Iranian Educational Psychology Association

Iranian Journal of Learning and Memory

Print ISSN: 2645 - 5455
Online ISSN: 2645 - 5457

Homepage: https://journal.iepa.ir

Structural Model of Math Anxiety with Math Self-efficacy and Math Attitude: Mediating Role of Numerical Memory

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Article Info

Article type:
Research Article

Article history:
Received August 07, 2023
Received in revised form October 24, 2023
Accepted November 01, 2023
Published onlin November 10, 2023

Keywords:
Math anxiety, Mathematics Attitude, Mathematics self-efficacy, Numerical memory

ABSTRACT

The aim of this study was to investigate the relationship of math anxiety with math self-efficacy and math attitude, considering the mediating role of numerical memory via the structural equation modeling. The research adopted a correlational method. The statistical population of the study comprised secondary school students from Oshnavieh city in Iran (N= 4280) in 2019. From this statistical population, 200 students were selected as the sample using the cluster random sampling method, and were administered the Plack and Parker math anxiety tests (1982), Wechsler Numerical Memory Scale (2003), Liu and Koirala Math Self-Efficacy Scale (2009) and the Fennma-Sherman Math Attitude Scale (1976). The structural equation modeling approach was used to examine the data using SPSS 26 and AMOS 26 software. The findings of the study indicated that students' math anxiety is directly influenced by numerical memory (p= 0.001), mathematical self-efficacy (p=0.01), and mathematical attitude (p=0.1). Additionally, it was observed that mathematical self-efficacy indirectly influences students' math anxiety via numerical memory (p= 0.05). Furthermore, the indirect effect of math attitude via numerical memory on students' math anxiety was not confirmed (p=0.54). Based on these findings, it can be concluded that it is imperative to address both math self-efficacy and math attitude to reduce students' math anxiety. Consequently, it is recommended that educators create an environment that fosters a positive attitude towards mathematics lessons and enhances students' self-efficacy in mathematics.

Cite this article: Sepehrianazar, F., Parvanevatan, F., & Hendusin, S. (2023). Structural Model of Math Anxiety with Math Self-efficacy and Math Attitude: Mediating Role of Numerical Memory. *Iranian Journal of Learning and Memory*, *6*(23), 16-26. https://doi.org/10.22034/iepa.2023.408577.1435

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Introduction

People require mathematics not only for school, but also for everyday life, work, and various opportunities. Educational systems emphasize the importance of mathematics, highlighting its multiple functions for the mental and logical development of students. It serves as a powerful tool for global understanding and communication (Sepherianazer & Babaei, 2014). Mathematical concepts are an essential component of the curriculum in educational systems across various societies, starting from preschool to higher education levels (Niyaie et al., 2021). Mathematics fosters logical reasoning, critical thinking, creativity, abstract and spatial thinking, problem-solving, and even excellent communication skills. Failure to attain educational objectives in mathematics can lead to weaknesses, limitations, and hindered achievements in other academic disciplines (Anarinejad et al., 2022).

One of the challenges in mathematics education is math anxiety which involves worry and unpleasant feelings, often originating from unclear sources (Pourghaz et al., 2020). It refers to a range of negative emotional responses, such as fear or worry (Cipora et al., 2022), particularly associated with mathematical stimuli or activities within educational environments (Lau et al., 2022) and everyday situations (Guzmán et al., 2023). According to the findings of International Assessment Report (PISA), a significant number of teenagers experience anxiety and tension in math classes and when doing mathematical operations (Luttenberger et al., 2018; cited by Anarinejad et al., 2018). Math anxiety is a psychological condition that affects individuals when they encounter mathematical material during teaching and learning, problem-solving, or evaluation. This situation often leads to increased distraction and intrusive thoughts, interfering with mental structures and information processing. Consequently, it distorts an individual's perception of mathematical phenomena and concepts (Sepehrianazar & Mahmudi, 2014).

Various factors can contribute to the development of math anxiety. For instance, unpleasant teaching and assessment strategies (Ashcraft & Moore, 2009; cited by Rozgonjuk et al., 2020), emotional factors like previous negative experiences with math and the fear of public embarrassment (Khasawneh et al., 2021). A study conducted by Zanabazar et al. (2023) on students from the National University of Mongolia (NUM) and the Mongolian State University of Education (MSUE) showed that inadequate instruction, poor communication between students and teachers, excessive assignments, and outdated resources can all contribute to the development of mathematics anxiety. In their study, math anxiety had a strong negative correlation with teacher-related factors and a weaker correlation with family and students' related factors.

The academic study of math anxiety traces back to early 1950s when Mary Fides Gough introduced the term 'math phobia' to describe pseudo-phobic feelings toward mathematics. Then, the first test to measure math anxiety was developed by Richardson and Suinn (1972). Since then, significant research has been conducted in this area. Neuropsychological research has demonstrated that negative thoughts in the face of mathematical situations notably decrease memory load and disrupt learning and performance (Anarinejad et al., 2021). Delgado Monge et al. (2017) reported a higher prevalence of math anxiety among female students compared to male students and among those attending public schools compared to private schools. However, Altakhaineh (2020) found no significant difference in math anxiety between male and female students in Oman. Studies have revealed that arithmetic anxiety can lead to physical, cognitive, and behavioral manifestations, such as perspiration and an elevated heart rate (Niyai et al., 2019).

Additionally, research has indicated that performance goals, authoritarian parenting style (Sepahrianazer et al., 2014), math attitude (Naderidehsheykh et al., 2021), and BIS (Arji et al., 2018) directly impact math anxiety. Math anxiety influences working memory capacity by reducing and constraining processing resources (Maldonado Moscoso et al., 2022). Consequently, interventions aimed at memory training play a significant role in alleviating students' math anxiety (Zolfi and Rezaei, 2014). Numerical memory is one of the important factors in understanding and learning mathematics. Numerical memory refers to the ability to remember and recall numbers, and this ability is different in multiple people (Gasemi, et al., 2019). In teaching young children how to count, a logarithmic number line, with greater spacing between smaller numbers on the left than larger numbers on the right, is often employed, despite its unrelatedness to their grasp of larger numbers. Subsequently, this number line transitions into a more linear form (Psychological Scientific Association, 2010). In their experiments, Thomson and Ziegler (2010) drew a line from zero to 20, with children hearing numbers from 1 to 19. After reading a story, the children were asked questions such as, 'How many forks did the protagonist wash?' The children had to determine the position of each number on the line. The results demonstrated that the more linear the child's number line was, the better their understanding of the linear relationship of numbers and their ability to recall the numbers.

Number memory improves with age; one of the sources of this improvement may be the learning of linear spatial-numerical associations. Opfer et al. (2020) investigated the ability of 39 children aged 3 to 5 to recall randomly generated numbers (1–20) after a delay and found that linear spatial-numerical maps may aid children's memory for numbers more effectively than other numerical skills. Pelegrina et al. (2020) indicated that individuals with math anxiety exhibit specific challenges in numerical tasks resulting from deficits in representation, attentional control, or working memory (WM). These individuals must retain information in WM while solving problems and performing mathematical operations simultaneously. Nikoubakht et al. (2019) demonstrated that computer-based education is more effective than traditional education in enhancing students' numerical memory. Additionally, Zamani and Pouratashi (2018) highlighted a positive and significant correlation among students' academic progress, working memory scores, and academic self-efficacy beliefs.

Another variable investigated in this study is ‘math self-efficacy’. According to Bandura's socio-cognitive theory, self-efficacy refers to an individual's belief in their ability to succeed in a particular situation or perform a task. Mathematical self-efficacy is defined as the judgment of one's ability to learn successfully in mathematics (Goose et al., 2008), which has a positive impact on students' academic performance (Sun et al. 2018). Sharifisaki et al. (2014) examined 400 students and demonstrated that math self-efficacy serves as the most reliable predictor of mathematical progress. Rozgonjuk et al. (2020) indicated that gender and low self-efficacy predict higher levels of math anxiety. Živković et al. (2023) in their study with 145 students, Shehnikaramzadeh et al. (2010) with 240 students, Arji et al. (2019) with 351 female students, Hejazi and Naghsh (2007) with 400 third-year high school students, and Aghajani et al. (2012) with 480 second-year high school students demonstrated a significantly strong negative correlation between math anxiety and mathematics self-efficacy. In a study conducted by Wang et al. (2023), involving a cohort of 400 10- to 11-year-old students in China, it was revealed that math anxiety exhibited a positive association with feelings of rejection while displaying a negative correlation with emotional warmth. Notably, math anxiety was found to be interrelated with perceptions of rejection and parental upbringing styles, with math self-efficacy acting as a mediator in this intricate relationship. Furthermore, the findings also indicated that male students exhibited lower levels of math anxiety and higher levels of math self-efficacy when compared to their female counterparts.

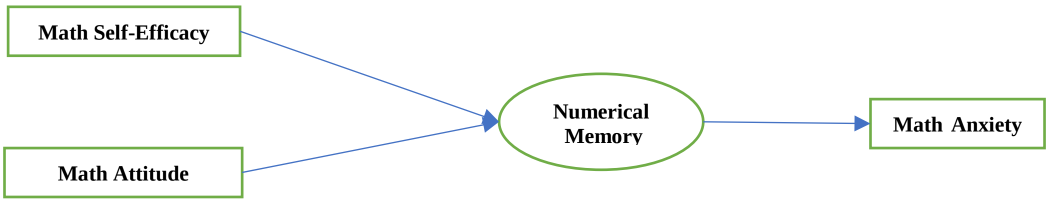
According to Johnston and Reid (1981; cited in Jung & Reid, 2009), students' attitude toward science is more crucial than their comprehension of the subject if they are going to apply their knowledge effectively. Several academics have deliberated on the concept of ‘mathematical mindset’. De-la-Peña et al. (2021) defined mathematics attitude as an individual's inclination toward mathematical tasks, influenced by their way of thinking, feeling, or acting. Rodríguez et al. (2020) regarded it as a student's beliefs about the efficacy and interest in engaging with mathematical assignments, while Lin and Huang (2014) classified it as exhibiting positive, negative, or neutral feelings toward mathematics. Wakhata et al. (2022) suggested that a positive attitude towards mathematics significantly impacts a student's overall success and the practical application of mathematics in real life. However, some students perceive mathematics as a strenuous and laborious subject, leading to feelings of anxiety and fear (Arnillo & Cruzado, 2014; as cited by Moussa & Saali, 2022), thereby hindering a favorable response to the subject (Ghanaat & Habibzadeh, 2021). Mutegi et al. (2021), in their study of 376 Kenyan students, Chaman and Callingham (2013) with 112 Indian students, Kargar et al. (2010) with 203 Malaysian students, and Rodriguez et al. (2020) with 897 5th and 6th grade Spanish students, demonstrated a positive correlation between negative attitudes toward math and math anxiety. Jung et al. (2009) assessed the numerical memory of 714 Korean students aged 12 to 14 using a picture intersection test and their attitude via a questionnaire, revealing that working memory is associated with students' attitude.

Few studies have examined self-efficacy, attitude toward math, numerical memory, and math anxiety within similar sample populations. Based on the aforementioned literature and the significance of exploring factors influencing math anxiety, this present study endeavored to address the direct and indirect effects of numerical memory, math self-efficacy, and math attitude on math anxiety via the following research question:

– Is the proposed model regarding the relationship between math attitude and math self-efficacy with math anxiety with the mediating role of numerical memory suitable?

To answer this research question, a model was formulated and tested. (Figure 1)

Figure 1.
Proposed Conceptual Model



Based on the formulated model, the following research hypotheses were proposed:

1- Numerical memory has a direct effect on the math anxiety.
2- Math self-efficacy has a direct effect on the numerical memory.
3- Math attitude has a direct effect on the numerical memory.
4- Math self-efficacy has an indirect effect on math anxiety via the numerical memory.
5- Math attitude through numerical memory has an indirect effect on the math anxiety.

Method

Design of the Study

This study adopted a correlational descriptive design using the structural equation modelling. In this research, math anxiety was the endogenous variable, math attitude and math self-efficacy are the exogenous variables, and numerical memory was the mediating variable.

Participants

The statistical population comprised first-grade of secondary school students from public schools. It is worth noting that, according to Homan (2015), a minimum of 20 samples is required for each sub-variable in structural equations. In the current study, there were a total of 7 sub-variables. Consequently, a sample of 140 was initially deemed necessary. However, considering the potential for questionnaire dropouts, 200 students aged 13-17 from four schools were selected as the study sample using the multi-stage random sampling method. The inclusion criteria were defined as follows: The student demonstrates a willingness to participate in the research by responding to the questionnaires and the student is enrolled in the first grade of secondary school. The exclusion criteria included the student unwillingness to collaborate with the researcher.

Instruments

Math Anxiety Scale

The students' math anxiety was measured using Pleck and Parker's math anxiety scale (1982), which was revised in 1982 by Richardson and Suinn. The scale comprises 24 statements on a 5-point Likert scale ranging from very slight anxiety (1) to high anxiety (5). The creators of the test initially reported the reliability of the entire test as 0.98 (Plake & Parker, 1982) while Blali et al. (2021) reported it as 0.88 and Sepehrianazar et al. (2014) indicated a Cronbach's alpha coefficient of 0.85 for this questionnaire. In the present study, the scale demonstrated high validity (X^2/df[1] = 1.83), RMSEA[2] = 0.06, GFI[3] = 0.80, and AGFI[4] = 0.83), with the factor loadings of the questions ranging from 0.41 to 0.70. Additionally, the reliability via the Cronbach's alpha was found to be 0.88.

Numerical memory test

To assess numerical memory, the Wechsler numerical memory test, a short-term memory test (Wechsler, 2003), was employed. This test comprises 14 questions, with each question carrying a maximum score of 4. The test's reliability has been assessed by various researchers, yielding the following results: Wechsler (2003) reported the reliability coefficient of the test to be 0.88. In Soleimani et al.'s study (2015), the Cronbach's alpha for this scale was reported as 0.76 and 0.79, and in Groth-Marnat's study (2003), it was reported as 0.93. In the present study, the test exhibited high validity (X^2/df = 1.95, RMSEA = 0.05, GFI = 0.91, and AGFI = 0.89) and the reliability via the Cronbach's alpha was determined to be 0.74.

Mathematical self-efficacy scale

To evaluate the students' mathematical self-efficacy, the scale of Liu and Koirala (2009) was used. It comprises 5 items measured on a 4-point Likert-type scale, ranging from never (1) to almost always (4). Considering the reliability of this questionnaire, Liu and Koirala (2009) reported the Cronbach's alpha coefficient of this

1 . Chi- Squar/Degrees of freedom
2 . Root Mean Square Error of Approximation
3. Goodness of Fit Index
4. Adjusted Goodness of Fit Index

questionnaire as 0.93 while Khayat Ghiasi (2020) reported the reliability coefficient of the test as 0.90. The validity of the test (X^2/df = 2.25, RMSEA = 0.06, GFI = 0.94, and AGFI = 0.92) indicates that the test exhibits a suitable fit. In the present study, the Cronbach's alpha was calculated to be 0.83.

Mathematical Attitude Questionnaire

The revised version of the Fennema-Sherman Mathematical Attitude Scale (2000) was employed to measure mathematical attitude. The questionnaire was originally developed by Fennema and Sherman in 1976 consisting of 27 items organized into three components. Participants rated each item on a five-point Likert scale, ranging from completely agree (1) to completely disagree (5). The reliability coefficient of the questionnaire was reported to be 0.91 by Shirbaigi and Hemmati (2010). The validity of test (X^2/df=3.21), RMSEA=0.10, GFI=0.64 and AGFI =0.61) indicates that the test demonstrates a suitable fit. The reliability obtained via Cronbach's alpha in this study was found to be 0.89.

Procedure

Before administrating the questionnaires, the students were assured that their responses would exclusively serve for research purposes, with a guarantee of the strict confidentiality of the obtained results. Then, they answered all the questionnaire. The data were subsequently analyzed using SPSS26 and AMOS26 software.

Results

The descriptive indices of the studied variables are shown in Table 1.

Table 1

Descriptive Statistics of the Variables

Variable	Mean	SD	Skewness	Kurtosis
Numerical memory	10.89	2.63	0.063	-0.750
Math Anxiety	65.01	17.62	-0.269	-0.746
Mathematical self-efficacy	55.24	13.44	-0.247	-0.108
Mathematical Attitude	96.4	16.16	0.128	-0.604

Based on the skewness and skewness in Table 1, which is between +2 and -2, the distribution of research variables is normal. The correlation matrix of research variables is presented in Table 2 to examine the relationship among the variables.

Table 2

Correlation Matrix of the Research Variables

Variable	Math Attitude	Math Self-Efficacy	Numerical Memory	Math Anxiety
Math Attitude	1*			
Math self-efficacy	0.64**	1		
Numerical memory	0.124**	0.16	1	
Math Anxiety	-0.46*	-0.52*	0.486**	1

*p ≤ 0.001 ** P≤ 0.05

Based on Table 2, math anxiety has a significant negative relationship with mathematical attitude, and self-efficacy and a significant positive relationship with numerical memory.

Table 3

Direct Effect Coefficients of Numerical Memory Variables, Self-Efficacy and Math Attitude on Math Anxiety

Direct effect			B	Beta	S.E.	C.R.	P
Numerical memory	→	**Math Anxiety**	0.14	0.931	0.396	2.347	0.0001
Math self-efficacy	→	**Math Anxiety**	-0.520	-0.42	0.077	-6.731	0. 01
Math Attitude	→	**Math Anxiety**	-0.243	-0.23	0.064	-3.809	0.01

Table 3 illustrates that the direct path coefficients of numerical memory with math anxiety (Beta = 0.931 and P = 0.001) and self-efficacy with math anxiety (Beta = -0.42 and P = 0.01) are significant. Additionally, the beta coefficient or direct path coefficient between math attitude and math anxiety (Beta = -0.23 and P = 0.01) was significant with a value of -0.23.

Table 4

Coefficients of the Indirect Effect of Math Attitude Variable and Math Self-Efficacy for Math Anxiety through Numerical Memory

Indirect effect	B	Beta	S.E.	C.R.	P
Math Attitude → Numerical memory → Math Anxiety	.931	0.04	0.007	.011	0.54
Math self-efficacy → Numerical memory → Math Anxiety	-.243	0.13	0.025	.014	0. 05

Table 4 demonstrates that the coefficient of the indirect path of math self-efficacy on math anxiety, with the mediating role of numerical memory, was found to be significant (Beta = 0.13 and P = 0.05). However, the coefficient of the indirect path of math attitude on math anxiety through numerical memory was not significant (Beta = 0.04 and P = 0.54). Therefore, based on the results, there is an indirect effect in the relationship between math attitude and math anxiety, and the mediating role of numerical memory was not significant.

Table 5

Goodness of Fit Indices of the Tested Research Model

X^2	P	df	X^2/df	GFI	AGFI	NFI	CFI	IFI	TLI	RMSEA
104.18	0.01	1	104/18	0.83	0.69	0.91	0.92	0.81	0.91	0.44

The fit indicators for the conceptual model of the current study are displayed in Table 5. A larger X^2 value indicates a lower fit of the model. However, X^2 is almost always statistically significant for models with a large sample size (Abareshi & Hosseini, 2013). In the current model, the X^2/df value was 104/18. The GFI value, ranging between zero and one, tends to indicate a better fit as it approaches one. In this research, the GFI index was 0.83. Additionally, an AGFI value of 0.85 or higher suggests a confirmed model fit (Abareshi et al., 2013). While the AGFI index in the present study was 0.69, the NFI (normalized fitness index) should ideally be above 0.90 (Abareshi et al., 2013), and in this study, the NFI value was 0.91. The CFI (Comparative Fit Index) and IFI (Incremental Fit Index) should be closer to 1, indicating a better model fit (Homan, 2014). The CFI value was 0.92, and the IFI value was 0.81. Additionally, an optimal value of the unnormalized fitness index TLI (Tucker Lewis Index) is considered to be 0.90, and the TLI value in this study was 0.92. Furthermore, a lower RMSEA value, closer to zero, signifies a more suitable model (Homan, 2014), and in this study, the RMSEA value was 0.44.

Figure 2 presents the coefficients of the direct and indirect effects of the paths leading to the math anxiety variable.

Figure 2

Direct and Indirect Path Analysis Model

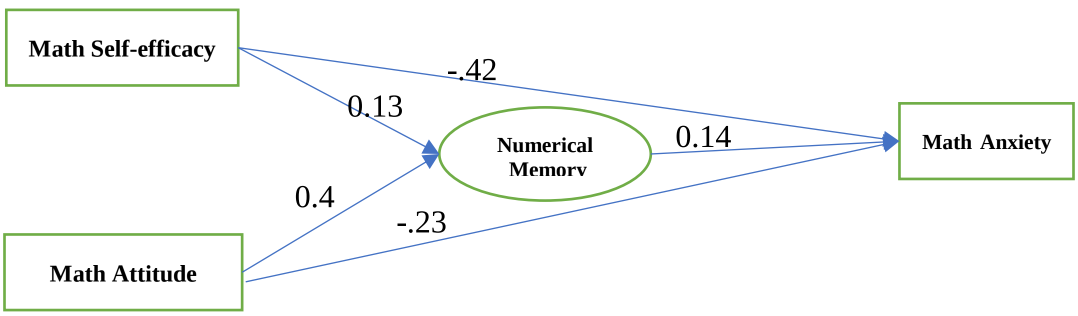


Diagram 2 displays the coefficients of the direct and indirect effects of the paths leading to the math anxiety variable. Based on the results presented in Tables 3, 4, and 5, the model demonstrated an average fit.

Discussion

The research findings confirm hypothesis 1 indicating a direct effect of numerical memory on math anxiety. This result is consistent with the research findings of Zolfi et al. (2014), Thomson et al. (2010), and Pellegrina et al. (2020). Additionally, the study results are aligned with those of Holmes et al. (2009) suggesting that memory training can alleviate students' difficulties in mathematics.

In explanation of this finding, it can be stated that solving mathematical problems serves as an example of a complex cognitive task that demands significant memory resources. Students with proficient numerical memory can effectively retain information while engaging in tasks involving reading, writing, or calculating numbers (Gatterkoli & Alloy, 2008), enabling them to approach mathematical tasks with more confidence and thereby reducing their anxiety levels. Maloney et al. (as cited in Maldonado Moscoso et al., 2022) suggested that inadequate numerical and spatial skills may compromise the successful development of effective math strategies, consequently leading to math anxiety. As per the research conducted by Finell et al. (2022), numbers can substantially induce anxiety, consequently leading to a depletion of cognitive processing resources. Additionally, neuroscientific investigations have indicated that in such instances, children exhibit reduced activity in the dorsolateral prefrontal cortex and the intraparietal sulcus, both of which are regions associated with mathematical processing.

The results of the research support hypothesis two indicating that math self-efficacy has a direct negative effect on math anxiety. The model suggests that math anxiety is inversely predicted by self-efficacy. This finding is consistent with the studies of Rozgonjuk et al. (2020), Arji et al. (2019), Živković et al. (2023), Aghajani et al. (2012), and Hejazi and colleagues (2007). In explaining this finding, reference can be made to Bandura's theory (1977) positing that emotional arousal, such as anxiety, can detrimentally impact self-efficacy. Hence, inadequate math self-efficacy may serve as a contributing factor to math anxiety. According to Bandura (1977), self-efficacy pertains to an individual's confidence in their ability to complete a task. Before undertaking any action, people evaluate their knowledge and capabilities; thus, students who perceive themselves as incapable of performing math operations may experience heightened anxiety, leading to reduced engagement with math materials. Conversely, students with stronger self-efficacy tend to be more proactive in addressing obstacles and spend more time on math assignments. This finding can be further explained by the attribution theory (Heider, 1958; cited in Martinko & Mackey, 2019). Students with high self-efficacy tend to attribute their successes to internal factors, such as their own ability, while those with low self-efficacy are more inclined to question their abilities in times of failure and attribute their successes to luck or happenstance. Consequently, students with lower self-efficacy in mathematics may worry about the role of chance in solving problems, considering mathematics as a personal threat. Their lack of confidence in their abilities contributes to anxiety when faced with mathematical problem-solving situations.

Also, the results indicated that there was a direct path of math attitude effect on math anxiety. The findings of the present research are aligned with the results of Mutegi et al. (2021), Chaman and colleagues (2013), Kargar et al. (2010), Rodríguez et al. (2020), and De-la-Peña et al. (2021). Research has consistently shown that math anxiety is correlated with students' negative attitudes toward mathematics. This implies that a negative math attitude tends to foster math anxiety, whereas a positive attitude works to alleviate it. In explaining this finding, it can be claimed that students' attitudes, as a crucial factor strongly, are linked to success and motivation. Negative attitudes towards mathematics tend to diminish students' interest in the subject and hinder their learning, thereby leading to poorer outcomes and potentially triggering anxiety. Additionally, we can refer to Zettle and Raines (2002), who argue that anxiety, being an uncomfortable state, can arise when students face challenging mathematical tasks, potentially contributing to a negative attitude towards math. Our study successfully replicated and corroborated recent research findings pertaining to the impact of negative attitudes on math anxiety. Notably, studies by Passolunghi et al. (2019) and Živković et al. (2023) have illustrated that negative attitudes can potentiate the avoidance tendencies and undermine self-efficacy; consequently, hampering academic proficiency and heightening math anxiety. Furthermore, neurocognitive investigations suggest that the negative attitudes linked to rumination in mathematical contexts significantly impede working memory, thereby affecting the learning process and academic performance, ultimately contributing to math anxiety, as indicated by Tashana et al. (2019).

The results also showed the significant indirect path of math self-efficacy on math anxiety through numerical memory. Individuals with high self-efficacy tend to leverage their cognitive capacities, such as memory, to accomplish their objectives. Moreover, as individuals with high self-efficacy typically experience less anxiety, they engage in less mental rumination, thereby enhancing their memory capabilities. Utilizing this enhanced memory capacity leads to greater success and, consequently, reduced anxiety. Therefore, considering the relationship between math self-efficacy and math anxiety, and the relationship between memory and math anxiety, it is plausible to explain the connection between self-efficacy and anxiety through the mediating role of memory.

Nonetheless, the results indicated that the indirect path of math attitude on math anxiety through numerical memory was not significant. In explaining this finding, we can refer to the findings of Jung and colleagues (2009) indicating that memory capacity acts as a control mechanism for learning. Therefore, when a student achieves success in mastering a lesson, their attitude toward the subject tends to become more positive. According to the findings of Beilock and DeCaro (2007), math anxiety may impair performance by overloading active memory. Students with lower active memory capacities often express negative sentiments about their studies, this rumination also increases math anxiety and disrupts performance. Experiencing poor performance is correlated to negative attitudes toward mathematics. Nazir and Khan (2019) showed that students with high numerical memory capacity had a better attitude towards mathematics and enjoyed it. As a result, numerical memory ability appears to influence mathematical attitude rather than the reverse.

Conclusions

In response to the research question, the proposed model did not exhibit a high level of fit, as indicated by the obtained fit indices. In explaining this finding, we can refer to the attentional control theory (ACT) suggesting that anxiety can have a detrimental impact on the attentional control system, leading to increased attention to stimuli associated with threats (Young et al., 2012). Furthermore, Vogel and Schwabe (2016) demonstrated that stress can adversely affect the hippocampus, amygdala, and frontal cortex of the brain, all of which play crucial roles in memory formation. Stress significantly impairs memory retrieval. Moreover, this study represents one of the pioneering attempts to explore the role of numerical memory as a mediator in the context of math anxiety. Consequently, the observed lack of model fit might be attributed to the possibility that the influence of anxiety on numerical memory outweighs the impact of numerical memory on anxiety. Moreover, constraining the functionality of memory can yield unfavorable outcomes in the process of learning mathematics, subsequently contributing to the development of negative attitudes towards the subject.

The current study had certain limitations, primarily due to the absence of control over variables such as intelligence, personality types, and the social and educational backgrounds of families, all of which may impact both memory and attitude. Building upon the findings of this study and taking into account the aforementioned limitations, it is recommended that future research endeavors to construct a model that explores the relationship between mathematical attitude and memory mediated through anxiety. Moreover, it is advisable to incorporate considerations of intelligence and personality into the examination of math self-efficacy, attitude toward math, numerical memory, and their collective impact on math anxiety and performance.

Furthermore, it is recommended that educators employ strategies to render mathematics education engaging and appealing to students, thereby fostering positive attitudes towards math lessons. It is important to recognize that recurrent experiences of either failure or success in mathematics can significantly influence a student's self-confidence. Hence, it is advisable for teachers to create an environment conducive to students experiencing success in mathematics lessons, thereby bolstering their self-efficacy. This enhancement in self-efficacy, in turn, may serve as a protective factor in the realm of math education, effectively moderating the impact of math anxiety.

Conflicts of Interest

No conflicts of interest declared.

References

Abareshi, A., & Hosseini, S.Y. (2013). *Structural Equation Modeling*. Sociologists.

Aghajani, S., Khormaee, F., Rajabi, S., & Rostamoqli khiavi, Z. (2012). The relationship of self-esteem and self-efficacy to mathematical anxiety in students. *Journal of School Psychology*, *1*(3), 6-26. DOI: d_1_3_91_7_1_1

Altakhayneh, B. (2020). The effect of mathematics anxiety on the achievement of middle school students in Amman. *Journal of Education and Learning*, *14*(3), 338-344.

Anari Nejad, A., Jashne Sade, M., & Zohouri, H. (2022). Reducing math anxiety using applied and interactive methods. *Journal of Education in Basic Science*, *8*(26), 26-35.

Arji, J., Arji, M., Sepehrianazar, F., & Gharib, A. (2019). The role of math learning anxiety, math testing anxiety, and self-efficacy in the prediction of test anxiety. *Chron Dis J*, *7*(2), 99-104.

Arji, J., Sepehrianazar, F., & Soleimani, E. (2018). Investigating the structural relationship between math anxiety, Gray's biological model of personality, and test anxiety through assessing the self-efficacy mediating role among junior girl students of Urmia high schools, Iran. *Chron Dis J*, *6*(3), 127-35.

Association for Psychological Science. (2010). Child's 'mental number line' affects memory for numbers. *ScienceDaily*, www.sciencedaily.com/releases/2010/09/100909114121.htm.

Balali, M., Sadeghi, J., & Homayouni, A. (2021). Structural relationships between mathematical academic beliefs and mathematical anxiety mediated by academic hardiness in male high school students in District 4 of Tehran. *Journal of Research in Educational Systems*, *15*(54), 104- 114.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, *84*, 191-215.

Beilock, L. S., &DeCaro, M. S. (2007). From poor performance to success under stress: working memory, strategy selection, and mathematical problem solving under pressure. *J. Exp. Psychol*., *33*, 983–998. DOI: 10.1037/0278-7393.33.6.983

Chaman, M., & Callingham, R. (2013). Relationship between mathematics anxiety and attitude towards mathematics among Indian Students. *Proceeding of the 36th Annual Conference of Mathematics Education Research Group of Australasia, Melbourn*, 138-145.

De-la-Peña, C., Fernádez-Cézar, R., & Solano-Pinto, N. (2021). Attitude toward mathematics of future teachers: How important are creativity and cognitive flexibility? *Front. Psychol*, *12*, 713941. DOI: 10.3389/fpsyg.2021.713941

Delgado Monge, I. C., González J. E., & Castro, J. F. (2017). Mathematics anxiety in college students in Costa Rica and their relationship with academic achievement and socio-demographic variables. *Propósitosy Representaciones*, *5*(1), 275 – 324.

Finell, J., Sammallahti, E., Korhonen, J., Eklöf, H., & Jonsson, B. (2022). Author information article notes copyright and license information, working memory and its mediating role on the relationship of math anxiety and math performance: A meta-analysis. *Front Psychol*, *2*. DOI: 10.3389/fpsyg.2021.798090.

Gasemigheshlagh, M., Sepehrianazar, F., & Keyvan, J. (2019). The effectiveness of training cognitive and metacognitive strategies on problem solving, numerical memory and mathematics self-efficacy in students. *Biquarterly Journal of Cognitive Strategies in Learning*, *6*(11), 217-234.

Gathercole, S., & Alloway, T. P. (2008). *Working memory and learning: A practical guide for teachers*. Sage.

Ghanaat, H., & Habibzadeh, A. (2021). Analyzing the impact of flipped classroom on students' mathematical academic achievement and attitude towards mathematics. *Research in Curriculum Planning*, *17*(67), 183-196. DOI: 10.30486/jsre.2021.1909828.1736

Cipora, K., Santos, F. H., Kucian, K., & Dowker, A. (2022). Mathematics anxiety—Where are we and where shall we go? *Annals of the New York Academy of Sciences*, *1513*(1), 10–20. https://doi.org/10.1111/nyas.14770

Goose, M., Brown, R., & Maker, K. (2008). Self-efficacy in mathematics: affective cognition, cognitive domains of functioning. *Proceeding of the 31st Annual Conference of the Mathematics Education Research Group of Australasia*, 507-513.

Groth-Marnat, G. (2003). *Handbook of psychological assessment* (4th ed.). John Wiley & Sons, Inc. [H. Pasha Sharifi & MR. Nikkhooi, Persian Trans.: Roshd].

Guzmán, B., Rodríguez, C., & Ferreira, R. A. (2023). Effect of parents' mathematics anxiety and home numeracy activities on young children's math performance-anxiety relationship. Contemporary *Educational Psychology*, *72*, 102140. https://doi.org/10.1016/j.cedpsych.2022.102140

Hejazi, E., & Naghsh, Z. (2007). Relationship between mathematics self-efficacy, mathematics usefulness perceived, self-regulation strategies and mathematics achievement: A gender comparison. *The Journal of Scientific and Research on Women's Studies*, *1*(2), 84-102. SID. https://sid.ir/paper/133268/en

Holmes, J., Gathercole, S. E., & Dunning, D. L. (2009). Adaptive training leads to sustained Enhancement of poor working memory in children**.** *J Dev Sci*, *4*, 9-15.

Homan, H. A. (2015). *Structural Equations Modeling Using LISREL Software*. SAMT.

Jung, E. S., & Reid, N. (2009). Working memory and attitudes. *Research in Science & Technological Education*, *27*(2), 205–223.

Kargar,M., Tarmizi, R. A., & Bayat, S. (2010). Relationship between mathematical thinking, mathematics anxiety and mathematics attitudes among university students. *Procedia - Social and Behavioral Sciences*, *8*, 537-542.

Kawai, N., & Matsuzawa, T. (2000). Numerical memory span in a chimpanzee. *Nature*, 403, 39-40.

Khasawneh, E., Gosling, C., & Williams, B. (2021). What impact does maths anxiety have on university students? *BMC Psychol*, *9*, 37. https://doi.org/10.1186/s40359-021-00537-2

Khayat Ghiasi, P. (2020). The effects of self-efficacy classroom-based strategies of teachers on the mathematics, mathematical self-efficacy and academic performance of junior high school female students in Ahwaz. *Research in Mathematics Education*, *1*(1), 55-73.

Lin, S., & Huang, Y. (2014). Development and application of a Chinese version of the short attitudes toward mathematics inventory. *Int J Sci Math Educ.*, *14*(1), 193–216. https://doi.org/10.1007/s10763-014-9563-8

Liu, X., & Koirala, H. (2009). The effect of mathematics self-Efficacy on mathematics achievement of high school students. *Proceedings of the NERA Conference*, Paper 30. http://digitalcommons.uconn.edu/nera_2009/30

Lau, N. T. T., Hawes, Z., Tremblay, P., & Ansari, D. (2022). Disentangling the individual and contextual effects of math anxiety: A global perspective. *Proceedings of the National Academy of Sciences of the United States of America*, *119*(7), 1–11. https://doi.org/10.1073/pnas.2115855119

Maldonado Moscoso, P.A., Castaldi, E., Arrighi, R., Primi, C., Caponi, C., Buonincontro, S., Bolognini, F., & Anobile, G. (2022). Mathematics and numerosity but not visuo-spatial working memory correlate with mathematical anxiety in adults. *Brain Science*, *12* (4), 422. https://doi.org/10.3390/brainsci12040422

Martinko, M.J., & Mackey, J.D. (2019). Attribution theory: An introduction to the special issue. *J Organ Behav*, *40*, 523–527. https://doi.org/10.1002/job.2397

Moussa, N. M., & Saali, T. (2022). Factors affecting attitude toward learning mathematics: A case of higher education institutions in the gulf region. *Sage Open Journal*, *12*(3), https://doi.org/10.1177/21582440221123023

Mutegi, M., Gitonga, C. M., & Rugano, P. (2021). Mathematics anxiety, attitude and performance among secondary school students in Kenya. *Educational Research and Reviews*, *16*(6), 226-235.

Naderi Dehsheykh, M., Hafezi, F., & Dasht Bozorgi, A. (2021). Relationship of students' math anxiety with their optimism and perceived classroom structure, mediated by mathematics attitudes. *Iranian Journal of Learning & Memory*, *4*(15), 69-76. https://dorl.net/dor/20.1001.1.26455455.2021.4.15.5.9

Nikoubakht, A., shehniyailagh, M., & Kiamanesh, A. (2019). The comparison of the effectiveness of computer-based education and traditional education on the numerical memory in students with mathematics disorder. *Journal of Psychological Science*, *18*(73), 55-65. http://psychologicalscience.ir/article-1-82-fa.html

Niyaie, S., Imanzadeh, A., & Vahedi, S. (2021). The effectiveness of flipped teaching on math anxiety and math performance in 5th grade students. *Technology of Education Journal (TEJ)*, *15*(3), 419-428. DOI: 10.22061/tej.2020.5908.2303

Opfer, J., Kim, D., Young, C. J., & Marciani, F. (2020). Linear spatial–numeric associations aid memory for single numbers. *Front. Psychol*, *10*, https://doi.org/10.3389/fpsyg.2019.00146

Passolunghi, M. C., Cargnelutti, E., & Pellizzoni, S. (2019). The relation between cognitive and emotional factors and arithmetic problem-solving. *Educational Studies in Mathematics*, *100* (3), 271–290. https://doi.org/10.1007/s10649-018-9863-y

Pelegrina, S., Justicia-Galiano, M.J., Martín-Puga, M.E., & Linares, R. (2020). Math anxiety and working memory updating: Difficulties in retrieving numerical information from working memory. *Front. Psychol*, *11*,669. DOI: 10.3389/fpsyg.2020.00669

Plake, B. S., & Parker C. S. (1982). The development and validation of a revised version of the Mathematics Anxiety Rating Scale. *Educational and Psychological Measurement*, *42*(2), 551-557.

Pourghaz, S., Toomaj, A., & Razzaqian Garmroodi, Z. (2020). The impact of augmented reality education on students' math anxiety and academic desire in mathematics. *Journal of Education in Basic Science*, *6*(18), 13-30.

Richardson, F. C., & Suinn, R. M. (1972). The Mathematics anxiety rating scale: Psychometric data". *Journal of Counselling Psychology*, *19* (6), 551–554. DOI: 10.1037/h0033456. ISSN 0022-0167.

Rodríguez, S., Regueiro, B., Piñeiro, I., Estévez, I., & Valle, A. (2020). Gender differences in mathematics motivation: differential effects on performance in primary education. *Front. Psychol*, *10*, 3050. DOI: 10.3389/fpsyg.2019.03050

Rozgonjuk, D., Kraav, T., & Mikkor, K. (2020). Mathematics anxiety among STEM and social sciences students: the roles of mathematics self-efficacy, and deep and surface approach to learning. *International Journal of STEM Education*, *7*, 46. https://doi.org/10.1186/s40594-020-00246-z

Sepehrianazar, F., & Babaee, A. (2014). Structural equation modeling of relationship between Mathematics Anxieties with parenting styles: The meditational role of goal orientation. *Procedia - Social and Behavioral Sciences*, *152*, 607 – 612.

Sepehrianazar, F., & Mahmoudi, L. (2014). Relationship between mathematics self-efficacy and students' performance in statistics: the meditational role of attitude toward mathematics and mathematics anxiety. *Journal of Educational science & psychology*, *4*(1), 32-42.

Sharifisaki, S., Fallah, M. H., & Zare, H. (2014). Role of mathematics self-efficacy, mathematics self-concept and perceived classroom environment in students' mathematics achievement with controlling the gender role. *Research in School and Virtual Learning*, *1*(4), 18-28.

Shehnikaramzadeh, M., Hejazi, E., Khanzadeh, A., & Hejazi, B. (2010). The role of math self-efficacy, goal orientations and math anxiety on math performance of high school second graders (Majoring in Math) in Tehran. *Psychological Achievements*, *17*(2), 187-212.

Shirbaigi, N., & Hemmati, A. (2010). Examination the invariability of factor structure in Fennema- Sherman mathematics attitudes scale fir Iranian bilingual high school students. *Training Measurement*, *1*(3), 49-70. https://sid.ir/paper/214521/en

Soleymani, S., Abbasi, M., & Toghyani, E. (2017). The effectiveness of cognitive- metacognitive strategies on the performance of attention memory of students with ADHD. *Journal of Cognitive Strategies in Learning*, *4*(7), 1-21. https://sid.ir/paper/255101/en

Sun, Z., Xie, K., & Anderman, L.H. (2018). The role of self-regulated learning in students' success in flipped undergraduate math courses. *Internet and Higher Educ*ation, *36*, 41-53.

Tashana S., & Jared Warner, J. (2019). "I Can Math!" Reducing math anxiety and increasing math self-efficacy using a mindfulness and growth mindset-based intervention in first-year students. *Community College Journal of Research and Practice*. doi:10.1080/10668926.2019.1666063

Thompson, C. A., & Siegler, R. S. (2010). Linear numerical-magnitude representations aid children's memory for numbers. *Psychological Science*, *21*(9), 1274–1281.DOI: 10.1177/0956797610378309

Vogel, S., & Lars Schwabe, L. (2016). Learning and memory under stress: implications for the classroom. *NPJ Science of Learning*, *1*, 16011. DOI: 10.1038/npjscilearn.2016.11

Wakhata, R., Mutarutinya, V., & Balimuttajjo, S. (2022). Secondary school students' attitude towards mathematics word problems. *Humanities and social sciences communications*, *9*, 444. https://doi.org/10.1057/s41599-022-01449-1

Wang, C., Li, X., & Wang, H J. (2023). The mediating effect of math self-efficacy on the relationship between parenting style and math anxiety. *Front. Psychol*., *14*, 1197170. DOI: 10.3389/fpsyg.2023.1197170

Wechsler, D. (2003). WISC-IV: *technical and interpretation manual*. The Psychological Corporation.

Young, C.B., Wu, S.S., & Menon, V. (2012). The neurodevelopmental basis of math anxiety. *Psychol Sci*, 23(5), 492-501. DOI: 10.1177/0956797611429134

Živković, M., Pellizzoni, S., Doz, E., Cuder, A., Mammarella I., & Passolunghi, M. C. (2023). Math self-efficacy or anxiety? The role of emotional and motivational contribution in math performance. *Social Psychology of Education*, *26*, 579–601, https://doi.org/10.1007/s11218-023-09760-8

Zettle, R., & Raines, S. (2002). The relationship of trait and test anxiety with mathematics anxiety. *College Student Journal*, *34*, 246-258

Zamani, A., & Pouratashi, M. (2018). The relationship between academic performance and working memory, self-efficacy belief, and test anxiety. *Journal of School Psychology*, *6*(4), 25-44. DOI: 10.22098/jsp.2018.603

Zanabazar, A., Deleg, A., & Ravdan, M. (2023). A study of factors causing math anxiety among undergraduate students. *International Journal of Innovative Research and Scientific Studies*, *6*(3), 578-585.

Zolfi, V., & Rezaei, A. (2015). The effect of working memory computer assisted intervention on mathematics anxiety, working memory and performance mathematics among students with mathematics learning disabilities. *(Journal of Instruction and Evaluation) Journal of Educational Science*, *8*(30), 75-86. SID. https://sid.ir/paper/183519/en