative attitude towards mathematics. Lack of motivation increases anxiety and academic achievement in mathematics decreases because it prevents students from studying. According to Taşdemir (2009), when students are found to have negative attitudes towards mathematics, these attitudes should be corrected as

soon as possible. Knowledge and experience are considered as important tools in correcting negative attitudes towards mathematics. Timely determination of attitudes towards mathematics course can make great contributions to students' future educational life and thus can significantly improve the quality of education. In this context, it is also quite important to identify attitudes toward the concept of derivatives, which is a critical topic that plays a significant role in developing mathematical thinking.

One of the concepts that many students struggle with and find difficult in mathematics education is the derivatives. The concept of a derivatives is the derivatives of a function, and this concept is derived from the limits of functions. Similarly, the development of the concept of an integral is also based on the concept of limits. Therefore, understanding the concept of limits is essential for comprehending the concepts of derivatives and integrals (Aksoy, 2007). Like other topics in mathematics, the topic of derivatives is perceived as a difficult subject due to the close relationship between concepts and rules, as well as the fact that previously learned knowledge forms the foundation for subsequent topics. For this reason, in a cumulative and sequential science like mathematics, no concept should be taught without first ensuring that its prerequisite concepts have been learned.

The ability of students to analyze situations they encounter in daily life by relating them to the concept of derivatives, to solve problems related to derivatives, and to make decisions, can positively influence their attitudes towards the topic of derivatives (Kara & Yalçınkaya, 2017). In this regard, in order for advanced mathematics topics to be learned, it is first necessary for students to understand the concept of derivatives and to have a positive attitude towards the topic of derivatives. Knowing students' attitudes towards the concept of derivatives is valuable in many ways to improve their learning experiences and to make mathematics education more effective. Therefore, it is important in this study to determine students' attitudes towards the significant topic of derivatives.

The Aim of the Research

The aim of this study is to examine the attitudes of 12th-grade high school students towards the topic of derivatives. In line with this objective, the following questions are sought to be answered. Do students' attitudes towards the topic of derivatives:

- Differ significantly in a statistically meaningful way according to variables such as gender, type of school, track of study, and participation in courses/tutoring?
- How are they related to variables such as first-term mathematics grade, level of liking mathematics, level of understanding the topic of derivatives, the teacher's ability to explain the topic of derivatives, weekly study hours for mathematics, and weekly study hours for derivatives?

Method

Research Model

This study, which examines the attitudes of 12th-grade high school students towards the topic of derivatives, is descriptive and correlational in nature. Descriptive (survey) research involves collecting data to identify certain aspects or characteristics (such as abilities, opinions, attitudes, beliefs, or knowledge) of a group (Fraenkel & Wallen, 2009). A descriptive research design was preferred to examine the level of students' attitudes toward the topic of derivatives and to analyze these attitudes in terms of variables such as gender, type of school, track of study, and participation in courses/tutoring. Correlational research is used to determine relationships between two or more variables (Fraenkel & Wallen, 2009; Karasar, 2011). A correlational research design was preferred to determine the relationship between students' attitudes toward the topic of derivatives and the variables of first-term mathematics grade, level of liking mathematics, level of understanding the topic of derivatives, the teacher's ability to explain the topic of derivatives, weekly study hours for mathematics, and weekly study hours for derivatives.

Participants

The participants of the study consist of 223 students who are enrolled in the 12th grade at randomly selected high schools in Diyarbakır during the spring term of the 2023-2024 academic year and who voluntarily participated in the research. 151 of the students are girls and 72 are boys. 170 of the students study at Anatolian High School and 48 at Imam Hatip High School.

Data Collection Tool

In the study, a personal information form and an attitude scale towards the subject of derivatives were used as data collection tools. The personal information form included questions aimed at determining variables such as students' gender, type of school, track of study, participation in courses/tutoring, first-term mathematics grade, level of liking mathematics, level of understanding the topic of derivatives, the teacher's ability to explain the topic of derivatives, weekly study hours for mathematics, and weekly study hours for derivatives.

The attitude scale towards the topic of derivatives was developed by Kara and Yalçınkaya (2017). Permission to use the scale in this study was obtained from the authors via e-mail. It is based on a 5-point Likert scale, ranging from "Strongly agree (5)" to "Strongly disagree (1)." In the first stage, exploratory and confirmatory factor analyses were performed for the construct validity of the scale consisting of 40 items. As a result of the exploratory factor analysis, 12 items were removed from the scale and a three-factor structure was obtained. All three factors explained 48.7% of the total variance. Then, 8 items were removed from the scale by confirmatory factor analysis. After the reliability analysis, 5 more items were removed from the scale due to low reliability coefficient. Finally, the scale consists of three dimensions (behavioral, cognitive and problem solving) and 15 items. The behavioral dimension, related to acting in line with feelings and opinions about derivatives, includes items 1, 2, 7, 8, 9, 10, 12, 13, and 14. The cognitive dimension, focused on understanding, storing, and applying derivatives in daily life, includes items 6, 11, and 15. The problem-solving dimension, concerning research and solving problems related to derivatives, consists of items 3, 4, and 5. The reliability coefficients of the dimensions in the scale were found as follows: the Cronbach's Alpha coefficient for the behavioral dimension was .87, for the cognitive dimension .60, for the problem-solving dimension .60, and for the overall scale .62. The number of items and example items for each dimension are presented in Table 1.

Table 1. *Number of Items in the Dimensions of the Scale, Example Items*

Dimensions	Number of Items	Example Item
Behavioral	9	I get anxious when I see terms related to derivatives.
Cognitive	3	I use derivatives in many places in my life.
Problem-solving	3	When given the graph of the derivative of a function, I can comment on the function.

The three-factor structure of the attitude scale towards the topic of derivatives, developed by Kara and Yalçınkaya (2017) for teacher candidates, was adapted for 12th-grade high school students through a second-order confirmatory factor analysis (CFA). Before conducting CFA, certain assumptions and requirements for the dataset obtained from the sample were tested. For this purpose, the dataset was examined in terms of sample size adequacy, missing data, univariate and multivariate outliers, as well as univariate and multivariate normality.

In factor analysis studies, Kline (2011) suggests that a typical sample size should be approximately 200 participants. Tabachnick and Fidell (2001) also stated that a sample size of 150 is adequate. Accordingly, it was concluded that the sample size of 223 students was adequate for CFA. For the missing values observed in the dataset, values reflecting the series' mean were assigned. To identify univariate outliers, Z-scores were calculated (between -1.72457 and +2.02038), and it was ensured that they remained within the ±3 range (Çokluk et al., 2012). Accordingly, no univariate outliers were found in the dataset. For multivariate outliers, Aybek's (2021) web tool, which was developed to prepare data for factor analysis and operates using R software in the background, was utilized. Through this tool, three observations in the dataset were identified as multivariate outliers. The assumption of univariate and multivariate normality was tested on the dataset that had been

downloaded from Aybek's (2021) web tool and cleansed of multivariate outliers. For univariate normality, the skewness (-.068) and kurtosis (-.404) coefficients of the total score were calculated, and since these values fell within the ±1 range, the assumption of univariate normality was considered to be met (Çokluk et al., 2012). Multivariate normality was assessed using the Henze-Zirkler multivariate normality test available in Aybek's (2021) web tool (Gezer & İlhan, 2023). The results (HZ = 1.389001, p = .000) indicated that the dataset did not meet the assumption of multivariate normality. Since the dataset did not satisfy the multivariate normality assumption, CFA was conducted using the Robust Maximum Likelihood estimation method (Şimşek, 2007). Following the modification procedures (13-14, 7-9, 1-2, 2-12) a three-factor structural model was established in the original form of the scale, and model fit was achieved (χ^2/sd=2.39, RMSEA=.079, GFI=.90, SRMR=.067, NNFI=.91, CFI=.93). The path diagram for the three-factor model obtained from the second-order confirmatory factor analysis is presented in Figure 1.

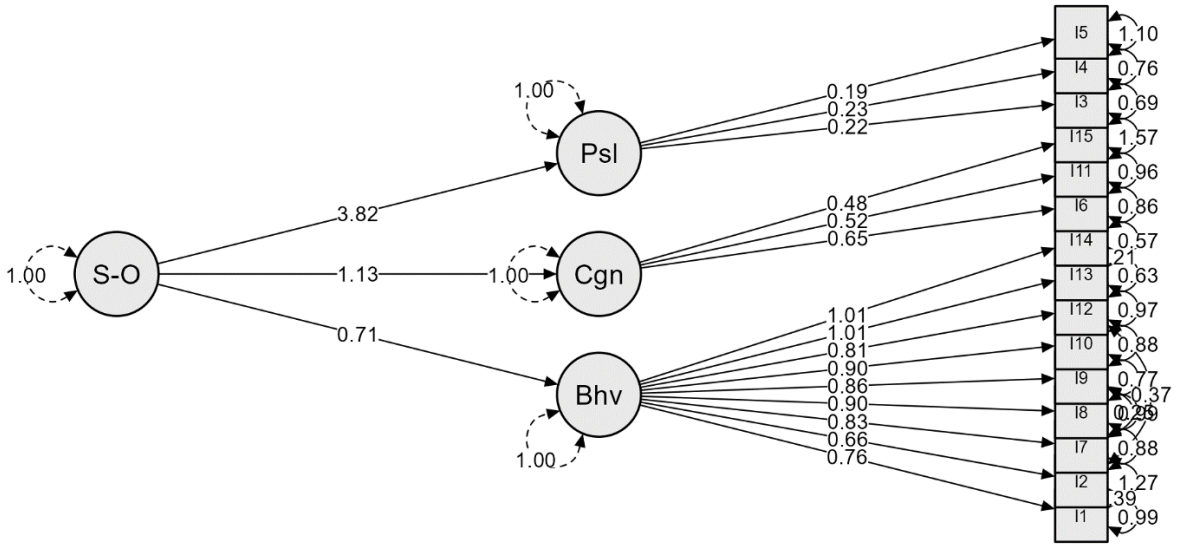

Figure 1. Path diagram of the three-factor model obtained from second-order confirmatory factor analysis

In this study, the Cronbach Alpha Reliability Coefficient was calculated for the overall scale and its sub-dimensions; it was found to be .92 for the behavioral dimension, .62 for the cognitive dimension, .72 for the problem-solving dimension, and .90 for the overall scale. Raines-Eudy (2000) stated that reliability measures range between 0 and 1, with values above .50 being considered reliable. Therefore, it can be said that the data obtained from the attitude scale towards derivatives is reliable.

Data Analysis

In the study, SPSS software was used to analyze the obtained data. Descriptive statistics were employed to determine the level of students' average scores for each dimension of the attitude scale towards derivatives. The interpretation of the average scores was categorized as follows: 1.00–1.80 was considered "very low," 1.81–2.60 was considered "low," 2.61–3.40 was considered "medium," 3.41–4.20 was considered "high," and 4.21–5.00 was considered "very high."

To decide on the analysis to be used for examining the average scores of students on each dimension of the attitude scale towards derivatives in terms of variables such as gender, type of school, track of study, and participation in courses/tutoring, it was tested whether the data for the subgroups of variables followed a normal distribution, as outlined by Büyüköztürk (2011) and Field (2009). For this purpose, skewness and kurtosis values were examined. Since the skewness and kurtosis values for the subgroups of variables were within the range of +1 and -1, the data were considered to follow a normal distribution, and an independent samples t-test was used.

To determine the type of correlation analysis to use for examining the relationships between the average scores of students on each dimension of the attitude scale towards derivatives and variables such as first-term mathematics grade, level of liking mathematics, level of understanding the topic of derivatives, the teacher's ability to explain the topic of derivatives, weekly study hours for mathematics, and weekly study hours for derivatives, the skewness and kurtosis values of the variables were examined. Since the skewness and kurtosis values of all variables, except for weekly study hours for derivatives, were within the range of +1 to -1, Pearson Correlation Coefficient was used. Spearman-Brown Correlation Coefficient was used to compare students' attitudes towards derivatives with weekly study hours for derivatives. Additionally, in the study, a correlation coefficient with an absolute value between .70 and 1.00 was considered high, between .30 and .70 was considered moderate, and between .00 and .30 was considered low (Büyüköztürk, 2011).

To adapt the three-factor structure of the attitude scale towards the topic of derivatives, developed for teacher candidates, to 12th-grade high school students, a second-order confirmatory factor analysis was conducted using the "JASP 0.18.3" program. For this purpose, various fit indices were used. χ^2/df ratio below 5 indicates moderate fit, while a ratio below 3 indicates excellent fit (Çokluk et al., 2012). RMSEA value below .08 is considered acceptable, and a value below .05 indicates excellent fit. GFI indices above .85 are considered acceptable, while values above .90 indicate excellent fit. NNFI and CFI indices above .90 are acceptable, and values above .95 represent excellent fit (Marcholudis & Schumacher, 2007; cited in Seçer, 2015). An SRMR value below .10 is acceptable, while a value below .05 is considered an excellent fit criterion (Bayram, 2013; Hu & Bentler, 1999; Kline, 2011).

Findings

In this section, the findings obtained from the research are presented. The descriptive statistics results for each dimension of the attitude scale towards the topic of derivatives are shown in Table 2.

Table 2. *Descriptive Statistics Results for Each Dimension of The Attitude Scale Towards the Topic of Derivatives*

Dimensions	N	Minimum	Maximum	Mean	Standard Deviation
Behavioral	223	1.00	5.00	3.14	1.11
Cognitive	223	1.00	5.00	2.69	1.03
Problem Solving	223	1.00	5.00	3.11	1.01

As seen in Table 2, the average scores of students in the behavioral dimension are 3.14, in the cognitive dimension 2.69, and in the problem-solving dimension 3.11. Based on these findings, it can be said that students' attitudes towards all dimensions are at a moderate level.

The t-test results for the average scores of each dimension of the attitude scale towards the topic of derivatives according to the "gender" variable are presented in Table 3.

Table 3. *T-Test Results of The Average Scores of Students for Each Dimension of The Attitude Scale Towards the Topic of Derivatives Based on the "Gender" Variable*

Dimensions	Gender	n	Mean	Standard Deviation	t (221)	p
Behavioral	Female	151	3.15	1.15	.167	.868
	Male	72	3.12	1.02		
Cognitive	Female	151	2.67	1.01	-.465	.642
	Male	72	2.74	1.07		
Problem-solving	Female	151	3.18	.98	1.513	.132
	Male	72	2.96	1.05		

When Table 3 is examined, it is seen that the average scores of students in the behavioral, cognitive, and problem-solving dimensions do not show a statistically significant difference based on gender.

The t-test results of the average scores of each dimension of the students' attitude scale towards the topic of derivatives according to the "type of school" variable are presented in Table 4.

Table 4. *T-Test Results of the Average Scores of Students for Each Dimension of The Attitude Scale Towards the Topic of Derivatives Based on the "Type of School" Variable*

Dimensions	Type of School	n	Mean	Standard Deviation	t (216)	p
Behavioral	Anatolian High School	170	3.23	1.09	2.155	.032
	Imam Hatip High School	48	2.84	1.10		
Cognitive	Anatolian High School	170	2.76	1.03	1.708	.089
	Imam Hatip High School	48	2.47	.96		
Problem-solving	Anatolian High School	170	3.17	1.01	2.129	.034
	Imam Hatip High School	48	2.83	.90		

When Table 4 is examined, while the average scores in the cognitive dimension do not show a statistically significant difference based on school type, the average scores in the behavioral and problem-solving dimensions do show a statistically significant difference. Accordingly, it can be said that the attitudes of Anatolian High School students in the behavioral and problem-solving dimensions are significantly higher compared to those of Imam Hatip High School students.

The t-test results of the average scores of each dimension of the students' attitude scale towards the topic of derivatives according to the "track of study" variable are presented in Table 5.

Table 5. *T-Test Results of The Average Scores of Students for Each Dimension of The Attitude Scale Towards the Topic of Derivatives Based on the "Track of Study" Variable*

Dimensions	Track of Study	n	Mean	Standard Deviation	t (216)	p
Behavioral	Science	133	3.44	1.00	5.488	.000
	Equal Weight	85	2.64	1.11		
Cognitive	Science	133	2.88	.90	4.156	.000
	Equal Weight	85	2.32	1.06		
Problem-solving	Science	133	3.24	.99	2.884	.004
	Equal Weight	85	2.85	.95		

When Table 5 is examined, the average scores of students in the behavioral, cognitive, and problem-solving dimensions show a statistically significant difference based on the track type. Accordingly, it can be said that students in the science track have significantly higher attitudes in each dimension compared to students in the equal weight track.

The t-test results of the average scores of each dimension of the students' attitude scale towards the topic of derivatives according to the "participation in courses/tutoring" variable are presented in Table 6.

Table 6. *T-Test Results of The Average Scores of Students for Each Dimension of The Attitude Scale Towards the Topic of Derivatives Based on the "Participation in Courses/Tutoring" Variable*

Dimensions	Participation in Courses/Tutoring	n	Mean	Standard Deviation	t (220)	p
Behavioral	Yes	53	3.42	1.19	2.192	.029
	No	169	3.04	1.07		
Cognitive	Yes	53	2.84	1.04	1.189	.236
	No	169	2.65	1.02		
Problem-solving	Yes	53	3.31	.96	1.743	.083
	No	169	3.04	1.02		

According to Table 6, the average scores of students in the cognitive and problem-solving dimensions do not show a statistically significant difference based on whether they attend a course/private tutoring. However, the average scores in the behavioral dimension show a statistically significant difference based on this variable. In this case, it can be said that students who attend courses/private tutoring have significantly higher attitudes in the behavioral dimension compared to those who do not attend.

The Pearson Correlation Analysis results regarding the relationship between the average scores of each dimension of the students' attitude scale towards the topic of derivatives and their first-term mathematics grades are presented in Table 7.

Table 7. *Pearson Correlation Analysis Results for The Relationship Between Students' Average Scores for Each Dimension of The Attitude Scale Towards the Topic of Derivatives and Their First-Term Mathematics Grades*

Dimensions	First-Term Mathematics Grades
Behavioral	Pearson r =.478** p=.000
Cognitive	Pearson r =.204** p=.003
Problem-solving	Pearson r =.338** p=.000

**p < .01

In Table 7, it can be seen that there is a moderate, positive, and statistically significant relationship between students' average scores in the behavioral and problem-solving dimensions and their first-term mathematics grade. Additionally, according to Table 7, there is a low-level, positive, and statistically significant relationship between students' average scores in the cognitive dimension and their first-term mathematics grade.

The Pearson Correlation Analysis results for the relationship between students' average scores for each dimension of the attitude scale towards the topic of derivatives and their level of liking the mathematics are presented in Table 8.

Table 8. *Results of The Pearson Correlation Analysis of The Relationship Between Students' Average Scores for Each Dimension of The Attitude Scale Towards the Topic of Derivatives and Their Level of Liking Mathematics*

Dimensions	Level of Liking Mathematics
Behavioral	Pearson r =.397** p=.000
Cognitive	Pearson r =.205** p=.002
Problem-solving	Pearson r =.313** p=.000

**p < .01

In Table 8, it is observed that there is a moderate, positive, and statistically significant relationship between the average scores in the behavioral and problem-solving dimensions and the level of liking mathematics. According to Table 8, there is a low-level, positive, and statistically significant relationship between the average scores in the cognitive dimension and the level of liking mathematics.

The results of the Pearson Correlation Analysis of the relationship between the average scores for each dimension of the students' attitude scale towards the topic of derivatives and their level of understanding of the derivative topic are presented in Table 9.

Table 9. *Pearson Correlation Analysis Results of The Relationship Between the Average Scores of Each Dimension of The Students' Attitude Scale Towards the Topic of Derivatives and Their Levels of Understanding of The Derivative Topic*

Dimensions	Level of Understanding the Topic of Derivatives
Behavioral	Pearson r =.585** p=.000
Cognitive	Pearson r =.301** p=.000
Problem-solving	Pearson r =.258** p=.000

**p < .01

In Table 9, it is seen that there is a moderate, positive, and statistically significant relationship between the students' average scores in the behavioral and cognitive dimensions and their levels of understanding of the derivative topic. According to Table 9, there is a low-level, positive, and statistically significant relationship between the students' average scores in the problem-solving dimension and their levels of understanding of the derivative topic.

The Pearson Correlation Analysis results of the relationship between the average scores of each dimension of the students' attitude scale towards the derivative topic and the teacher's ability to explain the derivative topic are presented in Table 10.

Table 10. *Pearson Correlation Analysis Results of the Relationship Between the Average Scores of Students for Each Dimension of the Attitude Scale Towards the Topic of Derivatives and the Teacher's Ability to Explain the Topic of Derivatives*

Dimensions	Teacher's Ability to Explain the Topic of Derivatives	
Behavioral	Pearson r =.211**	p=.002
Cognitive	Pearson r =.075	p=.268
Problem-solving	Pearson r =.153*	p=.022

$^{**}p < .01$ $^{*}p < .05$

Table 10 shows that there is a low, positive, and statistically significant relationship between students' average scores in the behavioral and problem-solving dimensions and the teacher's ability to explain the topic of derivatives. Additionally, Table 10 indicates that there is no statistically significant relationship between students' average scores in the cognitive dimension and the teacher's ability to explain the topic of derivatives.

The Pearson Correlation Analysis results of the relationship between the average scores of students for each dimension of the attitude scale towards the topic of derivatives and weekly mathematics study hours are presented in Table 11.

Table 11. *Pearson Correlation Analysis Results of the Relationship Between Students' Average Scores on Each Dimension of the Attitude Scale Towards Derivatives and Weekly Mathematics Study Hours*

Dimensions	Weekly Study Hours for Mathematics	
Behavioral	Pearson r =.345**	p=.000
Cognitive	Pearson r =.041	p=.544
Problem-solving	Pearson r =.220**	p=.001

$^{**}p < .01$

According to Table 11, there is a moderate, positive, and statistically significant relationship between students' average scores in the behavioral dimension and their weekly mathematics study hours. There is a low-level, positive, and statistically significant relationship between students' average scores in the problem-solving dimension and their weekly mathematics study hours. However, there is no statistically significant relationship between students' average scores in the cognitive dimension and their weekly mathematics study hours.

The Spearman Brown Correlation Analysis results of the relationship between students' average scores on each dimension of the attitude scale towards derivatives and weekly derivative study hours are presented in Table 12.

Table 12. *Spearman Brown Correlation Analysis Results for the Relationship Between Average Scores of Each Dimension of the Students' Attitude Scale Towards Derivatives and Weekly Derivative Study Hours*

Dimensions	Weekly Study Hours for Derivatives	
Behavioral	Spearman r =.456**	p=.000
Cognitive	Spearman r =.212**	p=.002
Problem-solving	Spearman r =.302**	p=.000

$^{**}p < .01$

Table 12 shows that there is a moderate, positive, and statistically significant relationship between the average scores of students in the behavioral and problem-solving dimensions and the number of weekly derivative study hours. According to Table 12, there is also a low-level, positive, and statistically significant relationship between the average scores in the cognitive dimension and the number of weekly derivative study hours.

Discussion and Conclusion

In this study, which examined the attitudes of 12th-grade high school students towards the topic of derivatives, it was found that the students' attitudes towards the behavioral, cognitive, and problem-solving dimensions of the derivative topic were at a moderate level. Accordingly, it can be said that the students' attitudes towards acting in accordance with their feelings about derivatives, understanding, storing, and applying derivatives in daily life, conducting research and examination related to derivatives, and solving questions about this topic are at a moderate level.

Students' attitudes towards the behavioral, cognitive, and problem-solving dimensions do not show a statistically significant difference based on gender. Similarly, in the study conducted by Kara and Yalçınkaya (2017), no statistically significant difference was observed when evaluating teacher candidates' attitudes towards derivatives based on gender. The research by Çelik and Ceylan (2009) also found no significant difference in high school students' attitudes towards mathematics based on gender. Similarly, Çelik and Bindak's (2005) study did not find a statistically significant difference in teacher candidates' attitudes towards mathematics based on gender. Based on this study and other research findings, it can be concluded that gender does not have any effect on students' attitudes towards mathematics classes or the topic of derivatives.

In the study, it was found that the attitudes of Anatolian High School students towards the behavioral and problem-solving dimensions were significantly higher compared to those of İmam Hatip High School students. The attitudes of students in science tracks were significantly higher towards each dimension compared to those in equal weight tracks. Furthermore, students who participated courses/tutoring centers had significantly higher attitudes towards the behavioral dimension compared to those who did not attend. In contrast to these findings, Çelik and Bindak (2005) found no relationship between students' attendance at tutoring centers and their attitudes towards mathematics. Çelik and Ceylan (2009) determined that the attitudes of science high school students towards mathematics were significantly different from those of students in other types of high schools. However, Duru et al. (2005) found that students' attitudes towards mathematics did not show a significant difference based on the type of high school they graduated from. Based on these findings, it may be challenging to draw a definitive conclusion about the impact of school type and participation in courses/tutoring centers on students' attitudes towards the topic of derivatives. This situation indicates that various factors, such as teaching methods applied in schools or courses/tutorial centers, may influence students' attitudes toward the topic of derivatives. However, for the generalizability of these findings, studies with larger samples and more students from different types of schools should be conducted.

In the study, it was found that there is a moderate, positive, and statistically significant relationship between students' attitudes towards the behavioral and problem-solving dimensions and their first-term mathematics grades, as well as their enjoyment of math. For the cognitive dimension, a low-level, positive, and statistically significant relationship was found with first-term mathematics grades and enjoyment of mathematics. Similarly, Peker and Mirasyedioğlu (2003) examined the relationship between high school sophomores' math attitude scores and achievement scores, finding a moderate, positive, and significant relationship between students' attitudes towards math and their achievement scores. Elalmış et al. (2023) found in their research that a positive attitude towards math has a positive impact on academic success. Eldemir (2006) highlights that the lack of desired success in math is largely due to the development of negative attitudes towards the subject. Therefore, it can be said that as high school students' attitude scores towards math/the topic of derivatives increase, their math achievement scores may also improve.

In this study, it was determined that there was a medium level, positive and statistically significant relationship between students' attitudes towards behavioral and cognitive dimensions and their level of understanding of the derivative topic, and a low level, positive and statistically significant relationship between students' attitudes towards problem solving dimensions and their level of understanding of the derivative topic. Additionally, a low-level, positive, and statistically significant relationship was found between students' attitudes towards the behavioral and problem-solving dimensions and the teacher's ability to explain the topic of derivatives. This finding indicates that there is, albeit a weak one, a relationship between the teacher's ability to explain the topic of derivatives and students' attitudes towards the derivatives topic. Çeliköz and Duran (2017) found in their study that the teacher's efforts to help students understand mathematics had a positive impact on the students and assisted them in developing a positive attitude towards the subject. Based on these findings, it can be said that the teacher's ability to explain the lesson and their efforts to help students understand mathematics influence students' attitudes towards the topic of derivatives.

In the study, a moderate level of positive and statistically significant relationship was found between students' attitudes towards the behavioral dimension and their weekly mathematics study hours. A low level of positive and statistically significant relationship was found between attitudes towards the problem-solving

dimension and weekly mathematics study hours. Additionally, the study found a moderate level of positive and statistically significant relationship between attitudes towards the behavioral and problem-solving dimensions and weekly derivative study hours, and a low level of positive and statistically significant relationship between attitudes towards the cognitive dimension and weekly derivative study hours. Based on these findings, it can be said that students' study hours have a certain degree of impact on their attitude towards mathematics. In particular, the moderate relationship between the behavioral dimension and weekly study time suggests that students who study mathematics regularly and systematically may develop a more positive attitude towards the subject. However, the low-level relationship in the cognitive dimension indicates that study time alone is not sufficient, and that other variables, such as effective study strategies, are also important for students to make sense of the topic.

One of the topics in mathematics education that many students struggle with and find challenging is derivative (Akkaya, 2009). This study examines students' attitudes towards the topic of derivatives. The research findings indicate that students' attitudes towards derivatives are at a moderate level. To enhance students' attitudes towards derivatives, real-life applications of the derivative concept should be provided to help students better understand and relate to the topic. Since students in the science track have been found to have more positive attitudes towards derivatives, supplementary materials and additional studies should be prepared specifically for students in the equally weighted track. To improve the attitudes of Imam Hatip High School students towards derivatives, mathematics support programs tailored to school types can be developed. Given that participation in private tutoring and courses has shown positive effects in some aspects, offering free mathematics courses in schools may help improve students' attitudes. As there is a positive relationship between students' attitudes towards derivatives and the teacher's ability to explain the topic, teachers should be encouraged to participate in professional development training. Considering that students' attitudes towards derivatives are related to their study time, guidance services should be enhanced to help students develop effective study habits. Implementing these recommendations may contribute to improving students' attitudes towards derivatives. Future research should examine the effects of different variables and be conducted with a larger sample size.

Declarations

Acknowledgements: This study is derived from the first author's non-thesis master's project, conducted under the supervision of the second author.

Authors' contributions: All authors contributed to the study. The first author was involved in literature review, data collection, analysis and writing. The second author contributed to conceptualization, literature review, design, methodology, analysis, writing, review, editing, and supervision.

Competing interests: The authors declare no conflict interests.

Funding: There is no grant support in this study.

Ethics Committee Decision: All procedures performed in studies involving human participants were in accordance with the ethical standards. The ethical committee approval for this study was obtained from the Social Sciences Ethics Committee at Dicle University (Registration Number is E-14679147-663.05-720106).

References

Akdemir, Ö. (2006). *İlköğretim öğrencilerinin matematik dersine yönelik tutumları ve başarı güdüsü* [Yayımlanmamış yüksek lisans tezi]. Dokuz Eylül Üniversitesi.

Akkaya, E. (2009). *Matematik öğretmen adaylarının türev kavramına ilişkin teknolojik pedagojik alan bilgilerinin öğrenci zorlukları bağlamında incelenmesi* [Yayımlanmamış yüksek lisans tezi]. Marmara Üniversitesi.

Aksoy, Y. (2007). *Türev kavramının öğretiminde bilgisayar cebir sistemlerinin etkisi* [Yayımlanmamış doktora tezi]. Gazi Üniversitesi.

Altun, H., & Yılmaz, S. (2016). İlköğretim matematik öğretmenliği lisans öğrencilerinin türev konusundaki akademik başarıları ile öğrenme stilleri arasındaki ilişkilerin incelenmesi. *Batı Anadolu Eğitim Bilimleri Dergisi*, *7*(13), 161-182.

Aybek, E.C. (2021). *Data preparation for factor analysis.* https://shiny.eptlab.com/dp2fa/

Aydın, B., & Doğan, M. (2012). Matematik öğretimi: Geçmişten günümüze matematik öğretimi önündeki engeller. *Batman Üniversitesi Yaşam Bilimleri Dergisi*, *1*(2), 89-95.

Bayram, N. (2013). *Yapısal eşitlik modellemesine giriş, AMOS uygulamaları*. Ezgi Kitabevi.

Büyüköztürk, Ş. (2011). *Sosyal bilimler için veri analizi el kitabı.* Pegem Akademi Yayıncılık.

Çavdar, D., & Şahan, H. H. (2019). Matematik dersinde akademik başarı, öz yeterlik ve matematik dersine yönelik tutum arasındaki ilişkinin incelenmesi. *Necatibey Eğitim Fakültesi Elektronik Fen ve Matematik Eğitimi Dergisi*, *13*(2), 979-999. https://doi.org/10.17522/balikesirnef.605618

Çelik, H. C., & Bindak, R. (2005). Sınıf öğretmenliği bölümü öğrencilerinin matematiğe yönelik tutumlarının çeşitli değişkenlere göre incelenmesi. *Kastamonu Eğitim Dergisi*, 427-436.

Çelik, H. C., & Ceylan, H. (2009). Lise öğrencilerinin matematik ve bilgisayar tutumlarının çeşitli değişkenler açısından karşılaştırılması. *Pamukkale Üniversitesi Eğitim Fakültesi Dergisi*, 26, 92-101.

Çeliköz, N., & Duran, B. (2017). Öğretmen davranışlarının matematik başarısı üzerindeki etkisinin 8. sınıf öğrenci görüşleri bağlamında incelenmesi. *Ahi Evran Üniversitesi Kırşehir Eğitim Fakültesi Dergisi*, *18*(3), 564-585.

Çokluk, Ö., Şekercioğlu, G., & Büyüköztürk, Ş. (2012). *Sosyal bilimler için çok değişkenli istatistik SPSS ve LİSREL uygulamaları*. Pegem Akademi Yayıncılık.

Demirhan, G., & Altay, F. (2001). Lise birinci sınıf öğrencilerinin beden eğitimi ve spora ilişkin tutum ölçeği. II. *Spor Bilimleri Dergisi*, *12*(2), 9-20.

Dowker, A., Cheriton, O., Horton, R., & Mark, W. (2019). Relationships between attitudes and performance in young children's mathematics. *Educational Studies in Mathematics, 100*(3), 211–230. https://doi.org/10.1007/s10649-019-9880-5

Duru, A., Akgün, L., & Özdemir, M. E. (2005). İlköğretim öğretmen adaylarının matematiğe yönelik tutumlarının incelenmesi. *Atatürk Üniversitesi Kazım Karabekir Eğitim Fakültesi Dergisi*, (11), 520-536.

Elalmış, S., Demirkıran, F., & Doğan, E. E. (2023). Matematik dersine yönelik tutum ile başarı arasındaki ilişki: Bir TIMSS Çalışması. *Edebiyat Dilbilim Eğitim ve Bilimsel Araştırmalar Dergisi*, *2*(1), 145-157.

Eldemir, H.H. (2006). *Sınıf öğretmeni adaylarının matematik kaygısının bazı psiko-sosyal değişkenler açısından incelenmesi* [Yayımlanmamış yüksek lisans tezi]. Cumhuriyet Üniversitesi.

Field, A. (2009). *Discovering statistics using SPSS* (3.Baskı). Sage Publications.

Fraenkel, J. R., & Wallen, N. E. (2009). *How to design and evaluate research in education* (7. Edition). McGraw-Hill.

Gezer, M., & İlhan, M. (2023). Revize edilmiş çevresel kimlik ölçeğinin Türkçeye uyarlanması: Öğretmen adayları üzerinde geçerlik ve güvenirlik çalışması. *International Journal of Geography and Geography Education*, (49), 97-114. https://doi.org/10.32003/igge.1243408

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling*, *6*(1), 1-55. https://doi.org/10.1080/10705519909540118

İnceoğlu, M. (2000). *Tutum algı iletişim*. Beykent Üniversitesi Yayınları.

Kara, M., & Yalçınkaya, İ. (2017). İlköğretim matematik öğretmen adaylarının türev konusuna yönelik tutum ölçeğinin geliştirilmesi ve farklı değişkenler açısından değerlendirilmesi. *Uluslararası Eğitim Bilimleri Dergisi*, (10), 169-188.

Kara, Y., & Özkaya, A. (2022). Ortaokul öğrencilerinin matematik motivasyonları, tutumları ve başarıları arasındaki ilişkinin incelenmesi. *International Journal of Educational Studies in Mathematics*, *9*(1), 33-48.

Karasar, N. (2011). *Bilimsel Araştırma Yöntemi***.** Nobel Yayıncılık.

Kiwanuka, H. N., Van Damme, J., Van den Noortgate, W., & Reynolds, C. (2020). Temporal relationship between attitude toward mathematics and mathematics achievement. *International Journal of Mathematical Education in Science and Technology*, 51, 1–25. https://doi.org/10.1080/0020739x.2020.1832268

Kline, R. B. (2011). *Principles and practice of structural equation modeling*. The Guilford Press.

Ministry of National Education. (2024). *Secondary education mathematics curriculum*. https://mufredat.meb.gov.tr/

Oral, B. (2004). Eğitim fakültesi öğrencilerinin öğretmenlik mesleğine ilişkin tutumları. *Eurasian Journal of Educational Research, 15,* 88-98.

Peker, M., & Mirasyedioğlu, Ş. (2003). Lise 2. sınıf öğrencilerinin matematik dersine yönelik tutumları ve başarıları arasındaki ilişki. *Pamukkale Üniversitesi Eğitim Fakültesi Dergisi*, *14*(14), 157-166.

Raines-Eudy, R. (2000). Using structural equation modeling to test for differential reliability and validity: An empirical demonstration. *Structural Equation Modeling*, *7*(1), 124-141. https://doi.org/10.1207/S15328007SEM0701_07

Saracoğlu, F. (2016). *İlköğretim altıncı sınıf öğrencilerinin matematik başarıları ve matematik dersine yönelik tutumlarının incelenmesi*

[Yayımlanmamış yüksek lisans tezi]. Ahi Evran Üniversitesi.

Seçer, İ. (2015). *Psikolojik test geliştirme ve uyarlama süreci, SPSS ve LISREL uygulamaları.* Anı Yayıncılık.

Şimşek, Ö. F. (2007). *Yapısal eşitlik modellemesine giriş (Temel ilkeler ve LİSREL uygulamaları).* Ekinoks Publishing.

Tabachnick, B. G., & Fidell, L. S. (2001). *Using multivariate statistics*. Allyn & Bacon.

Tabuk, M. (2019). Matematik başarısı ve matematiğe ilişkin tutum: Meta-analiz çalışması. *Marmara Üniversitesi Atatürk Eğitim Fakültesi Eğitim Bilimleri Dergisi*, *49*, 167-186.

Taşdemir, C. (2009). İlköğretim ikinci akdeme öğrencilerinin matematik dersine karşı tutumları: Bitlis ili örneği. *Dicle Üniversitesi Ziya Gökalp Eğitim Fakültesi Dergisi*, (12), 89-96.

Tezbaşaran, A. A. (1997). *Likert tipi ölçek geliştirme klavuzu*. Türk Psikologlar Derneği.

Yenilmez, K., & Özabacı, N. Ş. (2003). Yatılı öğretmen okulu öğrencilerinin matematik ile ilgili tutumları ve matematik kaygı düzeyleri arasındaki ilişki üzerine bir araştırma. *Pamukkale Üniversitesi Eğitim Fakültesi Dergisi*, *14*(14), 132-146.

Yıldız, N. (2006). *Matematik eğitiminde türev öğrenimi ve öğretimi ile ilgili sorulmuş bazı etkin sorular ve cevapları hakkında öğrencilerin ve öğretim elemanlarının görüşleri üzerine bir fenomenografik çalışma* [Yayımlanmamış yüksek lisans tezi]. Gazi Üniversitesi.