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An Investigation of Mathematics Anxiety and Academic Coping Strategies Among High School Students in Vietnam: A Cross-Sectional Study

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Increasing numbers of students around the world are suffering from mathematics anxiety. The main objective of this study is to investigate the relationship between mathematics anxiety and gender, grade, career choices, and academic achievement in Grade 10, 11, and 12 students. This study used the Revised Version of the Mathematics Anxiety Rating Scale to survey 1,548 high school students (570 males and 978 females) from high schools in Vietnam. A multivariate analysis of variance (MANOVA) test, Pearson correlation and multiple linear regression were used to analyze data. The results show that there are significant differences in the influence of grade, academic achievement, and students' career choices on mathematics anxiety. Academic coping strategies, gender, grade, and career choices are significant predictors of mathematics anxiety. Grade 12 students have higher levels of mathematics anxiety than others. Students with high average mathematics scores (9.0–10.0) have higher levels of mathematics anxiety than students with lower scores. Besides, students choosing finance and economics or industrial engineering to pursue into higher education also experienced higher levels of mathematics anxiety than others. This study contributes to the general discussion about the nature of mathematics anxiety and the relationship between mathematics anxiety and academic achievement.

Keywords: mathematics anxiety, high school student, academic achievement, academic coping strategies, average mathematics score, gender, career choice, grade

1 INTRODUCTION

Industrial Revolution 4.0 has had a considerable influence on many aspects of society, including not only economic development (optimising production processes through digital and intelligent technologies) but also the transformation of education. The economy now demands new management systems and improvements in the skills of the whole population, especially students. Thus, education in Vietnam has been transformed under the Education 4.0 initiative to deliver high quality, appropriately skilled human resources to society. This transformation has introduced curricula with complex academic content that requires cognitive flexibility, critical thinking, and creativity. These requirements create numerous challenges in the learning process, including the availability of appropriate material resources and the effects of environmental conditions and, especially, psychological conditions. The resultant academic pressure, stress and anxiety cause loss of energy among students, as well as reduced motivation and difficulty concentrating in class.

Wiedemann (2015) suggested that anxiety is characterised by nervousness and fear, with physical manifestations including tremors, increased pulse rate, and muscle pain. Anxiety is a basic human emotion that generates physiological reactions to stressors when a "fight or flight" defence response is activated in order to protect the individual from a threatening object or phenomenon (Sue et al., 2015).

In the Vietnam context, Mathematics is an important and compulsory subject for all students in the educational system from primary to high school. At each different grade level, the knowledge of mathematics is continuously improved. Therefore, the pressure easily comes when students have to acquire a large amount of mathematics knowledge, take and prepare for mathematics exams. Specifically, mathematics is a compulsory subject in entrance and graduation exams. These have increased more and more pressure on high school students when they have to tackle mathematics problems in the classroom, have a good performance in mathematics and prepare for the school graduation exams at the same time. For these reasons, the authors were interested in mathematics anxiety levels of high school students in Vietnam. Mathematics anxiety includes tension and emotions that affect the ability to manipulate numbers and tackle issues associated with mathematics in day-to-day situations (Richardson and Suinn, 1972). McAnallen (2010) suggested that mathematics anxiety is a response associated with avoiding mathematics that leads to a failure to gain critical skills and, ultimately, to make appropriate decisions on career orientation.

Specific research questions posed of this study:

1) What do factors affect the levels of mathematics anxiety among high school students?
2) How do academic coping strategies influence high school students' anxiety?

Male and females have differences in the substantial aspects of life including the attraction to the mathematics domain (Keshavarzi and Ahmadi, 2013); spatial processing ability (Maloney and Beilock, 2012); stress reactivity (Altemus et al., 2014) and social stereotypes about women and mathematical abilities (Beilock et al., 2007). Therefore, gender difference became the first variable that the authors were interested in examining. Besides, each student has the ability to learn maths and mathematics knowledge absorption differently from others, which leads to differential academic pressure on high school students. Accordingly, their academic achievements and performances in maths are not the same. This proves that mathematics average score should be the following variable affecting the levels of mathematics anxiety which the authors need to be researched on.

Studies investigating the level of mathematics anxiety in high school students have revealed contradictory findings about gender differences in the relationship between mathematics anxiety and academic performance. Keshavarzi and Ahmadi (2013) studied 834 high school students in Iran and reported a non-significant difference between the genders in mathematics anxiety. Another scientific study on mathematics test anxiety and numerical anxiety surveying the mathematics achievement of 140 pre-university students reported that males and females suffer the same level of mathematics anxiety. Akbayir (2019) also found that there is no gender difference in mathematics anxiety. Nevertheless, recent studies have shown a gender difference in the levels of mathematics anxiety. The study by Lew and Hwang (2019) on 459 high school students (124 male and 335 female) from four high schools in Seoul, Korea, showed that mathematics anxiety is significantly higher among female students than male students. The results of Lew and Hwang's study are in agreement with several prior studies. In research on mathematics anxiety in China with students from Grade 7 to Grade 12, Luo et al. (2009) found that females suffer from a greater degree of mathematics anxiety than males. A similar conclusion was reached by Karimi and Venkatesan (2009) who conducted research on 284 Grade 10 students in Karnataka state, India, and found differences in mathematics anxiety according to gender. This finding is also supported by a study by Maloney and Beilock (2012), which showed there are gender differences in mathematics-associated competencies and that females have higher levels of mathematics anxiety. In addition, Taylor and Fraser (2013) suggested that girls experience higher anxiety levels about mathematics evaluation than boys in mathematics learning.

Several scientific studies have focused on the negative effects of mathematics anxiety. Puteh and Khalin (2016) found a negative relationship between mathematics anxiety and mathematics achievement based on the results of mid-term examinations. Zakaria et al. (2012) showed that there is a correlation between academic achievement and mathematics anxiety; the higher the anxiety score, the poorer the academic achievement. According to the authors, the reason for this finding could be a relationship between students' comprehension of mathematics, and their confidence. A study by Karimi and Venkatesan (2009) on 284 high school students showed that there is a statistically negative relationship between mathematics anxiety and mathematics scores. This finding supports the prior study of Woodard (2002), which revealed that students with a high level of mathematics anxiety attain lower mathematics scores than those with a low level of mathematics anxiety. This result implies that students with high levels of mathematics anxiety perform less well in mathematics. Similarly, Lew and Hwang (2019) found that mathematics anxiety is negatively associated with academic achievement. Likewise, in a study involving 514 high school students, Milovanović (2020) showed that there is a significant negative correlation between students' average grades in mathematics and mathematics anxiety.

In the Vietnam context, each grade level has different mathematical problems. In grade 10 and grade 11, students have many pressures and difficulties in adapting new mathematics concepts, principles and formulas, which leads to worries and concerns among these students. In the last year of high school, grade 12, students have to make a decision of future career orientation and attempt to study for examination entrance. Moreover, maths is the crucial requirement of each ology in university, consequently, students in this period of time have more considerable anxiety than others. Therefore, the authors examine the relationship between grade levels variable and mathematics anxiety levels. The effects of grade level (school year) on students' mathematics anxiety have been examined by numerous educators and researchers. The study by Luo et al. (2009) of Grades 7 to 12 in China did not find evidence of statistically significant differences in mathematics anxiety between students but did find that the mean level of anxiety differed according to grade. Specifically, the level of mathematics anxiety was found to rise steadily from Grade 7 to 9, with a greater proportion of students in Grade 9 than in other years experiencing the highest anxiety level. The results showed a considerable decline in the levels of anxiety from Grade 9 to 10, but anxiety then peaked again in Grade 11 before declining again in Grade 12. Jackson and Leffingwell (1999) found a different pattern, with mathematics anxiety beginning in elementary school and growing through high school and the first year of college. Lew and Hwang (2019) found that levels of mathematics anxiety in Grade 11 students are the highest and in Grade 12 students the lowest. Likewise, with data collected from 1,352 Grade 8 to 11 students in Bahrain, Al Mutawah (2015) found that Grade 11 students suffer greater mathematics anxiety than other students.

Further studies mention other factors affecting the levels of mathematics anxiety among students. Mathematics anxiety causes students to tend to quit mathematics courses (specifically advanced mathematics courses) and adopt pessimistic attitudes towards activities that include mathematics, avoiding degree subjects and occupations that require quantitative skills (Hembree, 1990; Ma, 1999; Ho et al., 2000). Yüksel-Şahin (2008) surveyed Grade 4 and 5 students and concluded that individuals who have positive feelings about their mathematics classes experience lower levels of mathematics anxiety. Similarly, students who are positive about their mathematics teacher experience significantly lower levels of mathematics anxiety. In addition, Yüksel-Şahin (2008) suggested that students with higher levels of accomplishment in learning mathematics have lower levels of mathematics anxiety. Bursal and Paznokas (2006) found that negative experiences in school can increase the level of mathematics anxiety; criticism and intimidation by teachers might create an intimidating classroom atmosphere in which students are uncertain about asking or responding to questions. Teachers who punish students by giving mathematics assignments create negative attitudes towards mathematics (Oberlin, 1982). Mathematics anxiety could be brought about by low scores or failure in mathematics (Ma and Xu, 2004), leading to extremely negative feelings about the subject. Given the problems related to academic achievement and performance, it is essential to conduct further scientific research on students' anxiety in general, and mathematics anxiety in particular.

Factors affecting students' career choices have been extensively investigated by researchers. Authors suggest that there are several highly influential factors, such as self-efficacy appraisals of competencies in attaining performance, outcome expectations and desired objectives (Lent et al., 1994), gender role stereotypes (Singer and Stake, 1986), parental attitude (Mau et al., 1995), and social encouragement from friends (Lent et al., 2002).

However, few studies have investigated the influence of mathematics anxiety on students' career choices. Ashcraft (2002), and Ashcraft and Kirk (2001), suggested that mathematics anxiety directly and indirectly affects engagement in courses related to mathematics, attitudes towards mathematics, and career orientation. Anxiety affects the selection of degree courses that depend on the manipulation of numbers or include topics associated with mathematics (Hackett, 1985). Anxiety can also lead to refusal to participate in mathematics classes and avoidance of careers in finance and other fields related to mathematics (Ma, 1999; Kyttälä and Björn, 2010). These findings demonstrate consistency with studies conducted by Betz (1978), and Zettle and Houghton (1998), who suggested that students suffering from mathematics anxiety are more likely to avoid classes and careers associated with mathematics. Specifically, mathematics anxiety could reduce confidence in students' ability to complete mathematics-related tasks and limit students'career choices (Espino et al., 2017).

In the academic environment, although every student has the same learning environment, the same syllabus and so on, all of the students have different academic achievement and performance. This indicates that each high school student has their own coping strategies. Owing to this reason, the authors were interested in coping strategies and conducted this study to examine the effects of coping strategies on mathematics anxiety. The concept of coping strategies has been described in many previous studies. These strategies relate to cognitive and behavioural approaches to alleviating negative emotions that derive from difficult situations and stressful events, which could include academic failure, failure to complete tasks, and performing badly in tests (Lazarus, 2013; Ader and Erktin, 2010). Previous studies on academic coping relate to how students deal with academic challenges, obstacles, and difficulties; the findings of Krypel and Henderson-King (2010) show that these efforts can have either positive or negative aspects. Recent studies (Friedel et al., 2007) have indicated that coping strategies are divided into two main categories: adaptive coping strategies with positive outcomes, and maladaptive coping strategies with negative outcomes. Students with adaptive coping strategies tend to identify and analyse their own mistakes and reframe situations in a positive light. On the other hand, students with maladaptive coping strategies tend to blame their problems on everyone else and ignore their mistakes. Several instruments are available to assess students' coping strategies in academic contexts. The items in the positive coping group are used to measure adaptive strategies when students have poor experiences with mathematics, find their mistakes and improve their performance. Conversely, items in the projective, denial, and non-coping groups measure maladaptive strategies in terms of feelings, thoughts and behaviours when students face difficult problems in school. With projective coping, students tend to blame others for their problems, especially teachers. With denial coping, students ignore their own failures and crucial negative events in mathematics. With non-coping, students tend to blame and criticise themselves for their failures and worry about what others think of their mistakes (Friedel et al., 2007). Skaalvik (2018) found that use of coping strategies among students when dealing with mathematics is significantly predictive of mathematics anxiety. Students who have problem-focused coping strategies, finding out their mistakes and resolving to do better next time, are negatively associated with mathematics anxiety.

In Vietnam, anxiety among students is seen as an important topic. Thanh Tra (2019) conducted scientific research on levels of anxiety with 500 university and college students in Ho Chi Minh City and reported a high level of anxiety, identifying factors that have a negative impact on the mental health of students. In addition, Van (2018) showed that a large number of high school students in Ho Chi Minh City suffer from academic anxiety caused by false beliefs and cognitive distortion of themselves, problems in their relationships with teachers, and academic pressure from their parents.

Increasing numbers of students around the world are suffering from mathematics anxiety, which has negative effects on learning outcomes and academic achievement. It also creates obstacles in the learning process. This current research is conducted to examine mathematics anxiety among Vietnamese high school students and test the correlation between students' mathematics anxiety and academic coping strategies.

The research starts by reviewing the literature on mathematics anxiety in high school students. A research methodology is presented in the second section. In the following sections, the research results and discussion are introduced. Research on mathematics anxiety could make a major contribution to preventing anxiety among high school students, protecting and enhancing students' mental health during the learning process.

The first hypothesis is that students in Grade 12 have higher levels of mathematics anxiety than others. The second hypothesis is that high school students choosing to pursue medicine at a higher education level have greater levels of mathematics anxiety than pedagogy, finance-economics, social sciences, natural sciences, engineering industry, information technology, transportation sectors and others. The third hypothesis is that female high school students suffer more mathematics anxiety than male students. The fourth hypothesis is that students in Grade 11 and Grade 12 attaining an average mathematics score 9.0–10.0 experienced higher levels of mathematics anxiety than others from the same school years. The fifth hypothesis is that positive coping strategies would be positively correlated with mathematics anxiety. The final hypothesis is that average mathematics score would be positively correlated with the levels of mathematics anxiety.

2 MATERIALS AND METHODS

2.1 Participants

A recruitment process was undertaken to ensure that all the high school students participating in the research did so voluntarily. The sampling frames for the respondents were obtained from nine high schools in two city regions and three provinces in Vietnam. A total of 1,691 questionnaires were distributed, all of which were returned. The authors eliminated 143 responses that were incomplete or contained insufficient information; the final sample size was 1,548. The sample consisted of 513 10th graders (33.1%), 462 11th graders (29.8%), and 573 12th graders (37.0%); with 570 males (36.8%) and 978 females (63.2%). An overview of the socio-demographic characteristics of subjects is shown in **Table 1**.

TABLE 1 | Socio-demographic characteristics of subjects (N = 1,548).

	Participants
Gender	
Male, *n* (%)	570 (36.8)
Female, *n* (%)	978 (63.2)
Area	
Ho Chi Minh City, *n* (%)	862 (55.7)
Khanh Hoa Province, *n* (%)	110 (7.1)
Da Nang Province, *n* (%)	366 (23.6)
Thua Thien Hue Province, *n* (%)	91 (5.9)
Ha Noi Capital, *n* (%)	119 (7.7)
Grade	
Grade 10, *n* (%)	513 (33.1)
Grade 11, *n* (%)	462 (29.8)
Grade 12, *n* (%)	573 (37.0)
Average Mathematics Score	
<5.0, *n* (%)	63 (4.1)
5.0–6.0, *n* (%)	195 (12.6)
6.0–7.0, *n* (%)	356 (23.0)
7.0–8.0, *n* (%)	464 (30.0)
8.0–9.0, *n* (%)	347 (22.4)
9.0–10.0, *n* (%)	347 (22.4)
Career Choice	
Pedagogy, *n* (%)	239 (15.4)
Finance—Economics, *n* (%)	403 (26.0)
Social Sciences, *n* (%)	162 (10.5)
Natural Sciences, *n* (%)	158 (10.2)
Engineering—Industry, *n* (%)	180 (11.6)
Information Technology (IT), *n* (%)	152 (9.8)
Transportation Sector, *n* (%)	72 (4.7)
Medicine, *n* (%)	129 (8.3)
Others, *n* (%)	53 (3.4)

n: Number of participants.

2.2 Instrument and Procedures

2.2.1 Instrument

RMARS is a revised version of the original scale devised by Richardson and Suinn (1972); the measurement has 24 items and includes two aspects of mathematics anxiety measured by two subscales:

1) LMA is measured by 16 items and examines the anxiety caused by activities or processes of learning mathematics or statistics (a sample item is: "watching a teacher work an algebraic equation on the blackboard").
2) MEA is measured by 8 items and examines the anxiety caused by the assessment of mathematics or statistical learning process (a sample item is: "waiting to get a mathematics test returned in which you expected to do well").

RMARS is based on a 5-point Likert scale, which was used for all items, ranging from one to five (1 = never; 2 = rarely; 3 =

sometimes; 4 = regularly; 5 = always). Guidance for participants was provided at the top of the form.

Malhotra and Birks (2007) reported a method for ranking discrete values, as follows: (Maximum—Minimum)/n = (5–1)/5 = 0.8. Based on this method, the rankings used were never (1.00–1.80), rarely (1.81–2.60), sometimes (2.61–3.40), regularly (3.41–4.20) and always (4.21–5.00). In our total sample, Cronbach's alpha was 0.788. This value shows that the scale is significant and reliable.

The ACI was developed by Tero and Connell (1984) to assess students' coping strategies in academic contexts. The measurement is based on 13 items addressing four academic coping strategies: 1) positive coping comprises three items measuring adaptive strategies when students have poor experiences with mathematics; 2) projective coping comprises three items rating the extent to which students blame others for their problems; 3) denial coping comprises three items examining whether students downplay the importance of negative events or ignore failures in mathematics; and 4) non-coping comprises four items assessing whether students blame themselves for their failures in mathematics or worry about what others think of their mistakes. In our sample, Cronbach's alpha was 0.647, indicating that the scale is significant and reliable.

2.2.2 Procedures

An informed consent process was used and participation was completely voluntary; respondents could withdraw at any time and would not be penalised. For the questionnaires, the participants were informed of the research aims and asked to provide their age, gender, school, average mathematics score, residence location, and career choices. The students then completed the self-report information, with researchers present to help the students and ensure that the questionnaires were completed correctly. It took 3 months to collect the data as part of an 8-month research project, from October 2020 to May 2021.

The 24-item RMARS was translated for Vietnamese students. Firstly, we translated and validated the scale with permission from the author to use it in our research project. We then invited a native speaker of Vietnamese, who is fluent in English, familiar with the culture, and has a research background with experience of translation, to help with the translation exercise.

A Vietnamese native speaker translator created a forward translation of the scale. Then, the initial Vietnamese translation was reconciled by all members of the research group to agree the ultimate translation for backward translation.

The back-translation from Vietnamese to English was conducted by a professional translator (native speaker of English and fluent in Vietnamese) with no information on the initial scale. Ultimately, the analysis group compared the backward translation to the original to determine whether there were any significant differences or discrepancies.

Finally, further verification of the 24-item RMARS was performed with a group of 20 people to ensure there were no issues in the interpretation of the scale. After investigating the results of applying the scale, no problems arose and the final Vietnamese version of RMARS was formally adopted.

2.2.3 Data Analysis

A multivariate analysis of variance (MANOVA) test used to determine significant differences between mathematics anxiety and the independent variables (gender, grade, career orientation, and academic achievement). Pearson correlation was conducted to establish the relationship between mathematics anxiety, academic coping strategies, and independent variables. Multiple linear regression analysis was used to examine the relationship between the predictor variables (academic coping strategies, gender, grade) and the dependent variable (mathematics anxiety).

3 RESULT

3.1 Factorial Validity

The data were analyzed by using Analysis of Moment Structures (AMOS) version 20.0. The two-factor model of the 24-item RMARS, which included the LMA and MEA subscales, was evaluated using confirmatory factor analysis (CFA) (Plake and Parker, 1982) with the most widely used model fit indices:

- RMSEA (root mean square error of approximation). A value of RMSEA ≤0.08 shows a good fit and between 0.08 and 0.10 provides a mediocre fit (MacCallum et al., 1996). The RMSEA value of 0.05 indicates a good fit, RMSEA 90% confidence interval (0.047, 0.053), $p < 0.001$.
- GFI (goodness-of-fit index). A value of GFI ≥0.90 is considered a good model fit and GFI ≥0.95 was considered a well fit (Hair et al., 2018). In the present research, the GFI value was 0.94, which was higher than 0.90 and could be considered a good model fit.
- CFI (comparative fit index). The CFI value was 0.868, which is smaller than the standard value of 0.90 and this was not acceptable.
- TLI (Tucker-Lewis index). A value of TLI ≥0.90 is a good model fit and ≥0.95 is a well-fit (Bentler and Bonett, 1980; Sharma et al., 2005). The TLI value was 0.841, which was not fit.

The appropriate fit indices RMSEA and GFI imply that the two-factor model is a good fit with the data. The measurement model should meet the criteria for the goodness of fit so that further analysis can be undertaken (Halim et al., 2018).

CMIN/DF is a calculation of the chi-square ($\chi 2$) value divided by the degree of freedom. A value of CMIN/DF ≤ 2.00 shows a good model fit and CMIN/DF ≤ 5.00 shows an acceptable fit (Hair et al., 2018). CMIN/DF value was 4.815 and could be considered an acceptable fit.

3.2 Construct Validity

The value of Average Variance Extracted (AVE) was 0.151, which was under 0.5. Therefore, in the case of AVE was less than 0.5 but the composite reliability value in this study was 0.784, which was higher than 0.6, the convergent validity was still adequate (Fornell and Larcker, 1981). Discriminant validity was acceptable by

TABLE 2 | Descriptive statistics of mathematics anxiety.

Gender	Grade group			
	Grade 10	Grade 11	Grade 12	Combined
Males (N)	213	158	199	570
LMA				
M	3.34	3.36	3.44	3.38
SD	0.49	0.49	0.46	0.48
MEA				
M	3.35	3.28	3.41	3.35
SD	0.52	0.56	0.52	0.53
Females (N)	300	304	374	978
LMA				
M	3.29	3.29	3.35	3.31
SD	0.42	0.52	0.46	0.47
MEA				
M	3.36	3.23	3.4	3.34
SD	0.5	0.53	0.52	0.52

TABLE 3 | Correlation between LMA and MEA.

		LMA	MEA
LMA	Pearson Correlation	—	
	Sig. (2-tailed)		
	N	1548	
MEA	Pearson Correlation	0.576[a]	—
	Sig. (2-tailed)	0	
	N	1,548	1,548

[a]*Correlation is significant at the 0.01 level (2-tailed).*

Fornell and Larcker (1981) criterion. To evaluate discriminant validity, the AVE may be compared with the square of the correlations among the latent variables (Chin, 1998). The Average Variance Extracted (AVE) estimated for the two factors (LMA & MEA) was 0.162 (LMA) and 0.129 (MEA), which were lower than the square of the correlation between the two factors to provide evidence of discriminant validity which was 0.759.

3.3 Reliability

With a two-factor model of the 24-item RMARS, the study assessed the internal consistency of subscales using Cronbach's Alpha (Cronbach, 1951) and Composite Reliability (Wasko and Faraj, 2005). The values of Cronbach's alpha in this study were 0.81 (LMA) and 0.67 (MEA). Although Cronbach's alpha should be higher than 0.70 to ensure the reliability of the scale, values below 0.70 are still acceptable (Hair et al., 2007; Taber, 2018). The CR value of LMA was 0.725, which was higher than the recommended value of 0.7 (Fornell and Larcker, 1981) and the CR value of MEA was 0.505, which was lower than the recommended value. The CR of the 24-item RMARS was 0.784. Therefore, the variables in this study were considered reliable.

3.4 Descriptive Analysis

According to the norms for RMARS (Plake and Parker, 1982), the participants scored in the average range on the mathematics anxiety scale, with a mean of 3.34 (SD = 0.47) for the LMA subscale and 3.34 (SD = 0.52) for the MEA subscale. **Table 2** shows descriptive statistics of the dependent variables, including LMA and MEA results by gender and grade level groups.

3.5 Inferential Analysis

A MANOVA was performed with gender, grade, career choices and average mathematics score as independent variables, and the LMA and MEA subscales as dependent variables. To run MANOVA, the researchers conducted a preliminary analysis to examine the absence of multicollinearity and homogeneity of covariance matrices. Pearson correlations were performed between two dependent variables to test the MANOVA assumption that dependent variables would be moderately correlated with each other (Meyers et al., 2016). The correlation value r should not be greater than 0.90 (Tabachnick et al., 2007). As can be seen in **Table 3**, a meaningful pattern of correlations was observed amongst the two dependent variables, suggesting the appropriateness of using MANOVA.

The multivariate homogeneity of covariance matrices was examined using Box's M test; the M value of 861.630 was not significant ($p < 0.001$), hence the assumption of homogeneity of covariance matrices was not met. As a result, Pillai's trace value, a more robust statistic, was used to confirm the result.

A separate two-way univariate analysis of variance (ANOVA) for each of the dependent variables was conducted (**Table 4**). Levene's test of equality of error variances was used to test the assumption from the MANOVA and ANOVA that the variances for each variable are equal across the groups. If Levene's test is significant, this means that the assumption has not been satisfied. In this study, the value of Levene's test came out to be significant for all the variables in the LMA subscale [F (278, 1269) = 1.68, $p <$ 0.05], and MEA subscales [F (278, 1269) = 1.459, $p < 0.05$]. Therefore, when the follow-up ANOVAs were conducted, the results for LMA and MEA were interpreted with caution. A test of the standard deviations reported that none of the largest standard deviations was more than four times the size of the corresponding smallest, suggesting that the ANOVA was robust (Howell, 2007).

There was a significant difference in the level of mathematics anxiety between Grades 10, 11 and 12 when jointly considering LMA and MEA variables, Pillai's trace value = 0.01; F(4, 2538) = 3.051, $p = 0.016$, partial η2 = 0.005. Therefore, the results suggest that the first hypothesis (H1) should be rejected. A separate ANOVA was conducted for each dependent variable, with each ANOVA evaluated at an alpha level of 0.025 (that is, 0.05/2). There was a significant difference between Grades 10, 11 and 12 for MEA; F(2, 1269) = 3.861, $p = 0.021$, partial η2 = 0.006, with Grade 12 (M = 3.34, SD = 0.03) scoring higher than Grade 11 (M = 3.23, SD = 0.03) and Grade 10 (M = 3.29, SD = 0.03). There was no significant difference between Grades 10, 11 and 12 for LMA; F(2, 1269) = 3.121, $p = 0.044$, partial η2 = 0.005.

There was a significant difference in the level of mathematics anxiety according to career choice; Pillai's trace = 0.211, F(16, 2538) = 18.708, $p = 0.000$, partial η2 = 0.105. Therefore, the results suggest that the second hypothesis (H2) should be rejected. A separate ANOVA was conducted for each dependent variable. There was a significant difference between students' career

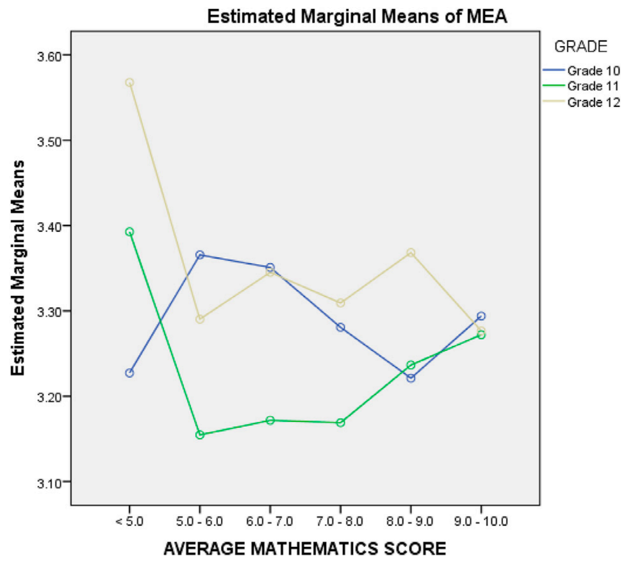

FIGURE 1 | Interaction plot.

choices in terms of LMA; $F(8, 1269) = 36.760$, $p = 0.000$, partial η2 = 0.188. Students choosing finance-economics (M = 3.53, SD = 0.03), or industrial engineering (M = 3.53, SD = 0.04) experienced higher levels of LMA than others. There was a significant difference between students' career choices on MEA; $F(8, 1269) = 14.379$, $p = 0.000$, partial η2 = 0.083. Students choosing finance-economics (M = 3.50, SD = 0.04) experienced higher levels of MEA than others.

There was no significant difference in the level of mathematics anxiety between male and female students in terms of LMA and MEA; Pillai's trace value = 0.003; $F(2, 1268) = 1.950$, $p = 0.143$, partial η2 = 0.003. Therefore, the results suggest that the third hypothesis (H3) should be rejected. With MEA, male students (M = 3.3, SD = 0.03) scored slightly higher than female students (M = 3.27, SD = 0.02). With LMA, male students (M = 3.3, SD = 0.02) scored slightly higher than female students (M = 3.22, SD = 0.02). However, these differences is statistically non-significant.

The results reveal that there is a significant multivariate effect on LMA and MEA in the interaction between grade level and students' average mathematics scores; Pillai's trace = 0.026, $F(20, 2538) = 1.664$, $p = 0.032$, partial η2 = 0.013. Therefore, the results suggest that the fifth hypothesis (Ho5) should be rejected. A separate ANOVA was conducted for each dependent variable. There was a significant difference between grade level and students' average mathematics scores on MEA; $F(10, 1269) = 2.251$, $p = 0.015$, partial η2 = 0.017. By looking at the interaction plots (**Figure 1**), students in Grade 11 (M = 3.39, SD = 0.11) and Grade 12 (M = 3.57, SD = 0.15) getting average mathematics scores below 5.0 had higher levels of MEA than others from the same school years. In Grade 10, students getting average mathematics scores 5.0–6.0 (M = 3.37, SD = 0.08) had higher levels of MEA than others from the same school years. The mean scores of students in MEA are presented in **Table 5**. There was no significant difference on LMA; $F(10, 1269) = 1,868$, $p = 0.056$, partial η2 = 0.015.

3.6 Correlation

Table 6 shows how mathematics anxiety correlates with academic coping strategies, average mathematics scores, and gender. The results are significant, with a moderately positive correlation between mathematics anxiety and positive coping ($r = 0.487$, $p < 0.01$); a weak positive correlation between mathematics anxiety and non-coping ($r = 0.213$, $p < 0.01$); gender ($r = 0.050$, $p < 0.05$); and average mathematics score ($r = 0.064$, $p < 0.05$). This finding shows that students with higher levels of positive coping and non-coping suffer mathematics anxiety to

TABLE 4 | The mean scores of students in MEA.

Dependent Variable	GRADE	AVERAGE MATHEMATICS SCORE	Mean	Std. Error	95% Confidence Interval	
					Lower Bound	Upper Bound
MEA	Grade 10	<5.0	3.227[a]	0.125	2.982	3.473
		5.0–6.0	3.366[a]	0.077	3.216	3.516
		6.0–7.0	3.351	0.066	3.221	3.481
		7.0–8.0	3.281	0.057	3.169	3.393
		8.0–9.0	3.221	0.055	3.114	3.329
		9.0–10.0	3.294[a]	0.082	3.134	3.454
	Grade 11	<5.0	3.393[a]	0.105	3.186	3.599
		5.0–6.0	3.155[a]	0.079	3.000	3.310
		6.0–7.0	3.172[a]	0.059	3.056	3.288
		7.0–8.0	3.169	0.064	3.043	3.295
		8.0–9.0	3.237[a]	0.060	3.119	3.354
		9.0–10.0	3.272[a]	0.104	3.067	3.477
	Grade 12	<5.0	3.568[a]	0.146	3.281	3.855
		5.0–6.0	3.290[a]	0.087	3.119	3.462
		6.0–7.0	3.345[a]	0.059	3.229	3.461
		7.0–8.0	3.309	0.056	3.199	3.420
		8.0–9.0	3.368	0.059	3.252	3.485
		9.0–10.0	3.276[a]	0.108	3.064	3.489

[a]*Based on modified population marginal mean.*

TABLE 5 | Combined univariate ANOVA.

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig	Partial Eta Squared
Corrected	LMA	144.587[a]	278	0.520	3.233	0.000	0.415
Model	MEA	124.075[b]	278	0.446	1.881	0.000	0.292
Intercept	LMA	5277.582	1	5277.582	32802.285	0.000	0.963
	MEA	5421.941	1	5421.941	22848.655	0.000	0.947
GENDER	LMA	0.592	1	0.592	3.679	0.055	0.003
	MEA	0.452	1	0.452	1.907	0.168	0.002
GRADE	LMA	1.004	2	0.502	3.121	0.044	0.005
	MEA	1.832	2	0.916	3.861	0.021	0.006
AMS	LMA	2.409	5	0.482	2.995	0.011	0.012
	MEA	1.497	5	0.299	1.262	0.278	0.005
CAREER	LMA	47.315	8	5.914	36.760	0.000	0.188
	MEA	27.296	8	3.412	14.379	0.000	0.083
GENDER * GRADE	LMA	0.999	2	0.499	3.105	0.045	0.005
	MEA	1.416	2	0.708	2.984	0.051	0.005
GENDER * AMS	LMA	1.280	5	0.256	1.591	0.159	0.006
	MEA	0.738	5	0.148	0.622	0.683	0.002
GENDER * CAREER	LMA	1.645	8	0.206	1.278	0.251	0.008
	MEA	1.114	8	0.139	0.587	0.790	0.004
GRADE * AMS	LMA	3.006	10	0.301	1.868	0.046	0.015
	MEA	5.257	10	0.526	2.215	0.015	0.017
GRADE * CAREER	LMA	3.520	16	0.220	1.368	0.149	0.017
	MEA	4.080	16	0.255	1.075	0.375	0.013
AMS * CAREER	LMA	8.932	40	0.223	1.388	0.056	0.042
	MEA	11.096	40	0.277	1.169	0.219	0.036
GENDER * GRADE * AMS	LMA	1.530	10	0.153	0.951	0.485	0.007
	MEA	1.649	10	0.165	0.695	0.730	0.005
GENDER * GRADE * CAREER	LMA	3.385	16	0.212	1.315	0.179	0.016
	MEA	6.590	16	0.412	1.736	0.035	0.021
GENDER * AMS * CAREER	LMA	7.073	37	0.191	1.188	0.205	0.033
	MEA	17.802	37	0.481	2.028	0.000	0.056
GRADE * AMS * CAREER	LMA	11.481	68	0.169	1.049	0.371	0.053
	MEA	21.529	68	0.317	1.334	0.039	0.067
GENDER * GRADE * AMS * CAREER	LMA	6.959	50	0.139	0.865	0.736	0.033
	MEA	12.674	50	0.253	1.068	0.349	0.040
Error	LMA	204.170	1269	0.161			
	MEA	301.131	1269	0.237			
Total	LMA	17592.535	1548				
	MEA	17741.234	1548				
Corrected Total	LMA	348.757	1547				
	MEA	425.206	1547				

[a]*R Squared = 0.415 (Adjusted R Squared = 0.286).*
[b]*R Squared = 0.292 (Adjusted R Squared = 0.137).*
Note: AMS: Average Mathematics Score.

TABLE 6 | Correlation.

	MA	*PC*	*PRC*	*DC*	*NC*	*AMS*	*GENDER*
MA							
PC	0.487[a]						
PRC	0.010	−0.117[a]					
DC	−0.131[a]	−0.254[a]	0.333[a]				
NC	0.213[a]	0.221[a]	0.121[a]	−0.130[a]			
AMS	0.064[b]	0.179[a]	−0.098[a]	−0.080[a]	−0.115[a]		
GENDER	0.050[b]	−0.028	0.017	0.082[a]	−0.127[a]	0.041	

[a]*Correlation is significant at the 0.01 level (2-tailed).*
[b]*Correlation is significant at the 0.05 level (2-tailed).*
Note: MA: Mathematics Anxiety; PC: Positive Coping; PRC: Projective Coping; DC: Denial Coping; NC: Non-Coping; AMS: Average Mathematics Score.

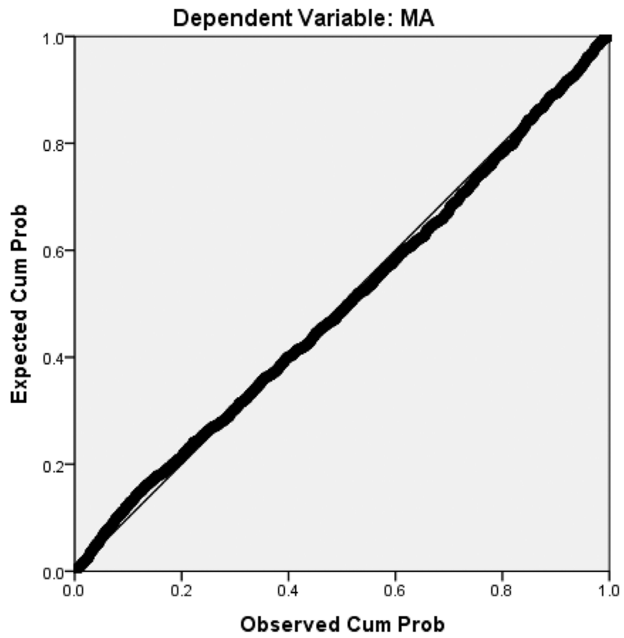

FIGURE 2 | Normal P-P-plot of the regression standardised residual.

a greater extent than others. In addition, the higher the mathematics anxiety level, the higher the average mathematics score. There was a significant, weak negative correlation between mathematics anxiety and denial coping (r = −0.131, $p < 0.01$), indicating that the higher the level of denial coping, the lower the level of mathematics anxiety and vice versa. Mathematics anxiety was not significantly correlated with projective coping strategies.

3.7 Regression

Multiple linear regression analysis was used to determine the factors influencing level of mathematics anxiety among high school students. Multiple linear regression analysis was performed with the following independent variables: academic coping strategies, including positive coping, projective coping, denial coping, and non-coping; students' average mathematics score; gender; grade; and career choice. The dependent variable was the mathematics anxiety scale. The preliminary assumption of multiple linear regression was used as the basis for examining multicollinearity. Additionally, the normal P-P plot of the regression standardised residuals shows that the scattered points are principally distributed on the diagonal, which suggests that the residuals could be judged to be normally distributed, as presented in **Figure 2**.

Multicollinearity was examined for all independent variables using Pearson's bivariate correlation. The correlation coefficients were less than 0.8, indicating that there was no multicollinearity between the independent variables (Allison, 1999). The variance inflation factor (VIF) and tolerance value were determined to test this assumption. The tolerance of every variable was higher than 0.1 and the VIF values for all variables were lower than 10, indicating that there was no multicollinearity between the independent variables in the multiple regression analysis (Uyanık and Güler, 2013). Therefore, the assumption was satisfied and the regression analysis was conducted.

Table 7 reveals that the corrected coefficient, Adjusted R2, was 0.384, indicating a change in the dependent variable, students' mathematics anxiety, due to a one-unit change in the independent variable. The regression model was statistically significant ($F(18, 1529) = 54.658$, $p < 0.001$, $R2 = 0.392$). The results of the multiple regressions with independent factors regressed against students' mathematics anxiety show that positive coping ($\beta = 0.198$, $p < 0.001$), projective coping ($\beta = 0.032$, $p < 0.05$), non-coping ($\beta = 0.036$, $p < 0.001$), gender ($\beta = 0.066$, $p < 0.05$), grade and career choices were significant predictors in the model.

Specifically, the difference in mathematics anxiety between grade 10 and grade 12 was −0.034. The difference in mathematics anxiety between grade 11 and grade 12 was −0.037. According to career choices, the difference in mathematics anxiety between Pedagogy students and others was 0.488. The difference in mathematics anxiety between Finance—Economics students and others was 0.672. The difference in mathematics anxiety between Social Sciences students and other students was 0.613. The difference in mathematics anxiety between Natural Sciences students and others was 0.484. The difference in mathematics anxiety between Engineering—Industry students and others was 0.725. The difference in mathematics anxiety between Information Technology (IT) students and others was 0.553. The difference in mathematics anxiety between Transportation Sector students and others was 0.136. The difference in mathematics anxiety between Medicine students and others was 0.578.

However, mathematics anxiety shows non-significant associations with average mathematics scores and denial coping strategies. Regression analysis showed that factors including positive coping, projective coping, non-coping, gender, grade, and students' future career choices are significant predictors of mathematics anxiety. When examining the interaction, results revealed non-significant interaction between grade and average mathematics scores in predicting mathematics anxiety among students.

4 DISCUSSION

The main aims of this research were twofold: firstly, to examine mathematics anxiety among Vietnamese high school students, and secondly, to test the correlation between students' mathematics anxiety and academic coping strategies.

The analysis was intriguing to the authors. It did not show any differences in mathematics anxiety between male and female high school students; this is a significant contribution to research on underlying gender differences in relation to mathematics anxiety. It was predicted that the findings would support the hypothesis that mathematics anxiety reduces the mathematics achievement of students; however, the fourth hypothesis was accepted. Although the result showed that there was a correlation between mathematics anxiety and mathematics achievement, mathematics anxiety had a non-significant effect on

TABLE 7 | The results of multiple regression analysis of mathematics anxiety.

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	F	R2	Adjusted R2
		B	Std. Error	Beta					
1	(Constant)	1.795	0.088		20.482	0.000			
	PC	0.198	0.012	0.369	16.566	0.000			
	PRC	0.032	0.012	0.058	2.685	0.007			
	DC	−0.009	0.011	−0.018	−0.807	0.420	54.658	0.392	0.384
	NC	0.036	0.009	0.087	4.060	0.000			
	AMS	0.002	0.013	0.007	0.191	0.849			
	GENDER	0.066	0.019	0.072	3.472	0.001			
	GRADE10	−0.034	0.069	−0.036	−0.485	0.628			
	GRADE11	−0.037	0.069	−0.038	−0.528	0.598			
	Pedagogy	0.488	0.053	0.400	9.158	0.000			
	Finance_Economics	0.672	0.052	0.671	13.053	0.000			
	NaturalScience	0.484	0.055	0.332	8.730	0.000			
	SocialSciences	0.613	0.056	0.426	11.001	0.000			
	Engineering_Industry	0.725	0.055	0.527	13.127	0.000			
	InformationTechnology	0.553	0.056	0.373	9.814	0.000			
	TransportationSector	0.136	0.063	0.063	2.140	0.033			
	Medicine	0.578	0.057	0.362	10.105	0.000			
	GRADE10*AMS	−0.008	0.017	−0.034	−0.438	0.661			
	GRADE11*AMS	−0.004	0.018	−0.015	−0.208	0.835			

mathematics achievement. The other important finding is that the more students suffer from mathematics anxiety, the more they adopt positive coping strategies.

These findings reinforce the general belief that students in Grade 12 suffer more from mathematics anxiety than those in Grades 10 and 11. The education curriculum in high school, especially in Grade 12, includes demanding academic tasks and complex academic content that give rise to academic pressure. Moreover, Grade 12 students have to pass a graduation examination to enroll in their desired university. Academic pressure can also be a consequence of parental pressure (Deb et al., 2015), which impacts students' mental health and leads to psychological problems related to mathematics anxiety. Our results do not show any significant correlation that contradicts the findings of Lew and Hwang (2019), who reported that Grade 11 students had the highest level of mathematics anxiety and Grade 12 students the lowest. Another study found that there is no significant difference in the levels of mathematics anxiety between grades (Luo et al., 2009).

This study shows that students choosing to pursue finance-economics or industrial engineering at a higher education level have greater levels of mathematics anxiety than others. This finding is in contrast with previous studies and can be explained in a number of ways. Chipman et al. (1992) reported that students with mathematics anxiety were likely to choose degree courses with the minimum requirements for knowledge related to mathematics, such as the arts and humanities, languages, politics, and psychology and sociology, instead of courses such as natural science and economics (Zettle and Raines, 2000). Finance-economics and industrial engineering are popular specialties requiring substantial mathematics knowledge. Moreover, one of the most important criteria for applying to these courses, is the score in the entrance examination, which has gradually risen each year in Vietnam. This rise could be interpreted in two ways: 1) higher levels of competence are needed for career choices, for instance, international collaboration, multidisciplinary knowledge, and subject knowledge (Tran et al., 2016); and 2) the number of students applying to finance-economics and industrial engineering courses has gradually increased which has led to greater competition. The higher level of mathematics anxiety among students pursuing finance-economics and industrial engineering may be a direct consequence of the increasing score requirement.

Gender differences in mathematics anxiety have been thoroughly studied and well documented. Specifically, mathematics anxiety has been found to be significantly higher in female students than in male students (Karimi and Venkatesan, 2009; Luo et al., 2009; Cheema and Sheridan, 2015; Lew and Hwang, 2019). However, when comparing our results to those of previous studies, the results run counter to the way in which gender difference has been debated in the fields of psychology and educational science. Several studies have found results that are consistent with our reported findings. Keshavarzi and Ahmadi (2013), and Akbayir (2019), also found no difference between male and female high school students in levels of mathematics anxiety. Until now, gender differences in mathematics anxiety have been assumed to be influenced by factors such as a student's attraction to the mathematics field (Keshavarzi and Ahmadi, 2013); the possibility that females are more willing to disclose anxiety(Ashcraft, 2002); social stereotypes about women and mathematical abilities (Beilock et al., 2007); spatial processing ability (Maloney and Beilock, 2012); and gender differences in stress reactivity (Altemus et al., 2014). In modern Vietnamese society, underestimation of the success of females in mathematics has been transmuted into respect for their abilities and achievements. This alteration in the Vietnamese context has contributed to removing gender stereotypes and increased self-confidence among females. Thus, female anxiety has decreased. Our findings on gender differences in mathematics anxiety could be explained by this shift.

The present research found an interaction between grade level and students' academic achievement. Specifically, students in Grade 11 and Grade 12 attaining an average score below 5.0 experienced higher levels of MEA than others from the same school years. This finding shows that students with low average scores are likely to experience greater anxiety associated with a mathematical examination or test. In the Vietnamese educational context, tests, and examinations in compulsory education, especially in high school, are widely regarded as an essential and effective tool for evaluating personal qualities. Therefore, low and poor scores lead to negative feelings, such as disappointment, embarrassment, irritation, stress and anxiety. This finding is very similar to results that have been previously reported. For example, Nicholson (2009) found that the academic achievement of Grade 11 students is negatively affected by anxiety related to tests. Another study, conducted by Karatas et al. (2013), found that the more test anxiety that students experienced, the poorer their score in university entrance examinations. Additionally, grade point averages could be affected by high levels of test anxiety (Whitaker Sena et al., 2007; Von Der Embse et al., 2013). Tests and examinations have negative effects not only on students' academic achievement but also on their health (Zeidner, 1998). Moreover, this anxiety is a factor inhibiting students from achieving their academic goals and demonstrating their full potential in the learning process (Zoller and Ben-Chaim, 1990).

Our data analysis reveals that there is a positive correlation between the level of mathematics anxiety and mathematics achievement among students. The result shows that individuals who have high levels of mathematics anxiety tend to have higher average scores in mathematics. Specifically, students attaining averages from 9.0 to 10.0 experience greater LMA than others. This is an interesting finding, as it is contrary to what we know from previous studies (Karimi and Venkatesan, 2009; Lew and Hwang, 2019; Milovanović, 2020), which have reported a significant negative correlation between mathematics anxiety and mathematics achievement. However, few previous studies have been conducted to explain the negative relationship between mathematics anxiety and mathematics achievement. This relationship could be associated with reduced student effort and comprehension in the learning process; reduced accomplishment of study goals (Lew and Hwang, 2019); low mathematics ability (Tobias, 1986; Hembree, 1990; Ma and Xu, 2004); and students' understanding and self-confidence in mathematics (Zakaria et al., 2012). For a long time in the Vietnamese educational context, grade point averages were considered to be the standard for evaluating whether students accomplished academic goals and gained academic achievements. Specifically, mathematics is an important subject for all students in the educational system and a compulsory subject in entrance and graduation exams. This situation increased students' determination to complete mathematics-related tasks and attain better performance in the field of mathematics. The higher the average score attained by a student, the greater their interest in education, and this led to anxiety about mathematics among students. Our views on the association between mathematics anxiety and mathematics achievement can be clarified by these explanations.

The relation between positive coping strategies and mathematics anxiety has been examined in detail in the studies mentioned. In particular, mathematics anxiety has been found to be negatively correlated with positive coping strategies. The higher the levels of mathematics anxiety that students experience, the less likely they are to adopt positive coping strategies (Skaalvik, 2018). The findings from the present study are the reverse. Our findings show that there is a positive relationship between mathematics anxiety and positive coping strategies among students. For decades, traditional education in Vietnam has created a favourable learning environment for enhancing students' knowledge, self-regulated learning ability, academic self-concept, motivation, and coping strategies. Several prior studies have examined academic motivation and self-regulated learning affecting the learning process of students; for instance, encouraging students to engage in learning-related tasks more efficiently (Zeynali et al., 2019), and proactively managing students' learning environment (Pintrich, 1999). Salomon and Ket (2007) reported that Vietnamese society is influenced by Confucian traditions. Specifically, the academic self-concept is considered particularly important in Vietnam's education system, placing a strong emphasis on students' willingness to persevere and their working hard. For these reasons, when students face academic challenges, obstacles and difficulties in mathematics, they tend to focus on solving problems rather than blaming others for their mistakes or ignoring negative events. Therefore, the higher the level of mathematics anxiety that students experience, the more likely they are to adopt positive coping, understanding their mistakes and working out how to do better the next time.

4.1 Limitations

This study has several limitations. The first is that participants were not distributed uniformly; specifically, female participants outnumbered male participants by a proportion of approximately two to one, and this may affect the inaccuracy of the results. Therefore, future research should be conducted to validate the findings of this study. Also, only five factors were examined in researching the influences of mathematics anxiety in high school students. Thus, other factors, such as teacher attitude, classroom environment, learning programs and teaching methods could be included in future investigations.

5 CONCLUSION AND IMPLICATIONS

Mathematics anxiety is an unpleasant emotional state, with tension and anxiety that affect the ability to manipulate numbers and participate in the mathematical learning process. This research makes a substantial contribution on the issue, as follows: 1) it highlights the effects of academic achievement and students' career choices on mathematics anxiety; 2) it provides additional evidence of non-significant effects of gender difference on mathematics anxiety; 3) it offers insights into academic coping strategies that students adopt to overcome mathematics anxiety.

Future research should be designed to study factors influencing the relationship between academic achievement, gender difference and mathematics anxiety in more depth. Additionally, further investigation is necessary to evaluate the significant impact of academic coping strategies on anxiety in the learning process.

Our study contributes to the general discussion about the relationship between mathematics anxiety and academic coping strategies (Skaalvik, 2018), grade (Lew and Hwang, 2019), academic achievement (Puteh and Khalin, 2016), and students' career choices (Chipman et al., 1992). Besides, the results are helpful for making students aware of mathematics anxiety, protecting themselves from mental illness such as stress, anxiety disorders and depression, and enhancing students' mental health during the learning process. From that, students could understand their mental health status and implement coping strategies to get over their academic anxiety. Our findings provide additional information for teachers, school counselors to realize student's negative emotions, opportunely support, and find appropriate methods to alleviate student's negative emotions during the teaching process (Asikhia et al., 2015; Olaoluwa, 2021). Moreover, educators can design mathematics curriculum integrating theories and practices, and develop psychological support programs for Vietnamese high school students (Van et al., 2019) such as organizing hands-on activities in mathematics learning, applying cooperative learning in small-group learning, providing extra tuition sessions, organizing more discussions activities and more student directed classroom, and focusing on individual mathematics improvement. It is also essential to create support groups about mathematics in school that students can share and socialize during the learning process.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding author.

AUTHOR CONTRIBUTIONS

V-LT-C contributed to conception and design of the study. H-TL-T, T-TN-T, M-TN-T, TT-L, and B-TN-D organized the database. T-TN-T and M-TN-T performed the statistical analysis. H-TL-T, T-TN-T, M-TN-T, TT-L, and B-TN-D wrote the first draft of the manuscript. All authors contributed to manuscript revision, read, and approved the submitted version.

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REFERENCES

Ader, E., and Erktin, E. (2010). Coping as Self-Regulation of Anxiety: A Model for Math Achievement in High-Stakes Tests. *Cogn. Brain Behav.* 14 (4), 311.

Akbayır, K. (2019). An Investigation about High School Students' Mathematics Anxiety Level According to Gender. *Jets*, 7(7), 62–70. doi:10.11114/jets.v7i7.4201

Al Mutawah, M. A. (2015). The Influence of Mathematics Anxiety in Middle and High School Students Math Achievement. *Ies*, 8(11), 239–252. doi:10.5539/ies.v8n11p239

Allison, P. D. (1999). *Multiple Regression: A Primer*. Thousand Oaks, CA: Pine Forge Press.

Altemus, M., Sarvaiya, N., and Neill Epperson, C. (2014). Sex Differences in Anxiety and Depression Clinical Perspectives. *Front. Neuroendocrinol* 35 (3), 320–330. doi:10.1016/j.yfrne.2014.05.004

Ashcraft, M. H., and Kirk, E. P. (2001). The Relationships Among Working Memory, Math Anxiety, and Performance. *J. Exp. Psychol. Gen.* 130 (2), 224–237. doi:10.1037/0096-3445.130.2.224

Ashcraft, M. H. (2002). Math Anxiety: Personal, Educational, and Cognitive Consequences. *Curr. Dir. Psychol. Sci.* 11 (5), 181–185. doi:10.1111/1467-8721.00196

Asikhia, O. A., and Mohangi, K. J. G. (2015). *The Use of Problem-Solving Training in Reducing Mathematics Anxiety Among Nigerian Secondary School Students*. 13(1), 6547–6558.

Beilock, S. L., Rydell, R. J., and McConnell, A. R. (2007). Stereotype Threat and Working Memory: Mechanisms, Alleviation, and Spillover. *J. Exp. Psychol. Gen.* 136 (2), 256–276. doi:10.1037/0096-3445.136.2.256

Bentler, P. M., and Bonett, D. G. (1980). Significance Tests and Goodness of Fit in the Analysis of Covariance Structures. *Psychol. Bull.* 88 (3), 588–606. doi:10.1037/0033-2909.88.3.588

Betz, N. E. (1978). Prevalence, Distribution, and Correlates of Math Anxiety in College Students. *J. Couns. Psychol.* 25 (5), 441–448. doi:10.1037/0022-0167.25.5.441

Bursal, M., and Paznokas, L. (2006). Mathematics Anxiety and Preservice Elementary Teachers' Confidence to Teach Mathematics and Science. *Sch. Sci. Maths.* 106 (4), 173–180. doi:10.1111/j.1949-8594.2006.tb18073.x

Cheema, J. R., and Sheridan, K. (2015). Time Spent on Homework, Mathematics Anxiety and Mathematics Achievement: Evidence from a US Sample. *Issues Educ. Res.* 25 (3), 246–259.

Chin, W. W. (1998). *The Partial Least Squares Approach to Structural Equation Modeling*, 295. Mahwah State, NJ: Modern methods for business research.

Chipman, S. F., Krantz, D. H., and Silver, R. (1992). Mathematics Anxiety and Science Careers Among Able College Women. *Psychol. Sci.* 3 (5), 292–296. doi:10.1111/j.1467-9280.1992.tb00675.x

Cronbach, L. J. (1951). Coefficient Alpha and the Internal Structure of Tests. *Psychometrika* 16 (3), 297–334. doi:10.1007/BF02310555

Deb, S., Strodl, E., and Sun, H. (2015). Academic Stress, Parental Pressure, Anxiety and Mental Health Among Indian High School Students. *Int. J. Psychol. Behav. Sci.* 5 (1), 26–34. doi:10.5923/j.ijpbs.20150501.04

Espino, M., Pereda, J., Recon, J., Perculeza, E., and Umali, C. (2017). Mathematics Anxiety and its Impact on the Course and Career Choice of Grade 11 Students. *Int. J. Educ. Psychol. Counselling* 2 (5), 99–119.

Fornell, C., and Larcker, D. F. (1981). Evaluating Structural Equation Models with Unobservable Variables and Measurement Error. *J. marketing Res.* 18 (1), 39–50. doi:10.1177/00224378101800104 10.2307/3151312

Friedel, J. M., Cortina, K. S., Turner, J. C., and Midgley, C. (2007). Achievement Goals, Efficacy Beliefs and Coping Strategies in Mathematics: The Roles of Perceived Parent and Teacher Goal Emphases. *Contemp. Educ. Psychol.* 32 (3), 434–458. doi:10.1016/j.cedpsych.2006.10.009

Hackett, G. (1985). Role of Mathematics Self-Efficacy in the Choice of Math-Related Majors of College Women and Men: A Path Analysis. *J. Couns. Psychol.* 32 (1), 47–56. doi:10.1037/0022-0167.32.1.47

Hair, J., Black, W., Babin, B., and Anderson, R. (2018). *Multivariate Data Analysis*. 8th Edn.. London: Cengage.

Hair, J. F., Money, A. H., Samouel, P., and Page, M. (2007). *Research Methods for Business*. Chichester, United Kingdom: Education+ Training.

Hembree, R. (1990). The Nature, Effects, and Relief of Mathematics Anxiety. *Jrme*, 21(1), 33–46. doi:10.5951/jresematheduc.21.1.0033

Ho, H.-Z., Senturk, D., Lam, A. G., Zimmer, J. M., Hong, S., Okamoto, Y., et al. (2000). The Affective and Cognitive Dimensions of Math Anxiety: A Cross-National Study. *J. Res. Math. Educ.*, 31(3), 362–379. doi:10.2307/749811

Howell, D. (20072007). *Statistical Methods for Psychology*. Belmont, CA: Thomson Wadsworth, 1–739.

Jackson, C. D., and Leffingwell, R. J. (1999). The Role of Instructors in Creating Math Anxiety in Students from Kindergarten through College. *Mt*, 92(7), 583–586. doi:10.5951/MT.92.7.0583

Karatas, H., Alci, B., and Aydin, H. (2013). Correlation Among High School Senior Students Test Anxiety, Academic Performance and Points of university Entrance Exam. *Educ. Res. Rev.*, 8(13), 919–926. doi:10.5897/ERR2013.1462

Karimi, A., and Venkatesan, S. (2009). Mathematics Anxiety, Mathematics Performance and Academic Hardiness in High School Students. *Int. J. Educ. Sci.*, 1(1), 33–37. doi:10.1080/09751122.2009.11889973

Keshavarzi, A., and Ahmadi, S. (2013). A Comparison of Mathematics Anxiety Among Students by Gender. *Proced. - Soc. Behav. Sci.*, 83, 542–546. doi:10.1016/j.sbspro.2013.06.103

Krypel, M. N., and Henderson-King, D. (2010). Stress, Coping Styles, and Optimism: Are They Related to Meaning of Education in Students' Lives? *Soc. Psychol. Educ.*, 13(3), 409–424. doi:10.1007/s11218-010-9132-0

Kurniawan Halim, J., Margaretha, S., and Rahardja Honantha, C. (2018). Consumer's Response to E-Mail Advertisement from Tour and Travel agency in Indonesia. *Adv. Soc. Sci. Edu. Humanities Res.*, 186, 162–165. doi:10.2991/insyma-18.2018.40

Kyttälä, M., and Björn, P. M. (2010). Prior Mathematics Achievement, Cognitive Appraisals and Anxiety as Predictors of Finnish Students' Later Mathematics Performance and Career Orientation. *Educ. Psychol.*, 30(4), 431–448. doi:10.1080/01443411003724491

Lazarus, R. S. (2013). Fifty Years of the Research and Theory of R.S. Lazarus. In *Fifty Years of the Research and Theory of RS Lazarus: An Analysis of Historical and Perennial Issues* (pp. 366–388). New York City, NY: Psychology Press. doi:10.4324/9780203774595

Lent, R. W., Brown, S. D., and Hackett, G. (1994). Toward a Unifying Social Cognitive Theory of Career and Academic Interest, Choice, and Performance. *J. Vocational Behav.* 45 (1), 79–122. doi:10.1006/jvbe.1994.1027

Lent, R. W., Brown, S. D., Talleyrand, R., McPartland, E. B., Davis, T., Chopra, S. B., et al. (2002). Career Choice Barriers, Supports, and Coping Strategies: College Students' Experiences. *J. Vocational Behav.*, 60(1), 61–72. doi:10.1006/jvbe.2001.1814

Lew, K., and Hwang, S. (2019). A Study on the Correlation between Mathematics Anxiety and Mathematics Achievement in High School Students. *Math. Edu.*, 58(3), 337–346. doi:10.7468/mathedu.2019.58.3.337

Luo, X., Wang, F., and Luo, Z. (2009). Investigation and Analysis of Mathematics Anxiety in Middle School Students. *J. Math. Edu.*, 2(2), 12–19. doi:10.7468/mathedu.2019.58.3.337

Ma, X., Xu, J., and Xu, J. 2004). The Causal Ordering of Mathematics Anxiety and Mathematics Achievement: a Longitudinal Panel Analysis. *J. Adolesc.*, 27(2), 165–179. doi:10.1016/j.adolescence.2003.11.003

Ma, X. (1999). A Meta-Analysis of the Relationship between Anxiety toward Mathematics and Achievement in Mathematics. *J. Res. Math. Educ.*, 30(5), 520–540. doi:10.2307/749772

MacCallum, R. C., Browne, M. W., and Sugawara, H. M. (1996). Power Analysis and Determination of Sample Size for Covariance Structure Modeling, *Psychol. Methods*. 1(2), 130–149. doi:10.1037/1082-989X.1.2.130

Malhotra, N. K., and Birks, D. (2007). Marketing Research. in *Essex*. European Edition (Essex, United Kingdom: An Applied Approach).

Maloney, E. A., and Beilock, S. L. (2012). Math Anxiety: Who Has it, Why it Develops, and How to Guard against it. *Trends Cogn. Sci.*, 16(8), 404–406. doi:10.1016/j.tics.2012.06.008

Mau, W.-C., Domnick, M., and Ellsworth, R. A. (1995). Characteristics of Female Students Who Aspire to Science and Engineering or Homemaking Occupations. *Career Dev. Q.*, 43(4), 323–337. doi:10.1002/j.2161-0045.1995.tb00437.x

McAnallen, R. R. (2010). *Examining Mathematics Anxiety in Elementary Classroom Teachers*. Connecticut: University of Connecticut.

Meyers, L. S., Gamst, G., and Guarino, A. J. (2016). *Applied Multivariate Research: Design and Interpretation*. Thousand Oaks, CA: Sage publications.

Milovanović, I. (2020). Math Anxiety, Math Achievement and Math Motivation in High School Students: Gender Effects. *Croat. J. Edu.*, 22(1), 175–206. doi:10.15516/cje.v22i1.3372

Minsoo, E., Zain, N. M., Ahmad, N. A., and Erlina, A. (2012). Mathematics Anxiety and Achievement Among Secondary School Students. *Am. J. Appl. Sci.*, 9(11), 1828–1832. doi:10.3844/ajassp.2012.1828.1832

M., P., and S. Z., K. (2016). Mathematics Anxiety and its Relationship with the Achievement of Secondary Students in Malaysia. *Ijssh*, 6(2), 119–122. doi:10.7763/IJSSH.2016.V6.630

Nicholson, A. M. (2009). *Effects of Test Anxiety on Student Achievement (ACT) for College Bound students Doctoral Dissertation*. Tennessee: Trevecca Nazarene University. School of Education.

Oberlin, L. (1982). How to Teach Children to Hate Mathematics. *Sch. Sci. Maths.*, 82(3), 261. doi:10.1111/j.1949-8594.1982.tb17187.x

Olaoluwa, S. A. (2021). Applying Cognitive Therapy for Depression and Anxiety in Mathematics Education for Students' Sustainable Performance, *Ce*. 12(6), 1407–1418. doi:10.4236/ce.2021.126107

Pintrich, P. R. (1999). The Role of Motivation in Promoting and Sustaining Self-Regulated Learning. *Int. J. Educ. Res.*, 31(6), 459–470. doi:10.1016/S0883-0355(99)00015-4

Plake, B. S., and Parker, C. S. (1982). The Development and Validation of a Revised Version of the Mathematics Anxiety Rating Scale. *Educ. Psychol. Meas.*, 42(2), 551–557. doi:10.1177/001316448204200218

Salomon, M., and Kêt, V. D. (2007). i M I, Education and Identity Formation in Contemporary Vietnam. *Compare: A J. Comp. Int. Edu.*, 37(3), 345–363. doi:10.1080/03057920701330222

Sena, J. D., Lowe, P. A., and Lee, S. W. (2007). Significant Predictors of Test Anxiety Among Students with and without Learning Disabilities. *J. Learn. Disabil.*, 40(4), 360–376. doi:10.1177/00222194070400040601

Sharma, S., Mukherjee, S., Kumar, A., and Dillon, W. R. (2005). A Simulation Study to Investigate the Use of Cutoff Values for Assessing Model Fit in Covariance Structure Models. *J. Business Res.*, 58(7), 935–943. doi:10.1016/j.jbusres.2003.10.007

Singer, J. M., and Stake, J. E. (1986). Mathematics and Self-Esteem: Implications for Women's Career Choice. *Psychol. women Q.*, 10(4), 339–352. doi:10.1111/j.1471-6402.1986.tb00759.x

Skaalvik, E. M. (2018). Mathematics Anxiety and Coping Strategies Among Middle School Students: Relations with Students' Achievement Goal Orientations and Level of Performance. *Soc. Psychol. Educ.*, 21(3), 709–723. doi:10.1007/s11218-018-9433-2

Sue, D., Sue, D. W., Sue, S., and Sue, D. M. (2015). *Understanding Abnormal Behavior*. New York City, NY: Cengage Learning.

Suinn, R. M., Edie, C. A., Nicoletti, J., and Spinelli, P. R. 1972). The MARS, a Measure of Mathematics Anxiety: Psychometric Data. *J. Clin. Psychol.*, 28(6), 373–375. doi:10.1037/h0033456doi:10.1002/1097-4679(197207)28:3+<373: aid-jclp2270280320>3.0.co;2-c

Tabachnick, B. G., Fidell, L. S., and Ullman, J. B. (2007). *Using Multivariate Statistics*, 5. MA: Pearson Boston.

Taber, K. S. (2018). The Use of Cronbach's Alpha when Developing and Reporting Research Instruments in Science Education. *Res. Sci. Educ.*, 48(6), 1273–1296. doi:10.1007/s11165-016-9602-2

Taylor, B. A., and Fraser, B. J. (2013). Relationships between Learning Environment and Mathematics Anxiety. *Learn. Environ Res*, 16(2), 297–313. doi:10.1007/s10984-013-9134-x

Tero, P., and Connell, J. (1984). *When Children Think They've Failed: An Academic Coping Inventory*. Unpublished manuscript. New Orleans, LA: University of Rochester.

Thanh Tra, K. T. (2019). *Depression, Anxiety and Stress Among Students in Ho Chi Minh City*, 98–104.

Tobias, S. (1986). Anxiety and Cognitive Processing of Instruction. *Self-related Cogn. anxiety Motiv.*, 35–54. doi:10.4324/9780203781609

Tran, L., Marginson, S., Do, H., Le, T., Nguyen, N., Vu, T., et al. (2016). *Higher Education in Vietnam: Flexibility, Mobility and Practicality in the Global Knowledge Economy*. Palgrave Macmillan. doi:10.1057/9781137436481

Uyanık, G. K., and Güler, N. (2013). A Study on Multiple Linear Regression Analysis. *Proced. - Soc. Behav. Sci.*, 106, 234–240. doi:10.1016/j.sbspro.2013.12.027

Van, N. T. (2018). Mức Độ Lo Âu Của Học Sinh Trung Học Phổ Thông Tại Thành Phố Hồ Chí Minh. *Tạp chí Khoa học* 15 (1), 117–127.

Van, S. H., Thien, V. G., Tat, T. D., Tran, L., and Duc, H. D. J. E. J. o. E. R. (2019). The Stress Problems and the Needs for Stress Counseling of High School Students in Vietnam. *Eur. J Ed Res* 8 (4), 1053–1061. doi:10.12973/eu-jer.8.4.1053

Von Der Embse, N., Barterian, J., and Segool, N. (2013). Test Anxiety Interventions for Children and Adolescents: A Systematic Review of Treatment Studies from 2000-2010. *Psychol. Schs.*, 50(1), 57–71. doi:10.1002/pits.21660

Wasko, M. M., and Faraj, S. J. M. q. (2005). Why Should I Share? Examining Social Capital and Knowledge Contribution in Electronic Networks of Practice. *MIS Q.*, 29(1), 35–57. doi:10.2307/25148667

Wiedemann, K. (2001). Anxiety and Anxiety Disorders. *Int. Encyclopedia Soc. Behav. Sci.*, 1, 560–567. doi:10.1016/B0-08-043076-7/03760-8

Woodard, T. (2004). The Effects of Math Anxiety on Post-Secondary Developmental Students as Related to Achievement, Gender, and Age. *Inquiry*, 9 (1).

Yüksel-Şahin, F. (2008). Mathematics Anxiety Among 4th and 5th Grade Turkish Elementary School Students. *Int. Electron. J. Maths. Edu.* 3 (3), 179–192.

Zeidner, M. (1998). *Test Anxiety: The State of the Art*. Kluwer Academic.

Zettle, R. D., and Houghton, L. L. (1998). The Relationship between Mathematics Anxiety and Social Desirability as a Function of Gender. *Coll. Student J.* 32 (1), 81–86.

Zettle, R. D., and Raines, S. J. (2000). The Relationship of Trait and Test Anxiety with Mathematics Anxiety. *Coll. Student J.* 34 (2), 246–259.

Zeynali, S., Pishghadam, R., and Hosseini Fatemi, A. (2019). Identifying the Motivational and Demotivational Factors Influencing Students' Academic Achievements in Language Education. *Learn. Motiv.*, 68, 101598. doi:10.1016/j.lmot.2019.101598

Zoller, U., and Ben-Chaim, D. (1990). Gender Differences in Examination-type Preferences, Test Anxiety, and Academic Achievements in College Science Education-A Case Study. *Sci. Ed.*, 74(6), 597–608. doi:10.1002/sce.3730740603

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