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The Correlation between Perfectionism and Cognitive Flexibility with Math Learning in Students: The Mediating Role of Achievement Anxiety

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ABSTRACT

The present study was conducted to investigate the mediating role of achievement anxiety in the relationship between perfectionism and cognitive flexibility in math learning in students. The study was correlational using structural equation modeling. The statistical population included senior high school female students in the academic year of 2022-2023. According to the obvious variables, allocation of 25 coefficients, and taking into account the incomplete questionnaires, 231 students were selected by convenience sampling. The instruments included Hewitt and Flett's perfectionism (1991) questionnaire, Dennis and Vander Wal's cognitive flexibility (2010) questionnaire, and Alpert and Haber's achievement anxiety (1960) questionnaire. Also, the students' math scores at the end of the semester were used to measure their math learning. The data were analyzed by Pearson's correlation coefficient test and structural equation modeling using SPSS18 and AMOS24 software. The results showed that perfectionism and achievement anxiety have a negative direct effect, and cognitive flexibility has a positive direct effect on math learning. Also, perfectionism and cognitive flexibility have an indirect effect on math learning through achievement anxiety. The research model was also confirmed and the result showed that the variable measurement models have a good fit and 41% of the math learning variance is explained by the research variables. The findings of this research can be beneficial for teaching and learning of students. With educational planning and helping students, their cognitive capacities and competencies can be increased and their mathematical learning can be effectively improved.

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Introduction

Mathematical science is always considered a difficult subject, so educational experts, professors, and teachers in this field have made many efforts to improve the learning of mathematics among students (Ayatollahi et al., 2024). We use numbers and fractions every day, while some mathematical competencies beyond basic arithmetic are required in most professions. Basic mathematics, i.e. elementary arithmetic and geometry, and some elements of calculus, are taught in school, not just for everyday life, but as tools for many different jobs (Martignon et al., 2023). Numerous factors play a role in math learning, and the variables of perfectionism, cognitive flexibility, and achievement anxiety can be important.

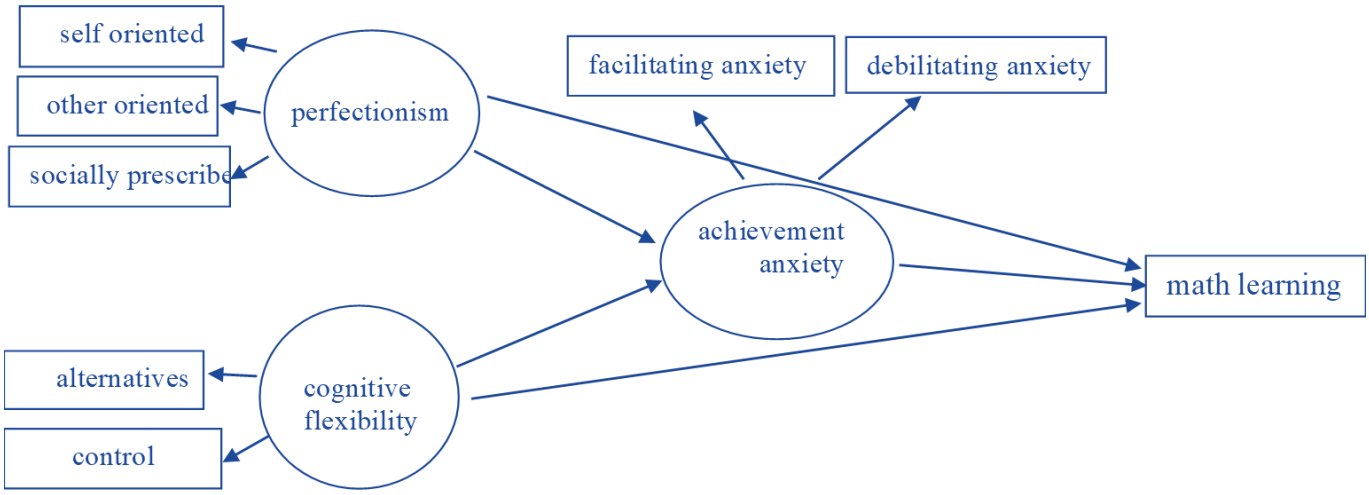
Cognitive flexibility involved in the process of learning mathematics reflects the ability to switch quickly between tasks or stimulus sets, and this ability is related to the learners' academic achievement (Feng et al., 2020). It assists humans in adapting to novel and changing environments (Zmigrod et al., 2019). Math academic beliefs such as metacognitive and motivational beliefs can affect self-regulation and math anxiety (Balali et al., 2023). Cognitive abilities have significant involvement in learning mathematics, especially cognitive flexibility, since it is a complicated branch of science and cannot be comprehensively learned by rote; therefore, students have to confront issues through their ideas and innovation, originated from their cognitive flexibility (Siregar et al., 2022).

Perfectionism as another important variable in math learning refers to a kind of individual attitude towards a work and striving to improve and perfect one's work. In students, this attitude can lead to extremism, which increases anxiety and lowers self-confidence. Students who are highly perfectionistic may feel overwhelmed when faced with mathematical problems that require accurate and error-free solutions (Buzzai et al., 2020). It is the important predictor of negative psychological outcomes such as anxiety (Felt & Hewitt, 2002). Perfectionism is a personality trait that profoundly impacts individuals' work, study, and life (Fang & Liu, 2022). Soleymani and Rekabdar (2010) stated that all dimensions of perfectionism, including parental perceptions, concerns over mistakes, doubts about actions, organization, and personal standards positively correlate with mathematics performance. Moreover, according to the research of Nunes-Pena and Bono (2021), there are positive relationships between concerns over errors, doubts about actions, and math anxiety. These variables also have negative correlations with academic achievement in general. Additionally, adaptive perfectionism is positively correlated with mathematics achievement, while maladaptive perfectionism has a negative relationship with that (Buzzai et al., 2020). Perfectionism has a direct effect on math anxiety, and with the mediation of math attitude, it has an indirect effect on math anxiety (Naderi Dehsheykh et al., 2021). According to the study of Afshar et al. (2011), those who are suffering from negative perfectionism are more susceptible to anxiety disorders, while positive perfectionism is a preventive factor. The research results of Mohammadi Nejad and Mohammadi Ahmadabadi (2023) showed that perfectionism has a positive relationship with math anxiety. Students with passive and maladaptive perfectionism indicated higher levels of math anxiety as they are extremely concerned about their mistakes and have more doubt over their actions in mathematics (Moore, 2010). Students who felt external pressure to be perfect (i.e., socially prescribed perfectionism) reported lower levels of math self-efficacy, as well as higher levels of negative physiological and affective states (Ford et al., 2023). Additionally, Burgess and DiBartolo (2016) stated that individuals with high personal standards of perfectionism illustrated more perfectionism cognition, contingent self-worth, as well as high levels of anxiety in performances.

Perfectionism and cognitive flexibility are highly effective in this regard. These factors, as well as academic achievement, and mathematics performance in particular, are under the control of academic anxiety as it interferes with concentration and memory which are inseparable from academic success (Hooda & Saini, 2017). Babaei et al.'s research (2023) showed that cognitive flexibility has a significant impact on anxiety and mental health. Also, the study by Wilson et al. (2018) has shown those who have a higher levels of anxiety traits showed reversal learning performance. If they face a lot of anxiety, this ability may decrease. This type of anxiety refers to the fear of inability and failure in learning and academic progress. Students suffering from this type of anxiety may refuse to try or perform less effectively when faced with mathematical challenges. Learning math requires practice, problem solving, and understanding complex concepts. Students who face high anxiety may be less successful in this process (Gökçe & Güner, 2024). In this regard, achievement anxiety can act as a mediating factor that regulates the relationship between perfectionism and cognitive flexibility with math learning by increasing or decreasing the anxiety. For example, perfectionist students who are highly perfectionistic and have little cognitive flexibility may be overly afraid of making mistakes and this fear leads to achievement anxiety which can become mathematical learning (Barroso, 2021). The previous research indicated relationships

between perfectionism, cognitive flexibility, and academic performance, but the mediating role of achievement anxiety in relation to perfectionism and cognitive flexibility in learning mathematics has not been investigated. Thus, this research investigated the mediating role of achievement anxiety in relation to perfectionism and cognitive flexibility in math learning in students.

Figure 1
Conceptual Model



Method

Design

This research was an applied research, with correlational type using structural equation modeling method.

Participants

The statistical population of this research included senior high school female students of Gorgan in the academic year of 2022-2023. To determine the sample size, according to the number of observed variables and the allocation of a coefficient of 25 for each variable, and taking into account the possibility of incomplete questionnaires, 231 female students of the 10th grade, aged 15-16, were selected as the sample size using the convenience sampling method to answer the research questionnaires.

Instruments

Hewitt and Felt's Perfectionism Questionnaire

The perfectionism questionnaire (MPS) was created by Hewitt and Flett (1991) and has 30 questions with a Likert scale ranging from 5 to 1 with three subscales: self-oriented perfectionism, other-oriented perfectionism, and community-oriented perfectionism. In Hewitt and Flett's (1991) research, internal consistency for self-oriented perfectionism, other-oriented perfectionism, and socially prescribed perfectionism was equal to .88, .74, and .81 respectively. In the research of Farazi et al. (2013), the reliability of the questionnaire was obtained using Cronbach's alpha for self-centered, other-centered, and socially prescribed perfectionism, and total reliability was .87, .73, .67, and .69, respectively. Also, in the research of Badamchi et al. (2023), the reliability of the total score of the scale was obtained using Cronbach's alpha of .94.

Alpert and Haber's Achievement Anxiety Questionnaire

The achievement anxiety questionnaire was created by Alpert and Haber (1960) and has 19 items that measure academic achievement anxiety. The questionnaire has two subscales of facilitating anxiety and debilitating anxiety. In Iran, the validity of the questionnaire was obtained by correlating with the test anxiety scale of .51, and the reliability of the questionnaire was obtained by Cronbach's alpha method as .80 and .81 (Paki, 2012). Also, in the research of Bojnordi et al. (2019), the reliability of this tool was obtained using Cronbach's alpha method of .83.

Dennis and Vander Wal's Cognitive Flexibility Inventory

The cognitive flexibility inventory was created by Dennis and Vander Wal (2010) with 20 questions based on a 7-point Likert scale from 1 to 7 and has two subscales of alternatives and control. In the research of

Dennis and Vander wal (2010), its validity with the Beck depression questionnaire was .39 and with the flexibility scale of Martin and Robin was .75, and the reliability of the scale with Cronbach's alpha method for the whole scale, and the components of alternatives and control were .91, .84 and .91 respectively. Also, using the retest method, the reliability was .81, .77 and .75 respectively. In the study of Kohandani and Abolmaali Alhosseini (2017), internal consistency was obtained using Cronbach's alpha test for the total score of this questionnaire and the two factors of alternatives and control were equal to .89, .77, and .81 respectively. The total score of the cognitive flexibility questionnaire and its two factors, alternatives, and control, had a significant negative relationship with Beck's depression test, which was -.665, -.577, and -.597, respectively.

For data analysis, mean, and standard deviation were used for descriptive statistics, and Pearson's correlation method and structural equations were used for inferential statistics using SPSS18 and Amos24 software.

Findings

The following table shows the descriptive statistics of research variables such as mean, standard deviation, minimum and maximum scores.

Table 1
Descriptive Statistics of *Research Variables*

	Min	Max	Mean	Std. Deviation
Self oriented	14	34	23.74	2.82
Other oriented	16	40	28.72	4.04
Socially prescribed	20	49	34.19	4.00
Perfectionism	50	122	86.65	10.43
Alternatives	24	52	34.54	5.02
Control	15	52	34.03	8.04
Cognitive flexibility	44	109	76.76	14.08
Facilitating anxiety	10	45	27.93	8.25
Debilitating anxiety	15	49	28.59	6.53
Achievement anxiety	25	91	56.52	14.14
Math learning	10	19	14.48	1.77

Table 1 shows the descriptive data including mean and standard deviation of variables and subscales.

The following table shows the normality data of the variables.

Table 2
Tests of Normality

	Kolmogorov-Smirnov			Skewness & Kurtosis	
	Statistic	**df**	**Sig.**	**Skewness**	**Kurtosis**
Self oriented	.049	231	.200	-.14	.16
Other oriented	.058	231	.055	-.10	.16
Socially prescribed	.053	231	.200	-.21	.16
Perfectionism	.039	231	.200	-.17	.16
Alternatives	.065	231	.060	.38	.16
Control	.051	231	.200	-.01	.16
Cognitive flexibility	.057	231	.070	.00	.16
Facilitating anxiety	.059	231	.058	-.01	.16
Debilitating anxiety	.051	231	.200	.26	.16
Achievement anxiety	.052	231	.200	-.04	.16
Math learning	.077	231	.062	.225	.16

According to Table 2 and regarding the normality of the data with Kolmogorov-Smirnov and the Skewness

and Kurtosis, it can be concluded that the data were normal, and inferential analysis can be performed on the data.

The following table shows the relationship between perfectionism, cognitive flexibility and achievement anxiety with math learning.

Table 3
Correlation Matrix of *Variables*

	1	2	3	4	5	6	7	8	9	10	11
Self oriented	1	.89**	.92**	.97**	-.09	-.11*	-.1*	.33**	.34**	.35**	-.16**
Other oriented	.89**	1	.83**	.95**	-.11*	-.14*	-.13*	.28**	.31**	.31**	-.13*
Socially prescribed	.92**	.83**	1	.95**	-.13*	-.15**	-.15*	.31**	.32**	.33**	-.17**
Perfectionism	.97**	.95**	.95**	1	-.12*	-.14*	-.14*	.32**	.33**	.34**	-.16**
Alternatives	-.091	-.11*	-.13*	-.12*	1	.91**	.94**	-.21**	-.19**	-.21**	.32**
Control	-.11*	-.14*	-.15**	-.14*	.91**	1	.99**	-.26**	-.22**	-.25**	.36**
Cognitive flexibility	-.11*	-.13*	-.15*	-.14*	.94**	.99**	1	-.25**	-.21**	-.25**	.35**
Facilitating anxiety	.33**	.28**	.31**	.32**	-.21**	-.26**	-.25**	1	.82**	.96**	-.19**
Debilitating anxiety	.34**	.31**	.32**	.33**	-.19**	-.22**	-.21**	.82**	1	.94**	-.23**
Achievement anxiety	.35**	.31**	.33**	.34**	-.21**	-.25**	-.25**	.96**	.94**	1	-.22**
Math learning	-.16**	-.13*	-.17**	-.16**	.32**	.36**	.35**	-.19**	-.23**	-.22**	1

**significance level 0.01, *significance level 0.05

The results listed in Table 2 show a significant correlation between perfectionism, cognitive flexibility, and achievement anxiety with math learning at a significance level of .01.

The following table shows the fit indices of the research variables.

Table 4
The Fit Indices Obtained From the Analysis of the Variables

Indicator	Values obtained modification
χ2/df	2.59
RMSEA	.037
GFI	.999
NFI	.999
CFI	.998
DF	213

The value of RMSEA is equal to .039, so this value is less than 0.1, which indicates that the mean of the squared errors of the model is suitable and the model is acceptable. Also, the chi-square value of the degree of freedom (2.564) is between 1 and 3, and the GFI, CFI, and NFI indices are almost equal and greater than 0.9, which shows that the research variable measurement model is appropriate.

The following table shows weighted regression statistics and critical ratios of exogenous variables.

Table 5
Weighted Regression Statistics and Critical Ratios of Research Variables

Exogenous variable	direction	Endogenous variable	b	β	R^2	t	P
perfectionism	➔	math learning	-.238	-.152	.036	-2.31	.01
cognitive flexibility	➔	math learning	.371	.322	.119	3.76	.01

Table 5 shows the standardized and unstandardized values of the prediction paths of the exogenous research variables on the endogenous variable with each other according to the t value obtained in the model. In general, all the obtained values are significant and indicate a meaningful prediction.

Table 6

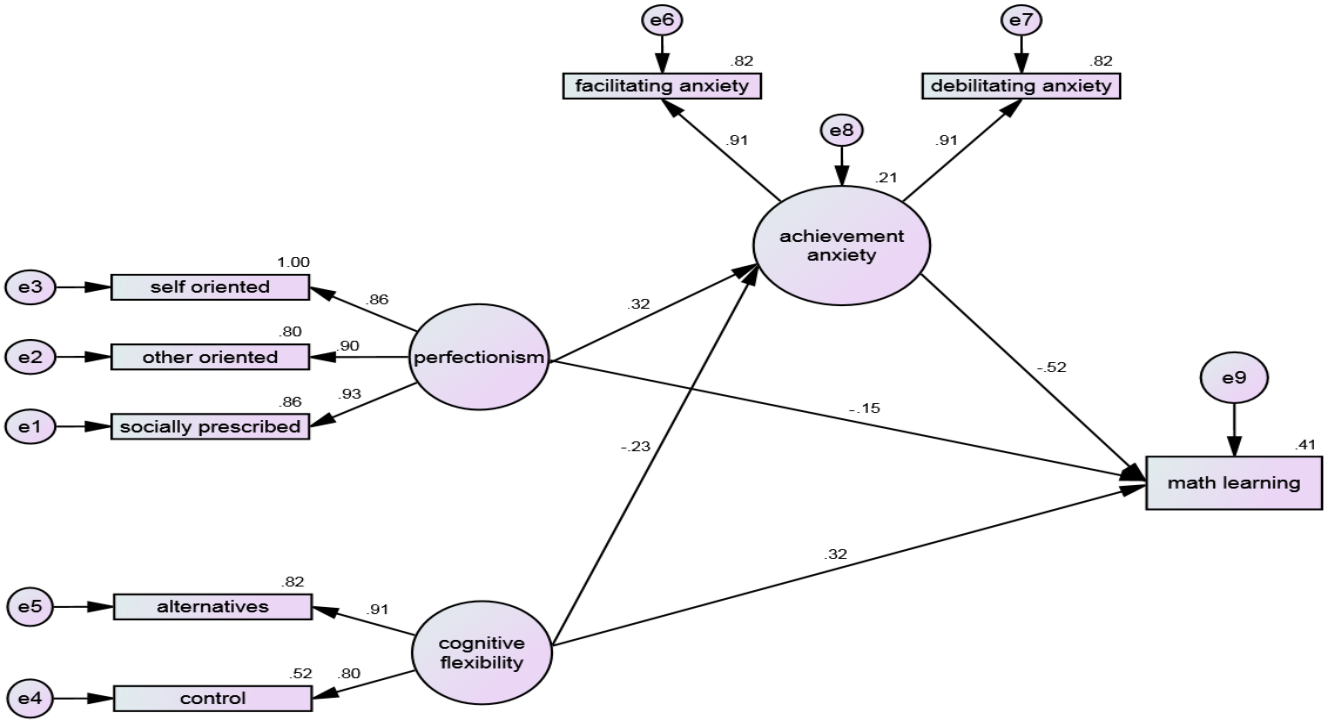
Indirect Model Estimation Using the Bootstrap Method

Variable	β	R^2	lower limit	upper limit	Sig.
perfectionism on math learning with the mediating role of achievement anxiety	-.403	.316	-.468	-.330	.01
cognitive flexibility on math learning with the mediating role of achievement anxiety	-.296	.190	-.351	-.227	.01

According to Table 6, the considered indirect paths according to the standardized values (β) in the indirect path, perfectionism, and cognitive flexibility on math learning with the mediating role of achievement anxiety were confirmed based on the bootstrap estimation method according to the significance level.

Figure 2

The Final Tested Model Along with the Standardized Prediction Statistics



Discussion

The present study was conducted to investigate the mediating role of achievement anxiety in the relationship between perfectionism and cognitive flexibility in math learning in students. The results showed that perfectionism and progress anxiety have a negative direct effect, and cognitive flexibility has a positive direct effect on math learning. Also, perfectionism and cognitive flexibility have an indirect effect on math learning through progress anxiety. The results of this research are in line with those of Ayatollahi et al. (2024), Savari (2020), Mohammadinejad and Mohammadi Ahmadabadi (2023), Martignon et al. (2023), as well as Siregar et al. (2022).

Learning mathematics and the factors affecting it in schools is a subject that has attracted many educational

theorists and researchers. Mathematical learning is affected by many emotional, cognitive, and emotional processes. Understanding mathematics is usually considered as a matter for career success and effective personal management in daily life; therefore, mathematics is considered as a vital subject in primary, secondary, and higher education (Baloglu & Kocak, 2006).

As a personality trait, perfectionism is a multidimensional construct characterized by striving for perfection and setting high standards for performance, along with a tendency to make highly critical evaluations of one's behavior and an oversensitivity to mistakes (Flett & Hewitt, 2002). Individuals with high perfectionism are characterized by an increased striving to be perfect and consistently set extreme standards for themselves, along with a tendency to make highly critical evaluations of their behavior (Young et al., 2004). They are not content with doing tasks well and it is not acceptable for them to perform better than others alone, but their satisfaction is achieved only when they complete their tasks without any mistakes and for this reason, they either do not take responsibility or leave it half-done. As a result, they fall academically (Ganji, 2013; quoted by Heidarian & Norouzi, 2014). Learning issues such as math are related to personality which can predict math learning ability in academic settings (Homayouni, 2011). Heidarian and Norouzi's research (2014) showed that there is a positive and significant relationship between negative perfectionism and test anxiety, and it is related to critical evaluations of personal performance, worry about mistakes, feelings of conflict between expectations and achievements, and anxiety. When appropriate strategies are not used, anxiety is created. Self-oriented perfectionism is related to the desire to succeed and the fear of failure (Flett & Hewitt, 2006). This means that self-centered perfectionism, in addition to being characterized by the desire to progress, is also motivated by the fear of failure. This concept refers to a person's ability to interact with new information and issues. Students who are flexible in this area are able to solve more complex and above-average math problems (McCaughey, 2022). Students with a perfectionist attitude usually seek to perform as well as possible and perform flawlessly. This can increase their stress and anxiety because they are always trying to meet their own and others' expectations (Isabel Nunez-Pena, & Bono, 2021).

Moreover, cognitive flexibility refers to the behavior that a person is able to adapt well to changes and facing new and unpleasant situations. Students with low cognitive flexibility may experience more anxiety when faced with the challenges of learning mathematics (Sinclair, 2022). Cognitive flexibility is considered an important aspect of executive function, which is defined as the ability to effectively adapt to variable tasks and is closely related to avoiding and directly facing problems in an individual's life because a person with flexibility has a wide range of responses, and can use and face problems more flexibly and effectively (Lee & Orsillo, 2014). Cognitive flexibility empowers a person against pressures, challenges, and emotional-social damages so that a person can deal with these situations appropriately and efficiently (Mollaei et al., 2020).

Conclusions

Cognitive flexibility is known as the key driver of behavior in complex and unstructured tasks, and it is a dynamic process and one of the important factors in social interactions, which is responsible for creating a positive adaptation of a person to the environment (Savar, 2020). In situations in which the problems of educational and academic life are faced, they try to consider different points of views and do not act hastily before obtaining sufficient information (Carbonella & Timpano, 2017).

Irrational fear and anxiety about mathematics hinder learning, and the subsequent possession of positive thinking causes peace in people, and fear causes loss of self-esteem, increased frustration, and academic failure (Gresham, 2004). The classroom is an emotional place where the students often experience various negative emotions. Negative academic emotions create anxiety, and negative and unfavorable effects on behavior and thoughts cause anger, shame, disappointment, and fatigue in learning, and cause a person to have low adaptability in education (Shahidi, 2014). Students can experience feelings of disappointment from the unfavorable results of their exams or the feeling of anxiety before the exam, etc., which harms the acquisition of new information, and problem-solving, and weakens academic performance (Stein, 2010). Students acquire attitudes to mathematics over time through direct experience of learning mathematics or receiving information about mathematics subjects (Mazana et al., 2019). The enjoyment of mathematics is how much the students enjoy doing and learning mathematics (Kupari & Nissinen, 2013). Students' enjoyment while learning can influence their behavior or cognitive aspects of attitude (Syyeda, 2016).

Mathematics is a main subject at all levels of education, and facing it correctly plays an important role in the future of students and the comprehensive development of the country. The importance of mathematics is not only limited to fields of study related to mathematics, such as mathematics, physics or experimental sciences, but many course materials in the

field of humanities, whether in high school or higher, deal with mathematics. Providing opportunities for math learning and self-efficacy can increase math learning performance (Wang et al., 2024). Therefore, learning mathematics is one of the life requirements of every member of society (Mirzaei & SanaiZavareh, 2017).

Learning math concepts or solving related problems for some students may be a source of anxiety. This can be due to the inability to understand the material or perform the exercises, which increases their anxiety (Milovanović, 2020). In general, the presence of achievement anxiety in students can be related to various factors such as perfectionism, cognitive flexibility, and learning difficulties, which cause problems in their mathematical learning. If the mathematical contents are similar to everyday problems, they can decrease anxiety in students (Homayouni & EbrahimiGhavam, 2014). To reduce these negative effects, it is necessary for teachers and educators to help students deal with their anxiety in a more effective way and teach them the necessary skills to solve mathematical problems along with the confidence necessary to face the challenges of this discipline.

The research is limited to female students and is not considered their educational background such as academic failure, so generalization should be done with caution. Also, this research has been done cross-sectional and it is better to examine the variables in a longitudinal research. It is suggested to use male samples in future research, conduct comparative research between male and female students, and make programs for teaching mathematics in different cultures and genders. It is also suggested that training courses be implemented for parents and students on the positive and negative aspects of perfectionism and educational anxieties. With educational planning and helping students, their cognitive capacities and competencies can increase and their mathematical learning can be effectively improved.

Conflicts of Interest

No conflicts of interst is declared.

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