Document Type: Original Article
https://dorl.net/dor/20.1001.1.26455455.2021.4.15.5.9

Iranian Journal of Learning and Memory 2021, 4(15), 69-76

Relationship of Students' Math Anxiety with their Optimism and Perceived Classroom Structure, Mediated by Mathematics Attitudes

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Abstract

The present study aimed to investigate the relationship between math anxiety with optimism and perceived classroom structure through mediating role of mathematics attitudes in female high school students. The statistical population of this descriptive correlational study comprised all the female high-school students in Ahvaz (Iran) in the academic year 2020-2021. A sample of 237 students was randomly selected via single-stage cluster sampling. In this study, the sample size was determined based on the number of predictor variables in the structural equation analysis. The research instruments included the Mathematics Anxiety Rating Scale (MARS), the Life Orientation Test (LOT), Dundee Ready Education Environment Measure (DREEM), and the Mathematics Attitude Scale (MAS). The proposed model was evaluated by structural equation modeling (SEM). The results showed that all direct paths except perceived classroom structure to math anxiety were significant ($p< 0.01$). The indirect paths from optimism to math anxiety mediated by mathematics attitude, and the path from perceived classroom structure to math anxiety mediated by mathematics attitude were significant ($p< 0.01$). The proposed method, therefore, has an optimal fit and is a major step towards identifying the factor affecting students' math anxiety.

Keywords: Math Anxiety, Mathematics Attitudes, Optimism, Perceived Classroom Structure, Students

Receive Date: 15 June 2021
Revise Date: 20 September 2021
Accept Date: 25 September 2021
Publish Date: 01 October 2021

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How to Site: 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

Introduction

Great emphasis has recently been placed on the contribution of mathematical knowledge to scientific, industrial, and technical development (Samuel & Warner, 2021). Understanding mathematics is a key determinant of occupational success and effective personal management of daily affairs. Learning mathematics is, therefore, the core of education in all stages. Mathematics is, in fact, a key personal skill required in daily life in modern societies (Sharifi, Fathabadi, Karimi, & Sharifi, 2018). Researchers have recently shown an avid interest in students' math anxiety. By examining this factor, researchers aim to identify and control the effects of students' mathematics-related emotions and psychological states (Sokolowski & Necka, 2016). Mathematics is an essential course in all levels of education. Many students experience fear and anxiety and show resistance towards this course due to various reasons, including ineffective teaching methods, an experience of failure, parental

pressure, having little practice, and the difficulty of mathematical concepts. As a result, they sometimes fail to perform even the simplest mathematical operations. These students are afraid of mathematics and problem-solving and constantly experience math anxiety that weakens the mental processes necessary for performing mathematical operations, thereby leading to pessimism and confusion (Ramirez, Shaw, & Maloney, 2018). These students escape learning mathematics by missing mathematics classes and due to their problems with math tests as well as great anxiety and worry about this course (Foley et al., 2017).

Given the important role of mathematics in personal life, it is critical to examine the factors affecting math anxiety, including optimism. Optimism is defined as the ability to perceive the world and its events in a better light, and the capability to react correctly to the realities of life (Shirmohammadi, Eftekhar Saadi, & Talebzadeh Shoushtari, 2021). Scheier and Carver (2018) regarded optimism as an interpersonal difference variable reflecting the maintenance of generalized positive experiences for the future. Dispositional optimism, or the tendency to expect good experiences, is a relatively stable personality trait that determines one's behaviors. Villavicencio and Bernardo (2016) found that optimism, positive emotions, self-regulation, and mathematics self-efficacy had a significant negative relationship with math anxiety.

In addition to optimism, students' perceived classroom structure can also affect their math anxiety. The optimal quality of the class environment and teaching facilitate math learning. Students have different perceptions of the learning environment depending on the classroom conditions and their own experiences, beliefs, and cognitive structures (Persson & Svensson, 2017). In educational settings, students' needs are associated with their wishes and tendencies, while the pressures are associated with the curriculum, teaching methods, management and organization of the institute, as well as the moral and emotional states of the teachers, managers, and other school personnel (Darling-Hammond, Flook, Cook-Harvey, Barron, & Osher, 2020). Deieso and Fraser (2019) observed a significant negative relationship between students' perception of the learning environment, mathematics attitudes, and math anxiety. Sharifi Saki, Fallah, and Zare (2014) also reported the mediating role of self-efficacy and self-concept in the relationship between perceived classroom environment and academic achievement.

Mathematics attitudes denote people's ability to identify and perceive the role of mathematics in the world so that they can make correct judgments and use mathematics to meet their real-life needs as constructive, concerned, and intellectual citizens (Ren, Green, & Smith, 2016). Learning attitudes refer to learning tendencies based on their positive/negative exposure to a certain topic, status, institution, or person (Hajebi, 2018). In the same vein, mathematics attitudes include mathematical reasoning and the use of concepts, procedures, facts, and tools for description, explanation, and prediction of phenomena (Batra & Grover, 2018). Based on this definition, the fundamental process for mathematics attitude assessment is modeling that starts with a real-world problem which is then mathematically formulated. This mathematical problem is then solved and the solution is translated into and interpreted in the language of the real world (Mavridis, Katmada, & Tsiatsos, 2017). Lukowski et al. (2019) found that positive mathematics attitudes and literacy improve students' performance and mitigate their math anxiety. Although the literature suggests a direct relationship between optimism, perceived classroom structure, and math anxiety, the present study aimed to examine the mediating role of mathematics attitudes in this relationship.

Students dislike or fail in mathematics for different reasons, including their previous failures, parental pressure on learning it, hatred of teachers, inappropriate teaching methods, and a lack of motivation for learning and practice. While mathematics is a critical course for students in all levels of education. Due to the lack of studies on the structural model of math anxiety based on optimism and perceived classroom structure with the mediating role of mathematical attitudes in students, the need for the present study is felt more than ever. Accordingly, the present study aimed to investigate the mediating role of mathematics attitudes in the association of math anxiety with optimism and perceived classroom structure in high school students.

Methods

Design

This was a descriptive correlational study using structural equation modeling (SEM).

Participants

The statistical population of this descriptive correlational study comprised all the female high-school students in Ahvaz (Iran) in the academic year 2020-2021. Depending on the number of predictor variables in structural equation analysis, the sample size should be at least 10 times the number of variables plus 50. In the present study, there was a total of 17 observed variables (17×10+50= 220). In total, to reduce sampling error 260 female Experimental Sciences students in Grades 10 (N= 85), 11 (N= 78), and 12 (N= 97) responded to the

questionnaires. The inclusion criteria were: having no mental disorders, consent to participate in the study, and age range between 16-18 years. The exclusion criteria included failure to completely answer all the questions.

Instruments

The Mathematics Anxiety Rating Scale (MARS): Plake and Parker in 1982 developed the MARS to evaluate high-school students' statistics and mathematics course-related anxiety. The MARS comprises 24 statements, and the respondents specify their level of agreement/disagreement with each statement on a five-point Likert scale. Scores of 1 through 5 denote low to high levels of anxiety, respectively. The sum of the scores of all statements yields the total math anxiety score (Plake & Parker, 1982). Vahedi and Farrokhi (2011) reported the reliability of this scale equal to 0.89 based on Cronbach's alpha coefficient. In the present study, Cronbach's alpha coefficient was 0.87 for the scale.

The Life Orientation Test (LOT): Scheier and Carver in 1985 developed the Life Orientation Test as an efficient and valid measure of optimistic and pessimistic styles. The respondents filled out the questionnaire based on the expected outcomes. According to the developers, this highly valid questionnaire evaluates people's overall expectations about the optimality of the future outcomes of their actions (Gustems-Carnicer, Calderón, & Forn Santacana, 2017). Khodaei, Zare, Alipour, and Shokri, (2017) reported a Cronbach's alpha of 0.88 for the questionnaire. In this study, Cronbach's alpha coefficient was 0.84 for the questionnaire.

Dundee Ready Education Environment Measure (DREEM): Dundee in 2001 developed this 49-item questionnaire to assess different dimensions of educational quality (students' perception of learning, the professor, their own scientific ability, the educational atmosphere, and social conditions) on a five-point Likert scale from very low (1) to very high (5). The maximum score the educational setting can attain is 245. Scores of 0-50, 51-100, 101-150, and 151-245 respectively indicate very poor, undesirable, optimal, and excellent attitudes (Prashanth & Ismail, 2018). Koohpayehzadeh et al. (2014) reported the reliability of this scale equal to 0.91 based on Cronbach's alpha coefficient. In the present study, Cronbach's alpha coefficient was 0.81 for the questionnaire.

The Mathematics Attitude Scale: Aiken's (1971) 16-item Mathematics Attitude Scale was administered to assess the students' mathematics attitude in the components of enjoyment, motivation, importance, fear, and anxiety on a five-point Likert scale. The scores range from 16 to 80 (León-Mantero, Casas-Rosal, Pedrosa-Jesús, & Maz-Machado, 2020). Yarmohamadi Vasel, Rashid, and Bahrami, (2014) reported the reliability of this scale equal to 0.85 based on Cronbach's alpha coefficient. In the present study, Cronbach's alpha coefficient was 0.83 for the mathematics attitude scale.

Procedure

Out of the four districts of Ahvaz (Iran), District 4 was randomly selected through single-stage cluster sampling, and seven schools were randomly selected from among the all-girls high-schools in this district. The researchers visited these schools, briefed the students' parents, and randomly selected seven classes. As the classes were held online due to the COVID-19 pandemic conditions, a link to the questionnaires was sent to the teachers to share with student groups. A total of 260 questionnaires were distributed among students. After eliminating 23 incomplete questionnaires, 237 students were finally included in this study.

Statistical Analyses

The data were analyzed using descriptive statistics (mean and standard deviation), Pearson's correlation test, and SEM in SPSS 27 and AMOS 24.

Findings

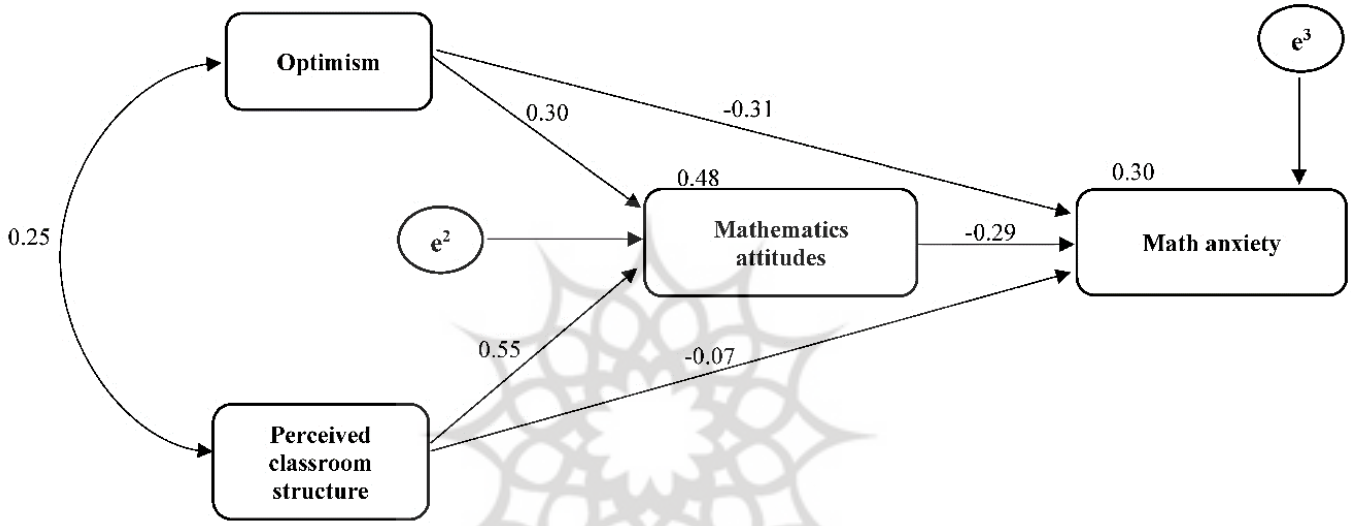
According to the results of demographic data, a total of 237 female Experimental Sciences students aged 17.32±1.67 years old participated in this study. Among students, 32.49% (n= 77) were in tenth grade, 29.96% (n= 71) in eleventh grade and 37.55% (n= 89) in twelfth grade.

The descriptive statistics, including mean, standard deviation (SD), and correlation matrix are presented in Table 1. The initial model proposed to explain math anxiety based on optimism, perceived classroom structure, and mathematics attitude is depicted in Figure 1.

Table 1.
Mean, Standard Deviation (SD), and Pearson Correlation Coefficients of the Studied Variables

Variables	M ± SD	1	2	3	4
1- Math anxiety	69.22 ± 28.41	1			
2- Optimism	12.78 ± 5.72	-0.46	1		
3- Perceived classroom structure	156.32 ± 52.26	-0.33	0.25	1	
4- Mathematics attitudes	60.17 ± 20.42	-0.47	0.44	0.62	1

Figure 1.
Initial Model Pertaining to the Relationship Between Math Anxiety with Optimism and Perceived Classroom Structure Through Mediating Role of Mathematics Attitudes



The root-mean-square error (RMSEA) of 0.418 indicated that the initial model needs modification (Table 2). As the initial model was saturated (i.e., all the possible paths were drawn), chi-square and other indices could not be calculated. After removing one path (from perceived classroom structure to math anxiety), the model was no longer saturated and the software could compute these indices. The final model is displayed in Figure 2. An RMSEA= 0.001 suggests the proper fit of the final model.

Table 2.
Fit Indicators of the Initial and Final Models

Fit indicators	χ^2	df	(χ^2/df)	IFI	RFI	TLI	CFI	NFI	RMSEA
Initial model	-	-	-	-	0.99	-	0.99	-	0.418
Final model	0.969	1	0.969	1.00	0.97	0.99	0.99	0.99	0.001

Figure 2.
Final Model Pertaining to the Relationship Between Math Anxiety with Optimism and Perceived Classroom Structure through Mediating Role of Mathematics Attitudes

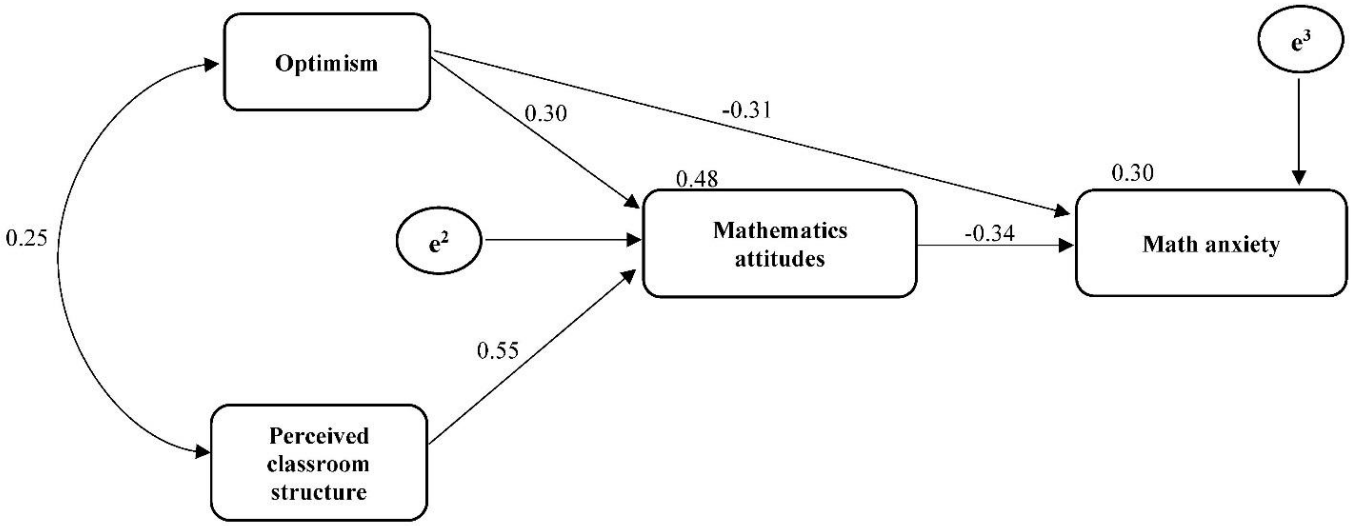


Table 3 presents the findings related to the path coefficients' estimation to examine the direct paths. The results showed there was a direct relationship between optimism and mathematics attitudes (β= 0.30, p< 0.01) and between perceived classroom structure and mathematics attitudes in the students (β= 0.55, p< 0.01). Moreover, there was a negative relationship between optimism and math anxiety (β= -0.31, p< 0.01) and between mathematics attitudes and math anxiety in the students (β= -0.34, p< 0.01) There was no significant relationship between perceived classroom structure and math anxiety in the girl high-school students (p> 0.05).

Table 3.
Direct Effects between Research Variables in the Initial and Final Modified Models

Path	Initial model		Final modified model	
	β	p	β	p
Optimism to math anxiety	-0.31	0.001	-0.31	0.001
Optimism to mathematics attitudes	0.30	0.001	0.30	0.001
Perceived classroom structure to math anxiety	-0.07	0.324	-	-
Perceived classroom structure to mathematics attitudes	0.55	0.001	0.55	0.001
Mathematics attitudes to math anxiety	-0.29	0.001	-0.34	0.001

The results showed there was a significant indirect path from optimism to math anxiety through the mediating role of mathematics attitudes in the students. Moreover, the indirect path from perceived classroom structure to math anxiety through the mediating role of mathematics attitudes was significant (p< 0.01) (Table 4).

Table 4.
Results of Analysis of Indirect and Intermediary Paths in the Initial and Final Modified Models

Predictor variable	Mediator variable	Criterion variable	Initial model		Final modified model	
			Bootstrap	p	Bootstrap	p
Optimism	Mathematics attitudes	Math anxiety	-0.44	0.001	-0.51	0.001
Perceived classroom structure	Mathematics attitudes	Math anxiety	-0.09	0.001	-0.10	0.001

Discussion

The present study aimed to investigate the mediating role of mathematics attitudes in the association of math anxiety with optimism and perceived classroom structure in female high school students. All the direct paths, except for the path from perceived classroom structure to math anxiety, were significant. The indirect paths to math anxiety were also significant through mathematics attitudes. This finding is consistent with the research results of Xie, Xin, Chen, and Zhang (2019).

The first finding was the significant relationship between optimism and math anxiety. Optimism leads people towards better performance, not only in mathematics but also in all educational affairs. The influence of optimism on people's motivation for progress can explain their effort and perseverance in attaining academic success. Some people possess a more advanced way of thinking and a high perception of their abilities. They tend to dominate, have high expectations of success, strongly evaluate success, and enjoy an optimistic attributional style. These people perform better not only in education but in all aspects of life thanks to their optimism, good mental health, and optimal well-being (Ruggeri, Garcia-Garzon, Maguire, Matz, & Huppert, 2020).

No significant relationship was observed between the perceived classroom structure and math anxiety. This finding is inconsistent to the findings of studies carried out by Sharifi Saki et al. (2014) and Deieso and Fraser (2019). Previous studies have reported a significant relationship between perceived classroom structure and math anxiety by using correlation and regression analysis. Herein, however, the hypotheses were tested by SEM. The relationship between perceived classroom structure and math anxiety initially turned out to be significant on Pearson's correlation test. Nevertheless, there was also a mediator variable in the model, which explained all the contribution of perceived classroom structure to math anxiety (indirect relationship). In other words, in this model, perceived classroom structure affects math anxiety, but indirectly. As another key factor, i.e., mathematics attitudes, explained the entire share of the direct path from perceived classroom structure to math anxiety, the direct relationship between perceived classroom structure and math anxiety was not significant.

The results demonstrated a negative direct relationship between students' mathematics attitude and math anxiety; thus, by improving mathematics attitudes, their math anxiety is expected to decrease. To the best of our knowledge, this is the first study to examine the relationship between students' mathematics attitudes and math anxiety. Iranian students in all grades usually suffer from academic underachievement in mathematics. Familial and school-related factors affect personality traits and factors which, in turn, can promote mathematics learning and alleviate math anxiety. Still, few studies have investigated these factors. A review of the literature revealed the effect of numerous personal variables on academic achievement, including motivational and attitudinal factors (Brew, Nketiah, & Koranteng, 2021). People who possess a positive attitude towards their performance and monitor their process of thinking and thought regulation further engage in challenging situations. Thanks to their curiosity, they can apply proper solutions to educational and mathematical problems and show more perseverance in doing so, thereby experiencing less math anxiety.

The results also showed that mathematical attitudes mediate the relationship between optimism, perceived classroom structure, and math anxiety. The researcher found no study reporting a similar finding in the literature. The direct path between optimism and math anxiety turned out to be significant. Optimism was also indirectly related to improved mathematics attitudes and, therefore, reduced math anxiety. Nevertheless, the path between perceived classroom structure and math anxiety was not significant. Based on the indirect hypothesis, perceived classroom structure was related to math anxiety only when the former variable was associated with improved mathematics attitudes which reduced students' anxiety. These findings collectively show that mathematics attitudes can effectively mediate the relationships among the research variables. Math anxiety is a state of discomfort and worry when solving mathematical problems, and can disrupt mathematics performance mathematics performance and the related factors.

Conclusion

Optimism and perceived classroom structure had a positive relationship with mathematics attitudes. Moreover, optimism and mathematics attitudes had a negative relationship with math anxiety in the students. According to the results of the present study, the proposed model had an acceptable fit and was a major step towards identifying the factor affecting students' math anxiety. Given that the proposed conceptual model had a good fit, it can be regarded as a scientific finding that can prove effective in preventing math anxiety. Holding in-service workshops by experienced teachers in the field of mathematics can familiarize teachers with interesting methods of teaching mathematics, improve students' optimism, and reduce their math anxiety levels.

Limitations and Suggestions

This study was limited by the use of self-report measures which are prone to bias. As the statistical population was limited to female high-school students in Ahvaz, the results should be generalized to female and male students in other grades and cities with caution. Future studies can recruit male students and compare the results with those of the present study. In-service training workshops should be held by experienced mathematics teachers to familiarize other teachers with engaging teaching methods to help improve students' mathematics attitudes and alleviate their math anxiety. Families and teachers should also enhance their knowledge and awareness of the importance of this issue and provide educational support to prevent academic underachievement, demotivation, and negative mathematics attitudes.

Conflict of Interest

No conflicts of interest declared.

References

Batra, C., & Grover, J. (2018). Exploring the effects of interactive hypermedia instructional program on mathematics attitude and achievement in relation to locus of control. *International Journal of Research in Social Sciences, 8*(6), 380-395.

Brew, E. A., Nketiah, B. & Koranteng, R. (2021). A literature review of academic performance, an insight into factors and their influences on academic outcomes of students at senior high schools. *Open Access Library Journal, 8*, 1-14.

Darling-Hammond, L., Flook, L., Cook-Harvey, C., Barron, B., & Osher, D. (2020). Implications for educational practice of the science of learning and development. *Applied Developmental Science, 24*(2), 97-140.

Deieso, D., & Fraser, B. J. (2019). Learning environment, attitudes and anxiety across the transition from primary to secondary school mathematics. *Learning Environments Research, 22*(1), 133-152.

Foley, A. E., Herts, J. B., Borgonovi, F., Guerriero, S., Levine, S. C., & Beilock, S. L. (2017). The math anxiety-performance link: A global phenomenon. *Current Directions in Psychological Science, 26*(1), 52-58.

Gustems-Carnicer, J., Calderón, C., & Forn Santacana, M. (2017). Psychometric properties of the Life Orientation Test (LOT-R) and its relationship with psychological well-being and academic progress in college students. *Revista Latinoamericana de Psicología, 49*(1), 19-27.

Hajebi, M. (2018). Predictors of vocabulary achievement: testing a model of life syllabus and web-based language teaching. *Iranian Journal of Learning & Memory, 1*(1), 85-96.

Khodaei, A., Zare, H., Alipour, A., & Shokri, O. (2017). Psychometric properties of the revised version of the life orientation test. *Journal of Applied Psychology, 10*(4), 387-405.

Koohpayehzadeh, J., Hashemi, A., Soltani Arabshahi, K., Bigdeli, S., Moosavi, M., Hatami, K., & Baradaran, H. R. (2014). Assessing validity and reliability of Dundee Ready Educational Environment Measure (DREEM) in Iran. *Medical Journal of The Islamic Republic of Iran, 28*(1), 366-374.

León-Mantero, C., Casas-Rosal, J. C., Pedrosa-Jesús, C., & Maz-Machado, A. (2020). Measuring attitude towards mathematics using Likert scale surveys: The weighted average. *PloS One, 15*(10), e0239626.

Lukowski, S. L., DiTrapani, J., Jeon, M., Wang, Z., Schenker, V. J., Doran, M. M., ... & Petrill, S. A. (2019). Multidimensionality in the measurement of math-specific anxiety and its relationship with mathematical performance. *Learning and Individual Differences, 70*, 228-235.

Mavridis, A., Katmada, A., & Tsiatsos, T. (2017). Impact of online flexible games on students' attitude towards mathematics. *Educational Technology Research and Development, 65*(6), 1451-1470.

Persson, L., & Svensson, M. (2017). Classmate characteristics, class composition and children's perceived classroom climate. *Journal of Public Health, 25*(5), 473-480.

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.

Prashanth, G. P., & Ismail, S. K. (2018). The Dundee ready education environment measure: A prospective comparative study of undergraduate medical students' and interns' perceptions in Oman. *Sultan Qaboos University Medical Journal, 18*(2), e173–e181.

Ramirez, G., Shaw, S. T., & Maloney, E. A. (2018). Math anxiety: past research, promising interventions, and a new interpretation framework. *Educational Psychologist, 53*(3), 145-164.

Ren, L., Green, J. L., & Smith, W. M. (2016). Using the Fennema-Sherman mathematics attitude scales with lower-primary teachers. *Mathematics Education Research Journal, 28*(2), 303-326.

Ruggeri, K., Garcia-Garzon, E., Maguire, A., Matz, S., & Huppert, F. A. (2020). Well-being is more than happiness and life satisfaction: a multidimensional analysis of 21 countries. *Health and Quality of Life Outcomes, 18*(1), 192.

Samuel, T. S., & Warner, J. (2021). "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, 45*(3), 205-222.

Scheier, M. F., & Carver, C. S. (2018). Dispositional optimism and physical health: A long look back, a quick look forward. *The American Psychologist, 73*(9), 1082–1094.

Sharifi Saki, 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.

Sharifi, M., Fathabadi, J., Karimi, A., & Sharifi, M. (2018). The effectiveness of teaching critical thinking skills on students' academic achievement in mathematics and science: A study in Timss framework. *Iranian Journal of Learning & Memory, 1*(1), 21-30.

Shirmohammadi, Z., Eftekhar Saadi, Z., & Talebzadeh Shoushtari, M. (2021). The association between self-compassion and academic well-being with the mediating role of perceived academic stress and academic optimism in female students. *International Journal of School Health, 8*(2), 101-109.

Sokolowski, H. M., & Necka, E. A. (2016). Remediating math anxiety through cognitive training: Potential roles for math ability and social context. *The Journal of Neuroscience: The Official Journal of the Societyfor Neuroscience, 36*(5), 1439-1441.

Vahedi, S., & Farrokhi, F. (2011). A confirmatory factor analysis of the structure of abbreviated math anxiety scale. *Iranian Journal of Psychiatry, 6*(2), 47–53.

Villavicencio, F., & Bernardo, A. (2016). Beyond math anxiety: positive emotions predict mathematics achievement, self-regulation, and self-efficacy. *The Asia-Pacific Education Researcher, 25*.

Xie, F., Xin, Z., Chen, X., & Zhang, L. (2019). Gender difference of Chinese high school students' math anxiety: the effects of self-esteem, test anxiety and general anxiety. *Sex Roles, 81*(3), 235-244.

Yarmohamadi Vasel, M., Rashid, K., & Bahrami, F. (2014). The effectiveness of instruction through the play in improving mathematics attitude of primary girl students. *Journal of School Psychology, 3*(3), 122-135.