International Electronic Journal of Mathematics Education
2022, 17(3), em0692
e-ISSN: 1306-3030
https://www.iejme.com

MODESTUM

Research Article

OPEN ACCESS

Exploring mathematics anxiety among primary school students: Prevalence, mathematics performance and gender

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Citation: Mitchell, L., & George, L. (2022). Exploring mathematics anxiety among primary school students: Prevalence, mathematics performance and gender. *International Electronic Journal of Mathematics Education, 17*(3), em0692. https://doi.org/10.29333/iejme/12073

ARTICLE INFO

Received: 2 Apr. 2022

Accepted: 26 Apr. 2022

ABSTRACT

This quantitative, survey research investigated the prevalence of mathematics anxiety among 62 fourth and sixth grade primary level students (aged nine to 12 years). It also explored the correlation between mathematics performance and mathematics anxiety as well as if there was a significant, statistical difference between the mathematics anxiety of males and females. The data relating to mathematics anxiety and mathematics performance were collected using the modified abbreviated math anxiety scale (mAMAS) and a teacher-made mathematics test, respectively. This data was analyzed using descriptive statistics, the Mann Whitney U test and Spearman rank order correlation. The results indicated that the prevalence of mathematics anxiety was high among the sample of grade four students while the prevalence rate was considerably lower among the sample of sixth graders. Small, non-significant positive and negative correlations were recorded between mathematics performance and mathematics anxiety for grade four and six students, respectively. Gender differences relating to mathematics anxiety were also non-significant. In light of these mixed findings practical implications and potential directions for future research are discussed.

Keywords: mathematics anxiety, mathematics performance, primary school, gender

INTRODUCTION

Mathematics anxiety, which is defined as “a feeling of tension and anxiety that interferes with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations” (Richardson & Suinn, 1972, p. 551), is an important component of the affective domain that plays a key role in students’ engagement with mathematics (Dowker et al., 2019; Ersozlu & Karakus, 2019; Maloney & Beilock, 2012). As a result of this, over the last few years there has been increased scholarly attention involving a wide range of jurisdictions (Morsanyi et al., 2016). Some of the facets of mathematics anxiety that have been explored in previous research include its prevalence among different samples, relationship to psychological and educational constructs such as mathematics performance and working memory (Ersozlu & Karakus, 2019; Luttenberger et al., 2018; Paechter et al., 2017), and the avoidance of certain career paths (Van Mier et al., 2019).

Despite this increase in the number of published research studies related to mathematics anxiety, there are still a number of gaps in the empirical literature which remain. For example, there is still no general consensus as it relates to how prevalent mathematics anxiety is in different jurisdictions and with different populations, such as individuals from developing countries (Cipora et al., 2022). Furthermore, few studies have investigated mathematics anxiety at the primary school level (Luttenberger et al., 2018), where some researchers posit that it begins to develop (Devine et al., 2012). Also, the relationship between mathematics anxiety and mathematics performance in primary school student samples is also not wholly known and so could benefit from additional research (Sorvo et al., 2017). Additionally, there is no clear pattern of gender differences found for different children of different ages, at different grade levels, in different jurisdictions (Van Mier et al., 2019). The aforementioned is also underscored by Else-Quest et al. (2010) who suggest that more research is needed to establish whether findings related to gender differences from the United States apply to other cultures and localities.

Invariably, prevalence of mathematics anxiety or gender differentials are likely to vary according to the populations sampled especially based on the instruments or the criteria used to estimate the prevalence of mathematics anxiety (Cipora et al., 2022). However, conducting research involving a multiplicity of samples from different localities is important as it helps to establish a global portrait related to mathematics anxiety. This is advantageous to gaining greater insights into the phenomenon, such as which findings are consistent or where commonalities, differences, limiting cases or counterexamples exist (Schoenfeld, 2000). Descriptive studies are useful in this regard as they assist in setting the foundation for ultimately constructing and validating a

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theoretical model of a construct (Grootenboer et al., 2008). Cipora et al. (2022) point out that to date no theory of mathematics anxiety has been proposed in the academic literature.

This research aims to address the aforementioned research gaps by seeking to ascertain the prevalence of mathematics anxiety among a sample of Jamaican primary school students in grades four and six (aged 9 to 12 years), identify if a correlation exists between mathematics anxiety and mathematics performance and to explore whether significant gender differences relating to mathematics anxiety exist within the sample. In Jamaica, a developing country, research relating to mathematics anxiety is scarce with only one study having been conducted to date with a high school sample (George & Dowdie, 2021) and so beyond the international significance of the research, there is also local importance.

Three research questions and two associated null hypotheses guided this investigation, as follows:

1. What is the distribution of mathematics anxiety (low, moderate, and high) among grades four and six students?
2. Is there a statistically significant correlation between grades four and six students' mathematics performance and their mathematics anxiety?

Null hypothesis:

H_0: There is no statistically significant correlation between grades four and six students' mathematics performance and their mathematics anxiety?

3. Is there a significant difference in mathematics anxiety between male and female students at grades four and six?

Null hypothesis:

H_0: There is no significant difference in mathematics anxiety between male and female students at grades four and six.

LITERATURE REVIEW

Overview of Mathematics Anxiety

Mathematics anxiety has been described as discomfort, negative emotions and/or feelings of apprehension that individuals of varying ages experience when engaged with situations involving mathematics (Maloney & Beilock, 2012; Paechter et al., 2017; Reali et al., 2016). It interferes with how numbers are manipulated in solving mathematical tasks in both academic and everyday circumstances (Richardson & Suinn, 1972). Mathematics anxiety has been found to interfere with both cognitive processes and information processing which includes encoding (which relates to the process of gathering and representing the information), organizing, storage and retrieval of information (Tobias, 1986).

Mathematics Anxiety Among Primary School Students

Mathematics anxiety has been investigated at various levels of education and among persons of different age groups. The educational levels at which mathematics anxiety has been researched include tertiary (Gresham, 2007; Karjanto & Yong, 2013), secondary (Devine et al., 2012; Karimi & Venkatesan, 2017), and primary (Van Mier et al., 2019) while some age groups include adults, adolescents and children (Sorvo et al., 2017). Ashcraft and Moore (2009) postulated that mathematics anxiety does not affect students at grades one to three at primary school (or these students do not report it); however, by grades four and five a degree of apprehension is experienced by some students. In a recent study, Szczygieł and Pieronkiewicz (2021) investigated mathematics anxiety among 347 Polish grade one students and found a small number (3%) reporting high mathematics anxiety. Devine et al. (2018) investigated mathematics anxiety among 1,757 school children [422 elementary (8 and 9 years) and 1,335 secondary (12 and 13 years)] from England. The findings revealed a mathematics anxiety prevalence rate of 11% in the entire sample (Devine et al., 2018). However, empirical study has reported high levels of mathematics anxiety among primary school students (Krinzinger et al., 2010). This sub-section focuses on literature relating to primary school children because this study has interest in understanding the prevalence of mathematics anxiety at this educational level.

Researchers have reported students experiencing high mathematics anxiety at both the lower primary level that includes grades one, two, and three (Krinzinger et al., 2010; Van Mier et al., 2019; Wu et al., 2012) and the upper primary level which includes grades four, five, and six (Hembree, 1990; Witt, 2012; Yuksel-Sahin, 2008). Krinzinger et al. (2010) studied mathematics anxiety among 140 second and third grade students (80 girls and 60 boys with ages ranging 6.8-8.5 years) in Germany and reported that 32.8% of the students experienced high or very high mathematics anxiety. These students were clinically described as having mathematical learning disabilities (MLDs) and this could be a possible reason the authors reported such a high prevalence of mathematics anxiety. Witt (2012) investigated mathematics anxiety among 55 students (37 girls and 18 boys at ages nine and 10) in southwest England. This sample had no child that required special educational needs. In order to analyze the results, the researcher split the sample into low mathematics anxiety (29 students/52.7%) and high mathematics anxiety (26 students/47.3%) groups by using the mean score and found that a large percentage of students (47.3%) experienced high anxiety. Dowker et al. (2016) posited that the majority of mathematics anxiety instruments assess scores on a continuum, and the persons who are labelled as highly mathematics anxious were not judged against a clear criterion for the severity of their anxiety. Therefore, while using the mean to subdivide the sample is comprehendible, there are concerns about the actual distribution of anxiety scores associated with mathematics anxiety levels. Yuksel-Sahin (2008) examined mathematics anxiety among 249 fourth and fifth graders in Turkey and reported high mathematics anxiety among these students and associated the mathematics anxiety with dislike for the teacher and dislike for the subject. Students who indicated a dislike for the subject mathematics or for the mathematics teacher reported higher mathematics anxiety than those students whose did not express a dislike for the subject or the teacher (Yuksel-Sahin, 2008).

The literature reviewed from different localities show considerable variability in the prevalence of mathematics anxiety reported for the research samples. This confirms the suggestion by Dowker et al. (2016) that there is need for additional research due to the inconsistency of findings across samples. This present research focuses on a sample of Jamaican primary students and explores the prevalence of mathematics anxiety among this group of students, thereby adding to the literature that exists. While Krinzinger et al. (2010) and Yuksel-Sahin (2008) focused on primary students from grades two and three (age range 6.8-8.5 years) and from grades four and five, respectively, this present study focuses on primary students in grades four and six (age range 9-12 years). Although all the grades are at the primary level, there is diversity in each investigation which helps to deepen the understanding about mathematics anxiety at this level. The combination of grades four and six, not yet seen in the literature, gives the unique perspective of investigating two upper primary school grades that are not consecutive so that the possibility of variance in mathematic anxiety scores is increased due to greater differences in both age and grade (Yuksel-Sahin, 2008).

Mathematics Anxiety and Mathematics Performance

Research has consistently found that there is a distinct link between mathematics anxiety and mathematics performance (Foley et al., 2017); however, the correlation is at a maximum, moderate (Cipora et al., 2022). Many studies have found that mathematics anxiety negatively influences mathematics performance (Ashcraft & Faust, 1994; Carey et al., 2016; Foley et al., 2017; Hembree, 1990; Ho et al., 2000). Nevertheless, researchers admit that the correlation between mathematics anxiety and mathematics performance is often not significant among primary students, especially with reference to 'performance anxiety' (Vanbinst et al., 2020). In this regard Zhang et al. (2019) analyzed 84 studies in a meta-analysis model that focused on mathematics anxiety and mathematics performance and reported that the results showed a robust negative 'link'. However, the researchers also reported that studies involving primary students reported the weakest 'link' between the mathematics anxiety experienced and mathematics performance (Zhang et al., 2019). Similarly, Namkung et al. (2019) conducted a meta-analysis that involved 131 studies that investigated mathematics anxiety and mathematics performance among both primary and secondary students. The results revealed that, in general, mathematics anxiety correlates negatively with mathematics performance at both the primary and secondary levels (Namkung et al., 2019). Recently, Barroso et al. (2021) conducted a meta-analysis study on 223 empirical studies that investigated mathematics anxiety and mathematics performance at primary, secondary, and tertiary educational levels. The researchers posited that the association between the mathematics anxiety experienced, and mathematics performance is weak for students in grades three to five and for students at grades that do mathematics examinations (Barroso et al., 2021). Hill et al. (2016) studied mathematics anxiety among 981 primary (N=639, 322 girls and 317 boys) and secondary (N=342, 148 girls and 194 boys) students in Italy. Results for secondary students showed that mathematics anxiety negatively correlated with mathematics performance; however, no such correlation was recorded among the primary students. Hill et al.'s (2016) non-correlation between the mathematics anxiety experienced and mathematics performance for primary students was similar to that of Witt (2012).

There are some researchers who have found a negative correlation between the mathematics anxiety experienced and the mathematics performance of primary level students. Yuksel-Sahin (2008) reported a strong negative correlation between the mathematics anxiety experienced and the mathematics performance of grades four and five students. According to Yuksel-Sahin (2008), the students who reported that they experienced high mathematics anxiety performed considerably lower in mathematics than the students who reported that they experienced lower levels of mathematics anxiety. Vanbinst et al. (2020) conducted an intergenerational study about mathematics anxiety in Belgium with 172 sixth graders (102 girls and 70 boys) ages ranging from 11-12 years old and both their biological parents. Results revealed that the arithmetical performance of grade six students was significantly and negatively associated with their mathematics anxiety. Empirical research from other localities such as San Francisco (USA) (Wu et al., 2012), Columbia (Reali et al., 2016), the Netherlands (Van Mier et al., 2019), have also reported similar findings. With reference to working memory, Kucian et al. (2018b) purported that mathematical performance is affected by mathematics anxiety and there is conclusive proof to support this claim. However, Devine et al. (2018) who investigated mathematics anxiety and mathematics performance among 1,757 primary and secondary school children from England showed that students with high mathematics anxiety were able to achieve moderate to high mathematics performance scores. These findings showed that mathematics anxiety is not confined to students who perform poorly in mathematics.

Considering that the body of literature relating to mathematics anxiety and mathematics performance is still relatively small, this domain could benefit from additional research. This present study therefore seeks to add to the literature on mathematics anxiety and mathematics performance by exploring whether a correlation exists between the two variables amongst a sample that has not been previously the focus of empirical literature. It focuses on grades four and six students at a primary school in Jamaica.

Mathematics Anxiety and Gender

Research focused on mathematics anxiety has also explored gender differences. Dowker et al. (2016) postulated that territories which provide equal learning opportunities for male and female students have shown a decline in gender differences relating to performance in mathematics. Some researchers have reported no difference in mathematics anxiety levels between males and females (e.g., Kucian et al., 2018a; Ma & Xu, 2004) while a study that involved both primary and secondary school students, reported that girls experienced higher levels of mathematics anxiety at both the primary and secondary school levels than boys (Hill et al., 2016). Van Mier et al. (2019) investigated mathematics anxiety and gender differences among 124 students in grades two and four (67 girls and 57 boys with ages ranging from 8-10 years) in the Netherlands and reported that mathematics anxiety levels were similar in boys and girls but mathematics anxiety and performance was only significant in girls. The researchers also reported that only girls had their mathematics performance negatively moderated by mathematics anxiety.

Yuksel-Sahin (2008) reported that mathematics anxiety differed significantly according to gender among the Turkish fourth and fifth graders. The results revealed that girls reported significantly more mathematics anxiety than boys. Other studies also found similar findings (Devine et al., 2012; Hill et al., 2016), although in contrast, Olmez and Ozel (2012) reported from a sample of 244 students (116 girls and 128 boys), that sixth and seventh grade boys in Turkey reported significantly more mathematics anxiety than their female counterparts. The researchers suggested that this finding could be due to the narrowing of the achievement gap in which recent literature shows that female students exhibit improved mathematics performance (Olmez & Ozel, 2012). With the scarcity of literature relating to mathematics anxiety and gender differences in the Jamaican context, this present study will provide a unique insight about gender differences among Jamaican primary school students in grades four and six.

METHODS

Research Design

The present study adopted a quantitative approach that employed a survey design.

Setting and Sample

Five educational levels: early childhood, primary, secondary, post-secondary, and tertiary comprise Jamaica's formal education system. Primary schools in Jamaica consist of six grade levels from grade one to six and accommodate students from six to 12 years old. At the primary level, knowledge, skills and attitudes are acquired that lay the foundation for future educational pursuits.

The research site is a coeducational public primary school where the first author teaches and is situated in an urban area in Jamaica. There are five classes in each grade level. Students are placed within a given class based on the literacy levels determined from related assessments. Although one school is involved in the present research, the school, in terms of its structure, composition (staff and students) and organization is characteristic of many other primary schools in Jamaica.

The research sample was randomly selected by employing the cluster sampling technique in which each class was treated as a cluster from which a sample was taken. Each of the five classes in grades four and six was treated as a sampling frame and a unique number was assigned to each student. A list of random numbers was then generated using Microsoft Excel and a sample of 13 students was randomly selected from each frame/class. This resulted in a total of 65 potential respondents from each of the two grade levels. The parents of these potential respondents were sent informed consent forms to review and complete.

The actual sample consisted of 62 students (25 and 37 students from grade four and six, respectively). This sample size was approximately 50% of the anticipated respondents that were generated using creative research systems' online sample size calculator that used a confidence interval of plus or minus five and a confidence level of 95% (Cohen et al., 2018).

The response rate was very low due to the COVID-19 pandemic. This research was conducted in term one of the 2020/21 academic year and similar to other jurisdictions internationally, concerns about the spread of the COVID-19 virus in Jamaica resulted in a transition from face to face classes to emergency remote teaching and learning. While the low response rate negatively affected the ability to generalize from the findings, this research still offers scholastic insights relating to mathematics anxiety prevalence, the existence of correlation between mathematics performance and mathematics anxiety, and gender difference related to mathematics anxiety among primary school students.

Data Collection

The physical distribution of consent forms, assent forms and questionnaires was risky due to concerns relating to the transmission of the novel corona-virus (COVID-19). Also, at the time of data collection, all classes were conducted virtually. Consequently, all forms and instruments were distributed electronically to parents and students. From the 130 informed consent forms that were sent to parents in the prospective, randomly selected sample via the WhatsApp Messenger app, 62 parents/guardians (25 and 37 students from grade four and six, respectively) gave their consent. The distribution period was from November 16 to December 4, 2020. This period of distribution was chosen because the students had settled in their learning environment after beginning online learning in October 2020.

Instruments

Two instruments were used to collect data from the respondents. These instruments included the modified abbreviated mathematics anxiety scale (mAMAS) and a teacher-made end of term test. Each instrument was administered electronically to the students and is discussed in detail below.

Mathematics anxiety scale

Information relating how students in grades four and six felt during mathematics related situations was collected using the mAMAS (see **Appendix A**). The mAMAS is considered to be a valid and reliable instrument in measuring mathematics anxiety levels in school age students at both the primary and secondary levels (Carey et al., 2017). Carey et al. (2017) reported the mAMAS alpha score to be 0.85. The alpha score for this present study was 0.82.

The scale was originally developed by Richardson and Suinn (1972), abbreviated by Hopko et al. (2003), and modified by Carey et al. (2017). The mAMAS consists of nine, five-point Likert type items (ranging from 1=low anxiety to 5=high anxiety), which rate the level of anxiety the students report that they experience when they engage in mathematical learning and evaluative situations.

Mathematics performance

The students' mathematics performance was assessed using teacher-made end of term tests. The tests assessed the mathematics content that had been covered in term one of the 2020/21 academic year. This included content from the number, measurement and geometry strands from the related grade levels in the mathematics curriculum in use–the Jamaica National Standards Curriculum. The grade four and six mathematics test contained 40 and 30 multiple choice items, respectively, and the test duration was 80 and 60 minutes, respectively. The teaching modality was online and testing was also done in the virtual space via the school's learning management system.

Data Analysis

Data analysis was conducted by using a computer program called *statistical package for the social sciences*. For research question one, "what is the distribution of mathematics anxiety (low, moderate, and high) among grades four and six students?", a mathematics anxiety total was calculated for each respondent by adding the number associated with the response to each statement, one for low anxiety to five for high anxiety. The instrument had possible minimum and maximum values of nine and 45, respectively. Ranges were then formed to group the mathematics anxiety totals as low anxiety (9-20), moderate anxiety (21-32), and high anxiety (33-45).

Research question two, "is there a statistically significant correlation between grades four and six students' mathematics performance and their levels of mathematics anxiety?", was addressed using Spearman rank order correlation because this procedure would reveal if correlation existed (whether negative or positive) along with the strength of the correlation by comparing the two dependent variables: mathematics performance z-scores and mathematics anxiety totals. To facilitate this analysis, the raw mathematics scores were converted to z-scores.

For research question three, "is there a significant difference in mathematics anxiety between male and female students at grades four and six?", it was investigated using the non-parametric Mann Whitney U test. The independent categorical variable (gender) was analyzed with the dependent continuous variable (mathematics anxiety totals) to determine if statistical difference existed between males and females.

Reliability and Validity

The reliability of an instrument is the ability to consistently reproduce a certain result while the validity deals with the ability to measure for an intended trait. Cronbach's alpha is the most commonly used test measure by researchers to show the reliability of a research instrument. The recommended range for alpha is 0.7-0.9 (Tavakol & Dennick, 2011). The alpha score for the mathematics anxiety scale was 0.82. The validity of the instrument has been verified by previous researchers (Carey et al., 2017). The construct validity of the mAMAS was determined through confirmatory factor analysis that revealed that the mAMAS had the same factor structure as the abbreviated math anxiety scale [AMAS] (Carey et al., 2017). Due to the small sample size, factor analysis was not conducted in this present study.

FINDINGS

Research Question 1: What is the distribution of mathematics anxiety (low, moderate, and high) among grades four and six students?

In order to investigate research question one, a mathematics anxiety score was computed for each respondent by finding the sum of the mathematics anxiety responses. The possible minimum and maximum scores (nine and 45, respectively) were then used to establish ranges that related to the levels of mathematics anxiety (low anxiety=9-20, moderate anxiety=21-32, and high anxiety=33-45). **Figure 1** presents the distribution of mathematics anxiety among grades four and six students within the three categories established.

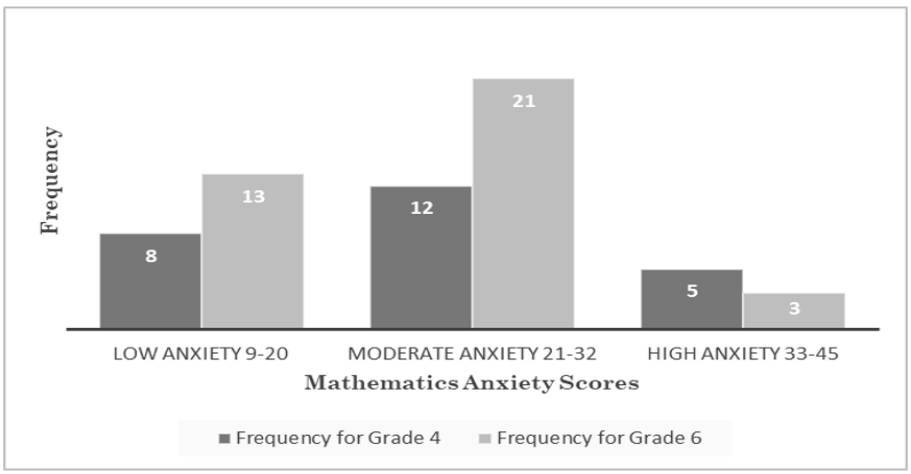

Figure 1. Distribution of mathematics anxiety scores for grades four and six students

Figure 1 shows that eight and 13 (32.0% and 34.1%) reported low mathematics anxiety, 12 and 21 (48.0% and 56.8%) moderate mathematics anxiety, and five and three (20.0% and 8.1%) high mathematics anxiety for grades four and six students, respectively. The results reveal that a greater percentage of grade four students (20.0%) reported experiencing high mathematics than grade six students.

Research Question 2: Is there a statistically significant correlation between grades four and six students' mathematics performance and their mathematics anxiety?

Null hypothesis:

H_0: There is no statistically significant correlation between grades four and six students' mathematics performance and their levels of mathematics anxiety?

The Spearman rank order correlation was used to investigate the relationship between mathematics anxiety and mathematics performance. This statistical technique revealed a small positive correlation between mathematics anxiety scores and mathematics performance z-scores for grade four students (rho=.184, n=24, p>0.01) while there is a small negative correlation between mathematics anxiety scores and mathematics performance z-scores for grade six students (rho=-.111, n=37, p>0.01). For the grade four sample, the mathematics performance z-scores of the five students who reported high mathematics anxiety ranged from -1.22894 to 1.18850. However, when the lowest z-scores were excluded, the remaining three scores ranged from 0.13362 to 1.18850. This means that although these students reported the highest mathematics anxiety scores, they still achieved performance scores that were among the highest in the sample. For both grades, the coefficient of determination was small (3.4% and 1.2%, grade four and six, respectively). For grade four students, mathematics anxiety and mathematics performance increased together but only 3.4% of the performance was determined by the mathematics anxiety experienced. In contrast, for grade six students, as mathematics anxiety increased mathematics performance decreased but only 1.2% of the performance was determined by the mathematics anxiety reportedly experienced. Based on these results, the null hypothesis is accepted. There is therefore no significant correlation between grades four and six students' mathematics performance and their levels of mathematics anxiety.

Research Question 3: Is there a significant difference in mathematics levels between male and female students at grades four and six?

Null hypothesis:

H_0: There is no significant difference in mathematics anxiety between male and female students at grades four and six.

The Mann Whitney U test was used to compare two independent variables (male and female) on a continuous variable (mathematics anxiety scores). The mathematics anxiety score for males (Mdn=13.67) was marginally higher than females (Mdn=12.38) among grade four students. By contrast, mathematics anxiety score for males (Mdn=17.16) was lower than females (Mdn=20.40) among grade six students. However, there was no significant difference in mathematics anxiety scores between males and females for both grades [$U(N_{Males}=12, N_{Females}=13)=70.00$, z=-.436, p>.05 and $U(N_{Males}=16, N_{Females}=21)=138.50$, z=-.906, p>.05, grades four and six, respectively].

DISCUSSION

This study investigated the prevalence of mathematics anxiety among samples of grade four and six students. Although the sample size was small (62 students: grade four–25 and grade six–37), the results revealed that five (20.0%) and three (8.1%), grade four and six students, reported high mathematics anxiety, respectively. The prevalence of mathematics anxiety was high among grade four students which was similar to previous research done in other jurisdictions (Krinzinger et al., 2010; Witt, 2012; Yuksel-Sahin, 2008) while the prevalence was considerably lower among grade six students which was similar to the prevalence rate (11.0%) reported by Devine et al. (2018). Krinzinger et al. (2010) and Witt (2012) reported mathematics anxiety prevalence of 32.8% and 47.3%, among second and third graders (ages ranging 6.8 to 8.5 years), and fifth graders (ages nine and 10 years), respectively. The mathematics anxiety prevalence rates of Krinzinger et al. (2010) and Witt (2012) were considerably higher than mathematics anxiety prevalence rates reported in this study. Dowker et al. (2016) posited that there is great variance in estimates about mathematics anxiety prevalence due to the population being sampled, the data collection instruments employed and the criteria used to categorize the respondents. It is apparent that the categories established for low, moderate and high mathematics anxiety also influenced the prevalence report. For example, Witt (2012) established two groups (low and high anxiety) while this present study made three groups (low, moderate, and high anxiety) and hence, reported less students in the high anxiety category. Ashcraft and Moore (2009) argued that by grades four and five, an apprehension towards mathematics is exhibited by some students. Therefore, the categories established for data analysis and reporting could be among the reasons for lower prevalence rate of high mathematics anxiety among the grades. The moderate anxiety category for both grades had the largest number of students (48.0% and 56.8%, grade four and six, respectively). Hence, if the two-group model employed by Witt (2012) was employed in this present study, the prevalence rate would have been higher with 48.0% and 62.2% of students reporting high mathematics anxiety in grade four and six, respectively.

There are other factors that may account for these research findings. Although the sample was randomly selected, perhaps there were common characteristics of the parents and children who opted to participate in this study even amidst the COVID-19 pandemic and within the context of emergency remote teaching and learning. Also, the parents who decided to grant consent could have been motivated to participate due to their desire to obtain mathematical assistance for their children. The benefits of investigating mathematics anxiety, such as being aware of the anxiety level so that appropriate intervention could be identified

or recommended, could have been interpreted as being immediate, hence, convincing parents of highly mathematics anxious students to offer consent. In grades four through six, students are engaged in high stakes assessment for mathematics and other core subjects. This ultimately determines their placement in high school. It is therefore interesting that there was a much higher percentage of mathematics anxious students in grade four than in grade six. Furthermore, the low prevalence of mathematics anxiety reported by grade six students could be due to the class the students were from. Scrutiny of the classes from which the students came, revealed that the grade six respondents came from the better performing classes than the grade four sample. From the researcher's experience as a primary school teacher for over 20 years, the students in these classes usually obtain better grades and their parents are more responsive to the class teacher.

The correlation between mathematics anxiety and mathematics performance was also investigated by this present study. The results indicated a small positive non-significant correlation for grade four students (rho=.184, n=24, p>0.01) and a small negative non-significant correlation for grade six students (rho=-.111, n=37, p>0.01). While the positive correlation among grade four students seemed uncommon to the researcher due to the many reports of negative correlation, it was similar to the positive non-significant correlation that Reali et al. (2016) found among grade five students (aged nine to 11 years). The positive correlation means that as mathematics anxiety increased, mathematics performance also increased. Close scrutiny of the grade four performance raw scores revealed that the scores of the five students who reported high mathematics anxiety ranged from 35% to 90% (65.5% average). However, when the lowest score was excluded, the remaining four scores ranged from 52% to 90% (72.8% average). This means that although these students reported the highest mathematics anxiety scores, they still achieved performance scores that were among the highest in the sample. The grade four results were similar to Devine et al. (2018) who reported high mathematics anxiety and moderate to high mathematics performance scores among a sample (1,757) of elementary school students (8-to 9-year-old) from England. The results showed that some students who obtained high mathematics scores also experienced high levels of mathematics anxiety; hence, mathematics anxiety is not only associated with poor performance. Ashcraft and Moore (2009) argued that mathematics anxious students are negatively affected by mathematics anxiety and their full potential is not realized. Therefore, a decrease in mathematics anxiety could positively impact the students in this research.

Mathematics anxiety and mathematics performance were negatively correlated among grade six students and this is commonly reported by researchers (e.g. Reali et al., 2016; Vanbinst et al., 2020; Van Mier et al., 2019; Wu et al., 2012; Yuksel-Sahin, 2008). Namkung et al. (2019) reported that the dominant finding among the 131 studies in their meta-analysis was that mathematics anxiety was negatively correlated with mathematics performance. The negative correlation means that as mathematics anxiety increased, mathematics performance decreased. Researchers argue that possible reasons for the negative correlation include: compromise of working memory resources, and an increase in the section of the brain (amygdala) that processes negative emotions (Maloney & Beilock, 2012). Similarly, Ashcraft and Moore (2009) argued that mathematics anxiety caused an 'affective drop' in which highly mathematics anxious students focused on the worrisome emotions that depleted the resources of working memory and resulted in poor mathematics performance. This present study did not focus on the causal relationship between mathematics anxiety and mathematics performance which are elucidated in the theories: deficit theory, cognitive interference theory, and reciprocal theory (Devine et al., 2012; Namkung et al., 2019). However, the cognitive interference theory which posits that high levels of anxiety negatively affect the learners' ability to recall prior learning has been credited by researchers to be responsible for a decline in mathematics performance (Namkung et al., 2019; Szczygieł & Pieronkiewicz, 2021). Szczygieł and Pieronkiewicz (2021) purported that mathematics anxiety limits the resources in working memory, and increases the tendency to avoid practicing mathematics and both occurrences invariably lead to decrease in mathematics performance. Therefore, it is quite likely that mathematics anxiety could be causing highly mathematics anxious students to practice less mathematics and contribute to the vicious cycle described as the reciprocal theory in which poor performance increases mathematics anxiety which in turns worsens poor mathematics performance (Namkung et al., 2019).

Although the correlation results for grades four and six students revealed contrasting results, there was still an element of commonality. Both grades exhibited small correlations. A meta-analysis of 131 studies revealed, in general, that mathematics performance is negatively correlated with mathematics anxiety for both primary and secondary samples (Namkung et al., 2019). Other recent meta-analysis studies have reported generally a small correlation between mathematics performance and mathematics anxiety at the primary level (Barroso et al., 2021; Zhang et al., 2019). Zhang et al. (2019) described the small correlation among primary school samples as a 'weak link' between the variables. Similarly, Barroso et al. (2021) reported a weak correlation between mathematics performance and mathematics anxiety at grades three to five and among samples that sit examinations. In Jamaica, both grades four and six students sit external, high stakes examinations. Due to the small coefficient of determination for each grade (3.4% and 1.2%, grade four and six, respectively), it was concluded that mathematics anxiety and mathematics performance did not have a significant correlation. This finding was similar to Olmez & Ozel (2012) and Zhang et al. (2019). This finding is significant because it increments knowledge at the primary school level about mathematics anxiety in Jamaica.

Gender difference was another area of interest in this study. Contrasting results were shown in the grades when the mathematics anxiety scores were disaggregated by gender. The score for males (Mdn=13.67) was marginally higher than females (Mdn=12.38) in grade four students, while in contrast, mathematics anxiety score for males (Mdn=17.16) was lower than females (Mdn=20.40) in grade six students. However, there was no significant statistical difference in gender among grade four and six students. The results in this present study are similar to previous studies (e.g., Kucian et al., 2018a; Ma & Xu, 2004), although there are researchers who have reported significant gender differences among primary level students (Hill et al., 2016; Van Mier et al., 2019). According to Dowker et al. (2016), there is a decline in gender differences relating to mathematics performance in territories that offer equal academic opportunities for male and female students. At the research site, typical for Jamaican schools, males and females receive equal learning opportunities. All students have equal opportunity to learn in their classes since classes are not divided by gender for instructions. Furthermore, at each grade, common planning is done so that all classes in a grade are

taught the same content using the same strategies and techniques. Both genders within a certain class usually perform at the same level since initially they were grouped by performance. This practice allows both boys and girls to strive for excellence without any bias being levelled at any gender. The equal learning opportunities and the class composition are probable reasons for the non-significant statistical difference in gender among grades four and six students.

CONCLUSION

Mathematics anxiety is a great impediment that a significant portion of the society have to contend with (Ashcraft & Moore, 2009). This study aimed to ascertain the prevalence of mathematics anxiety among a sample of grade four and six students in primary school in Jamaica, identify if a correlation exists between mathematics anxiety and mathematics performance and to explore whether significant gender differences as per mathematics anxiety exist within the sample.

The research is significant both globally and locally since it focuses on a primary school sample for which additional insights are needed relating to mathematics anxiety. This research also allows a more complete global portrait of different aspects related to mathematics anxiety to be established since it involves a jurisdiction that has only been studied in a limited way and a cohort that has not been part of previous empirical inquiries.

The findings for this research have implications for several stakeholders in education such as teachers, policy makers and teacher educators. Although the sample size was small, eliminating the prospects of generalization, it is very concerning that such a high rate of mathematics anxiety prevalence was found among grade four students. Dowker et al. (2016) argued that even with conservative estimates of mathematics anxiety prevalence, it is a very serious problem. First, it is important that teachers be aware that primary students may experience various levels of mathematics anxiety as they engage in mathematics related activities. Schools' administration and academic staff need to attempt to identify students who have higher levels of mathematics anxiety (moderate and high anxiety) and investigate ways of reducing the high mathematics anxiety by shifting negative emotions from learning mathematics and improving basic numeric and spatial skills (Maloney & Beilock, 2012; Van Mier et al., 2019). The research site in particular and schools in general also need to partner with parents of highly mathematics anxious students in educating them about the negative effects of mathematics anxiety and how they can assist their children in lessening the anxiety by modelling positive attitudes towards learning mathematics (Dowker et al., 2016; Soni & Kumari, 2015). Since the grade four students will eventually transition to higher grades, it is prudent that teachers at grades five and six make mathematics lessons fun and engaging in an effort to shift or lessen negative feelings associated with learning mathematics (Dowker et al., 2016).

Second, teacher educators who are involved in teacher training of pre-and in-service primary school teachers should include as part of the training, content relating to mathematics anxiety and other components of the affective domain and how these impact students' learning and performance. Third, since this research provides evidence that some primary school students do experience higher levels of mathematics anxiety, it offers preliminary support for embracing a broader approach to students' mathematics learning that includes a greater focus on affective components.

While this study is significant in that it filled existing empirical gaps, there were some limitations of the research. The study was conducted during emergency remote teaching and learning during the COVID-19 pandemic which was a novel period of teaching and learning in Jamaica's academic history. This unique teaching and learning environment although providing affordances, also created key challenges for students, parents and schools, such as acquiring electronic devices for engagement, the Internet connectivity issues, electricity outages, and the adaptation of teachers, students and parents to this new mode of learning (The Gleaner, 2019, 2020). These may have resulted in fewer parents granting consent for their child or ward to participate in the study and hence a smaller than anticipated sample size. It is possible that a larger, more representative sample could yield different results. This present study could be the genesis to larger and more extensive investigations in understanding mathematics anxiety at the primary school level in Jamaica. Another possible limitation relates to the electronic mode via which the instruments were administered. There is the possibility of students being assisted in completing the instruments since both the mathematics test and mathematics anxiety questionnaire were done virtually at home. Therefore, the results reported may not wholly reflect that of the student. When students return to face to face instruction, the study could be replicated but the instruments would be administered face to face instead of virtually.

Finally, the key finding that mathematics anxiety accounts for a very small proportion of students' mathematics performance suggests that further research is needed to gain insights into the factors that affect students' mathematics performance. In this regard, the school administration and staff at the research site and other primary schools could investigate other factors such as strategies and techniques used to teach mathematics, emotions/attitudes towards mathematics, and mathematics motivation among students in grades that sit high stakes examinations to gain further insights.

Author contributions: All authors have sufficiently contributed to the study, and agreed with the results and conclusions.

Funding: No funding source is reported for this study.

Declaration of interest: No conflict of interest is declared by authors.

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APPENDIX A-MATHEMATICS ANXIETY SCALE

Modified Abbreviated Math Anxiety Scale

Instructions:
Please give each sentence a score in terms of how anxious you would feel during each situation. Use the scale at the right side and circle the number which you think best describes how you feel.

	☺				☹
	Low anxiety	Some anxiety	Moderate anxiety	Quite a bit of anxiety	High anxiety
1. Having to complete a worksheet by yourself.	1	2	3	4	5
2. Thinking about a maths test the day before you take it.	1	2	3	4	5
3. Watching the teacher work out a maths problem on the board.	1	2	3	4	5
4. Taking a maths test.	1	2	3	4	5
5. Being given maths homework with lots of difficult questions that you have to hand in the next day.	1	2	3	4	5
6. Listening to the teacher talk for a long time in maths.	1	2	3	4	5
7. Listening to another child in your class explain a maths problem.	1	2	3	4	5
8. Finding out you are going to have a surprise maths quiz when you start your maths lesson.	1	2	3	4	5
9. Starting a new topic in maths.	1	2	3	4	5