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Primary Teachers' Mathematics Anxiety and Mathematics Teaching Anxiety as Predictors of Students' Performance in Mathematics

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ABSTRACTS

The study investigated primary teachers' mathematics anxiety as related to mathematics teaching anxiety and students' performance in mathematics among 480 primary teachers from twenty public primary schools. The study adopted the quantitative research method within the blueprint of the descriptive survey design. Findings revealed that test anxiety, course anxiety, application anxiety, computation anxiety, social anxiety, content knowledge teaching anxiety, self-confidence teaching anxiety, attitudes toward mathematics teaching anxiety, and teaching knowledge anxiety jointly contributed to a coefficient of multiple regression of 0.501 and a multiple correlation square of 0.251 to the prediction of student's performance in mathematics. By implication, 25.1% of the total variance of the dependent variable (performance in mathematics) was accounted for by the combination of the nine independent variables. Based on this study, it was thus, recommended that future studies in Nigeria and elsewhere should investigate the factor analytic structure of the mathematics teaching anxiety scale among in-service and preservice teachers of mathematics.

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1. INTRODUCTION

One psychological construct that often scares pre-service and in-service teachers in the mathematics classroom is mathematics anxiety (Awofala & Odogwu, 2017; Awofala & Awolola, 2011a) and mathematics anxiety is a non-intellectual factor that could endanger pre-service teachers' interest in mathematics, cause pre-service teachers to underestimate their real ability in mathematics, impede mathematics achievement, and act as a limiting factor for educational and career opportunities (Beilock & Maloney, 2015). As a performance-based anxiety disorder, mathematics anxiety involves physiological stimulation, negative cognitions, and avoidance behaviors that lead to an effective drop in mathematics and mathematics-related activities (Awofala & Odogwu, 2017; Awofala *et al*., 2023). Mathematics anxiety has a tripartite symptom in pre-service and in-service teachers learning mathematics. Physical symptoms manifest in the area of increased heartbeat, sweaty hands, tenseness, nausea, and troubled stomach (Awofala & Akinoso, 2017). Psychological symptoms manifest in the area of inability to concentrate and feelings of helplessness, loss of self-esteem, worry, and shame (Plaisance, 2009; Jackson, 2008). Behavioral symptoms include total avoidance of mathematics classes, not doing mathematics homework until the last minute, and not studying mathematics regularly (Plaisance, 2009; Jackson, 2008; Woodard, 2004; Freiberg, 2005). There exists a negative relationship between pre-service and in-service teachers' mathematics anxiety and mathematics achievement (Awofala & Odogwu, 2017) and mathematics anxiety which may occur across all grade levels tends to manifest in students around fourth grade and reach climax in post-primary school and adulthood (Awofala & Akinoso, 2017; Geist, 2010; Legg & Locker, 2009; Sun & Pyzdrowski, 2009; Scarpello, 2007; Woodard, 2004).

Mathematics anxiety in pre-service and in-service teachers is a function of years of agonizing experiences with mathematics and is a complex phenomenon that could be formed as a result of personality, intellectual, and environmental factors. Personality factors result from low self-worth or self-esteem, inability to handle frustration, coyness, and fear (Eden *et* al., 2013). The intellectual factor relates to the inability to comprehend or understand mathematical concepts (Eden *et al*., 2013). The environmental factors result from excessively tough parents and deleterious classroom experiences, such as incomprehensible textbooks, an emphasis on the drill without understanding, and a bad mathematics teacher (Eden *et al*., 2013). Mathematics teachers at all levels who find it difficult to explain concepts are impatient with students, are full of fearful remarks and have little passion for mathematics teaching, regularly create a harvest of mathematics-anxious students (Awofala & Odogwu, 2017; Plaisance, 2009; Sun & Pyzdrowski, 2009; Scarpello, 2007; Furner & Berman, 2004; Woodard, 2004).

Research evidence has indicated that pre-service and in-service teachers with high levels of mathematics anxiety have low confidence in their abilities to teach elementary mathematics effectively (Awofala & Falolu, 2017; Bursal & Paznokas, 2006) and often have lower levels of mathematics teaching self-efficacy beliefs (Bursal & Paznokas, 2006; Swars *et al*., 2006). Thus, these pre-service and in-service teachers may teach mathematics differently from those with lower levels of mathematics anxiety in such a way that they are more pre-occupied with using inappropriate teaching methods and whole-class instruction while engaging in less time to teach mathematics concepts (Ameen *et al*., 2002; Peker, 2009; Peker & Ertekin, 2011). Pre-service and in-service teachers with low mathematics anxiety are more confident to teach elementary mathematics than pre-service and in-service teachers with moderate and high mathematics anxiety (Haciomeroglu, 2013). It is evident that the introduction of the theoretical aspect of mathematics concepts in mathematics teaching methods courses amplified elementary pre-service and in-service teachers' mathematics anxiety levels and yet the use of manipulatives in

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planning student-centered teaching reduced their mathematics anxiety (Awofala, 2017a; Battista, 1986; Hembree, 1990; Harper & Daane, 1998; Bursal & Paznokas, 2006; Vinson, 2001; Gresham, 2007) and increase mathematical proficiency (Awofala, 2017b). Some major factors that could contribute to pre-service and in-service teachers' mathematics anxiety have been identified in the literature and these include negative school experiences as students, lack of family support, the effect of previous mathematics teachers, inappropriate teaching practices, and engagement with future teaching of mathematics (Malinsky *et* al., 2006).

Pre-service and in-service teachers' mathematics anxiety is also related to the teaching of mathematics. Mathematics teaching anxiety is defined as pre- and in-service teachers' feelings of tension and fear that take place during the teaching of mathematical concepts (Peker, 2006). Teaching anxiety is conceptualized as anxiety experienced concerning teaching activities that involve the preparation and execution of classroom activities (Gardner & Leak, 1994). Mathematics teaching anxiety can be defined as teachers' low self-confidence characterized by a negative mindset and tension toward mathematics teaching and problem-solving. Mathematics teaching anxiety may reflect real or perceived knowledge shortfalls in mathematics content as well as in mathematics teaching skills and memories of past occurrences of mathematics failure or anxiety. It has been shown that abstract discussions of mathematical concepts increased the teaching anxiety level of the pre-service elementary teachers who had a high incidence of anxiety for teaching mathematics, but using manipulative materials, getting familiar with developing creative teaching strategies for teaching math, and learning to design lesson plans in mathematical concepts lessened the teaching anxiety level of these future teachers. In addition, using (expanded) microteaching in teaching practice has been found to reduce the teaching anxiety level of pre-service mathematics teachers (Sen, 2009; Peker, 2009).

Mathematics teaching anxiety is more pervasive among pre-service teachers in that they feel extremely nervous and find it difficult to concentrate on the job of teaching (Peker, 2006) most especially during their practicum. Mathematics teaching anxiety influences how a teacher teaches in the classroom and will also affect how students learn mathematics. Hadly and Dorward (2011) found that teachers who had lower anxiety about teaching mathematics had more teaching experience and were more likely to teach using the National Council of Teachers of Math (NCTM) Standards-based instructional practices. Akinsola (2002) found that elementary in-service teachers' mathematics anxiety affects their studying and teaching of mathematics negatively and also has a debilitating effect on their problem-solving ability (Akinsola, 2008; Awofala & Awolola, 2011a).

It is expedient to note that more investigations are needed on the relationship between teachers' mathematics anxiety and mathematics teaching anxiety since most studies have investigated these two constructs separately and in pre-service teachers (Bursal & Paznokas, 2006; Gresham, 2009; Harper & Daane, 1998; Peker, 2009). From these studies, it is clear that pre-service teachers with high incidences of mathematics anxiety and mathematics teaching anxiety find it difficult to engage in effective learning of mathematics concepts. In addition, they find it difficult to teach mathematics effectively, especially during their teaching practice exercise or internship. The few studies that investigated the relationship between pre-service teachers' mathematics anxiety and mathematics teaching anxiety have produced inconclusive results (Brown *et* al.,2011; Peker & Ertekin, 2011; Hadly & Dorward, 2011). Brown *et al*., (2011) found that one-third of the pre-service teachers had a high incidence of mathematics anxiety but did not have mathematics teaching anxiety and it was concluded that the relationship between mathematics anxiety and mathematics teaching anxiety did not always exist. Peker and Ertekin (2011) revealed that there was a significant positive relationship between pre-service teachers' mathematics anxiety and mathematics teaching anxiety with a medium effect size. Hadly and

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Dorward (2011) found a positive relationship between elementary teachers' mathematics anxiety and mathematics teaching anxiety. Thus, only one study in this review investigated the relationship between practicing teachers' mathematics anxiety and mathematics teaching anxiety. Therefore, more investigations are needed in this area.

Teachers with a high incidence of mathematics anxiety might accidentally transmit their negative feelings, avoidance, and fear of mathematics to their students (Sloan, 2010) since mathematics anxiety is associated with how teachers teach mathematics (Blazer, 2011). Thus, elementary teachers with a high incidence of mathematics anxiety might stimulate an early development of mathematics anxiety in their students (Swetman *et* al., 1993; Vinson, 2001) which might lead to the development of negative attitudes towards mathematics (Awofala, 2016) and low mathematics performance for their students (Awofala & Odogwu, 2017; Gresham, 2009; Baton, 2010). Mathematics anxiety is particularly dominant among elementary teachers (Hadly & Dorward, 2011) who as a result show lack of mathematical competence and low acquisition of mathematical literacy (Awofala, 2006) which may interfere with their mathematical resilience posture (Awofala, 2021).

The relationship between primary teachers' mathematics anxiety and students' achievement/performance in mathematics remains elusive, even though some mathematics educators have hypothesized a link (Aiken, 1970; Chavez & Widmer, 1982) and few researchers have carried out investigations to approve or disapprove this relationship. Hadly and Dorward (2011) found that increased student mathematics achievement was related to elementary teachers' lower levels of anxiety about teaching mathematics, but was not related to their general anxiety about mathematics. Beilock *et al*. (2010) found that at the beginning of the school year there was no relation between female elementary teachers' mathematics anxiety and the female students' mathematics achievement but at the end of the school year the level of teachers' anxiety was negatively related to female students' achievement in mathematics. Aslan *et al*. (2013) found that teachers' mathematics anxiety didn't have any significant impact on children's number, operation, and geometric shapes achievement.

Mathematics anxiety is a common phenomenon among Nigerians and can develop at any age in students (Awofala & Odogwu, 2017). Despite this prevalence of mathematics anxiety in Nigeria, no study had investigated primary teachers' mathematics anxiety and mathematics teaching anxiety as predictors of students' performance in mathematics in Nigeria. This is a lacuna that this study would like to fill in the literature. Thus, the purpose of the present study was to investigate primary teacher mathematics anxiety as related to mathematics teaching anxiety and students' performance in mathematics.

Specifically in this study, the following research questions were addressed:

(i) Is there any significant relationship among primary teachers' test anxiety, course anxiety, application anxiety, computation anxiety, social anxiety, content knowledge anxiety, self-confidence anxiety, attitude towards mathematics teaching anxiety, teaching knowledge anxiety, and students' performance in mathematics?

(ii) What is the composite contribution of primary teachers' test anxiety, course anxiety, application anxiety, computation anxiety, social anxiety, content knowledge teaching anxiety, self-confidence teaching anxiety, attitude towards mathematics teaching anxiety, and teaching knowledge anxiety to the explanation of the variance in the students' performance in mathematics?

(iii) What is the relative contribution of each of primary teachers' test anxiety, course anxiety, application anxiety, computation anxiety, social anxiety, content knowledge teaching anxiety, self-confidence teaching anxiety, attitude towards mathematics teaching anxiety,

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and teaching knowledge anxiety to the explanation of the variance in the students' performance in mathematics?

2. METHODS

2.1. Research design

The study made use of the quantitative research method within the blueprint of the descriptive survey design.

2.2. Participants

The participants in this study were 480 grades three to six teachers (250 men and 230 women) from thirty primary schools in education districts II and III of Lagos State in South-West Nigeria. The two education districts were randomly selected from six education districts that make up Lagos state. There were 40 primary schools in education district II and 45 primary schools in education district III. 15 schools were randomly selected from each of the two education districts. The teachers were reached at a faculty meeting at the participants' respective schools. The least number of teachers in a school was 15 while the highest number of teachers in a school was 30. So, all the grades three to six teachers in the sampled schools were purposively selected for the study. Their age ranged from 23 to 59 years with a mean age of 41.8 years (SD=5 years 3 months). Teachers in the lower grades (grades one and two) were excluded because it is believed that real mathematics is yet to start in these grades as students are preoccupied with numeracy. The participants could also be categorized as 252 (52.5%) within the age bracket below 35 years and 228 (47.5%) within the age bracket 35-59 years. A threshold of 35 years was used because every teacher in Nigeria is expected to spend less or equal to 35 years in service before retirement. The participants ranged in teaching experience from first-year teachers to teachers with more than 30 years of teaching experience with a meaningful teaching experience of 18.2 years (SD=2years 7 months).

2.3. Instrumentation

The Mathematics Anxiety Rating Scale-Short Version (MARS-SV) developed by Suinn and Winston (2003) and adopted for this study was used to measure primary teachers' math anxiety. The MARS-SV has been used to determine the mathematics anxiety of practicing elementary school teachers (Hughes, 2015). The MARS-SV consists of 30 items on a five-point Likert scale anchored at points with the statements: strongly disagree-5, disagree-4, undecided-3, agree-2, and strongly agree-1 in which higher scores mirror the lower level of math anxiety. Within this scale, MARS-SV includes 5 broad dimensions: test anxiety, course anxiety, application anxiety, computation anxiety, and social anxiety. The reliability coefficient for the overall instrument was calculated as 0.93 for pre-service teachers (Haciomeroglu, 2013). The Cronbach alpha reliability coefficient was calculated as 0.86 for mathematics test anxiety, 0.85 for course anxiety, 0.92 for application anxiety, 0.92 for computation anxiety, and 0.88 for social anxiety subscales (Haciomeroglu, 2013). In the present study, the internal consistency reliability coefficient of the MARS-SV was computed with 80 primary teachers using the Cronbach alpha (α), and the following values were computed for the subscales: mathematics test anxiety (α=0.82); course anxiety (α=0.82); application anxiety (α=0.86); computation anxiety (α=0.92); social anxiety (α=0.90); and for the entire scale (α = 0.89).

The Mathematics Teaching Anxiety Scale (MATAS) developed by Peker (2006) and adapted for this study was used to measure primary teachers' mathematics teaching anxiety levels. The MATAS was created in the Turkish language by Peker (2006) but was later translated from the source language (Turkish) to the target language (English) by Adeyemi using the forward

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translation method. Weeks *et al*. (2007) stated that a forward translation method is one of the key translation approaches that involve a bilingual individual translating the original version of an instrument into a target language. The English version of MATAS denoted by MATAS-E used in this study consists of 23 items on a five-point Likert scale anchored at points with the statements: strongly disagree-5, disagree-4, undecided-3, agree-2, and strongly agree-1 in which higher scores indicate a lower level of mathematics teaching anxiety. The Cronbach alpha reliability coefficient of the four subscales of MATAS, content knowledge (10 items), self-confidence (6 items), attitude towards mathematics teaching (4 items), and teaching knowledge (3 items) were 0.90, 0.83, 0.71, and 0.61 respectively (Peker, 2006). The internal reliability of the entire scale was calculated as 0.91 (Peker, 2006). In the present study, the internal consistency reliability coefficient of the MATAS-E was computed with 80 primary teachers using the Cronbach alpha (α), and the following values were computed for the subscales: content knowledge (α=0.92); self-confidence (α=0.84); attitude towards mathematics teaching (α=0.76); teaching knowledge (α=0.68); and for the entire scale (α = 0.88).

2.4. Data collection procedure

The authors together with four research assistants administered the MARS-SV and MATAS-E to the whole sample at a faculty meeting at the participants' respective schools and the author equally retrieved records about the class average of the student scores on the state end-of-year mathematics examination from each participating teacher. This examination is a criterion-referenced examination designed by the Lagos State Universal Basic Education Board to evaluate the level of proficiency of students concerning the Nigerian 9-year basic education mathematics curriculum (Awofala *et al*., 2012; Awofala, 2012).

2.5. Data analysis

SPSS version 20 was used for the coding of the collected data. Research question one was answered using the Pearson product-moment correlation coefficient. Research questions two and three were answered using multiple regression analysis. The p-value for all the statistical analyses was put at a 0.05 level of significance.

3. RESULTS AND DISCUSSION

3.1. Research question one: Is there any significant relationship among primary teachers' test anxiety, course anxiety, application anxiety, computation anxiety, social anxiety, content knowledge anxiety, self-confidence anxiety, attitudes toward mathematics teaching anxiety, teaching knowledge anxiety, and students' performance in mathematics?

The results in **Table 1** showed the relationships among the mathematics anxiety subscales, mathematics teaching anxiety subscales of primary teachers, and performance in mathematics of primary students. Table 1 showed that there was a significant negative correlation between the primary students' performance in mathematics, each dimension of mathematics anxiety, and each dimension of mathematics teaching anxiety. In fact there was a significant negative correlation between students' performance in mathematics (MP) and primary teachers' test anxiety (TA) (r=-.105, $p<.05$), social anxiety (SA) (r=-.184, $p<.01$), course anxiety (CA) (r=-.126, p<0.01), application anxiety (AA) (r=-0.156, p<0.*01*), content knowledge teaching anxiety (CKTA) (r=-0.104, p<0.05), self-confidence teaching anxiety (SCTA) (r=-0.240, $p<0.01$), attitudes toward mathematics teaching anxiety (ATMT) (r=-0.124, $p<0.01$), and teaching knowledge anxiety (TKA) (r=-0.158, $p<0.01$). However, there was no significant relationship between primary teachers' computation anxiety (COMA) and students' performance in mathematics (r=-0.043, $p=0.172$). There was a significant positive correlation between primary teachers' test anxiety (TA) and

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application anxiety (AA) (*r*=0.479, *p<0.01*), self-confidence teaching anxiety (SCTA) (*r*=0.654, *p<0.01*), and teaching knowledge anxiety (TKA) (*r*=.478, *p<0.01*). There was a significant positive correlation between primary teachers' social anxiety (SA) and application anxiety (AA) (*r*=0.127, *p<0.01*), self-confidence teaching anxiety (SCTA) (*r*=0.137, *p<0.01*), and teaching knowledge anxiety (TKA) (*r*=0.125, *p<0.01*) as can be gleaned from **Table 1**.

3.2. Research Question Two: What is the composite contribution of primary teachers' test anxiety, course anxiety, application anxiety, computation anxiety, social anxiety, content knowledge teaching anxiety, self-confidence teaching anxiety, attitude towards mathematics teaching anxiety, and teaching knowledge anxiety to the explanation of the variance in the student's performance in mathematics?

The results in **Table 2** showed that the independent variables (test anxiety, course anxiety, application anxiety, computation anxiety, social anxiety, content knowledge teaching anxiety, self-confidence teaching anxiety, attitude towards mathematics teaching anxiety, and teaching knowledge anxiety) jointly contributed a coefficient of multiple regression of 0.501 and a multiple correlation square of 0.251 to the prediction of student's performance in mathematics. By implication, 25.1% of the total variance of the dependent variable (performance in mathematics) was accounted for by the combination of the ten independent variables. The results further revealed that the analysis of variance of the multiple regression data produced an *F*-ratio value significant at 0.001 level ($F_{(10, 469)}$ = 12.36; *p*<.001). The results of the relative contributions of the independent variables to the prediction of student performance in mathematics was that self-confidence made the best significant contribution to the prediction of performance in mathematics (*β* = -0.25, *t* = 5.48, *p*<0.001), while computation anxiety made the next significant negative contribution to the prediction of the dependent variable (*β* =-0.25, *t*=5.08, *p*<.001). Application anxiety made the next significant negative contribution to the prediction of the dependent variable (*β* =-0.17, *t* = 3.46, *p*<0.001). Teaching knowledge anxiety (*β* =-0.16, *t*=3.11, *p*=0.002) did make the next significant contribution to the prediction of students' performance in mathematics. Attitude toward mathematics teaching anxiety (*β* =-0.15, *t* = 2.77, *p*=0.006) made the next negative significant contribution to the prediction of student's performance in mathematics. Social anxiety (*β*=-0.11, *t*=2.76, *p*=0.010) did make a significant negative contribution to the prediction of students' performance in mathematics. Test anxiety (*β*=-4.73, *t*=1.81, *p*=0.070), content knowledge teaching anxiety (*β* =-4.58, *t* =-1.76, *p*=.080) and course anxiety (*β*=-0.06, *t* = 1.23, *p*=0.220) did not make any significant contribution to the prediction of student's performance in mathematics. According to the standardized coefficients the regression model is as follows: Performance in $\text{Mathematics}_{predicted}$ = 35.53 - 18.99 test anxiety - 1.44 social anxiety - 0.27 course anxiety - 0.62 application anxiety -0.99 computation anxiety – 18.38 content knowledge teaching anxiety - 1.08 self-confidence teaching anxiety -1.14 attitudes toward mathematics teaching anxiety - 0.87 teaching knowledge anxiety.

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Table 1. Correlations matrix for the relationship between teachers' mathematics anxiety dimensions, teachers' mathematics teaching anxiety dimensions, and primary students' performance in mathematics

		1	2	3	4	5	6	7	8	9	10	11	12
1	MP	1											
2	TA	-0.105*	1										
3	SA	-0.0184**	0.005	1									
4	CA	-0.126**	0.023	0.042	1								
5	AA	-0.156**	0.479**	0.127**	0.116*	1							
6	COMA	-0.043	0.005	0.045	0.452**	0.049	1						
7	CKTA	-0.104*	0.654**	0.004	0.021	0.479**	0.005	1					
8	SCTA	-0.240**	0.075	0.137**	0.138**	0.082	0.379**	0.075	1				
9	ATMT	-0.124**	0.022	0.044	0.198**	0.118*	0.452**	0.021	0.136**	1			
10	TKA	-0.158**	0.478**	0.125**	0.115*	0.298**	0.046	0.478**	0.078	0.117*	1		
11	MANX	-0.399**	320**	0.213**	0.442**	0.364**	0.111*	0.320**	0.408**	0.442**	0.367**	1	
12	MTA	-0.263**	0.745**	0.111*	0.404**	0.130**	0.345**	0.746**	0.565**	0.405**	0.126**	0.713**	1
Mean		57.96	2.58	3.34	2.42	3.38	3.71	2.58	2.79	3.38	1.52	2.98	2.71
SD		4.86	1.34	0.43	1.28	1.46	1.37	1.34	1.26	1.28	1.47	0.44	0.69
N		480	480	480	480	480	480	480	480	480	480	480	480

**Significance at p<0.01 *Significance at p<0.05

NB. MP=mathematics performance; TA=test anxiety; SA=social anxiety; CA=course anxiety; AA=application anxiety; COMA=computation anxiety; CKTA=content knowledge teaching anxiety; SCTA= self-confidence teaching anxiety; ATMT=attitude toward mathematics teaching anxiety; TKA=teaching knowledge anxiety; MANX=mathematics anxiety; and MTA=mathematics teaching anxiety.

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Table 2. Model summary, coefficient, and t-value of multiple regression analysis of primary teacher mathematics anxiety dimensions, mathematics teaching anxiety dimensions, gender, and the outcome measure (students' performance in mathematics)

Model summary Multiple R = 0.501; Multiple R2 = 0.251; Multiple R2 (adjusted) = 0.236; Standard error estimate = 4.70 $F_{(9, 470)}$=17.47, p<0.001							
	B	**Std Error**	**Beta**	**t**	**Sig**	**Unique Variance**	**Estimate**
Constant 35.53	2.12			16.77	0.00		
TA	-18.99	10.47	-4.73		-1.81	0.070	0.006
SA	-1.44	0.52	-0.11		-2.76	0.010	0.013
CA	-0.27	0.22	-0.06		-1.23	0.220	0.000
AA	-0.62	0.18	-0.17		-3.46	0.001	0.019
COMA	-0.99	0.19	-0.25		-5.08	0.000	0.042
CKTA	-18.38	10.46	-4.58		-1.76	0.080	0.005
SCTA	-1.08	0.20	-0.25		-5.48	0.000	0.048
ATMT	-1.14	0.41	-0.15		-2.77	0.006	0.016
TKA	-0.87	0.28	-0.16		-3.11	0.002	0.057

Note: TA=test anxiety; SA=social anxiety; CA=course anxiety; AA=application anxiety; COMA=computation anxiety; CKTA=content knowledge teaching anxiety; SCTA= self-confidence teaching anxiety; ATMT=attitude toward mathematics teaching anxiety; TKA=teaching knowledge anxiety.

3.3. Research Question Three: What is the relative contribution of each of primary teachers' test anxiety, course anxiety, application anxiety, computation anxiety, social anxiety, content knowledge teaching anxiety, self-confidence teaching anxiety, attitude towards mathematics teaching anxiety, and teaching knowledge anxiety to the explanation of the variance in the student's performance in mathematics?

To determine the relative contribution of each of the predictor variables, the authors created a set of nine reduced models where each reduced model excludes one of the nine predictor variables. Thereafter, we computed the change in the squared multiple correlations between the full model with all nine predictors and each of the eight-predictor-reduced models. This change in the squared multiple correlations represents the unique variance in the dependent variable accounted for by the omitted predictor that is independent of the variance accounted for by the other eight predictors. This unique variance is a better quantitative estimate of the importance of each predictor in predicting the dependent variable. Table 2 showed the unique variance estimate of each predictor variable. Teaching knowledge anxiety accounted for the largest amount of unique variance (5.7%) in students' performance in mathematics. This was followed by self-confidence teaching anxiety which accounted for 4.8% of the unique variance in the dependent measure. This was followed by computation anxiety which accounted for 4.2% of the unique variance in the dependent measure. Application anxiety accounted for 1.9% of the unique variance in students' performance in mathematics. Attitude toward mathematics teaching anxiety accounted for 1.6% of the unique variance in students' performance in mathematics. Social anxiety accounted for 1.3% of the unique variance in students' performance in mathematics.

The finding relating to the relationship between primary teachers' mathematics anxiety, mathematics teaching anxiety, and students' performance in mathematics showed that in the present study the primary teachers' mathematics anxiety and mathematics teaching anxiety had

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a significant negative relationship with the primary students' performance in mathematics. This agreed with the popular parlance that there is an inverse relationship between mathematics anxiety and performance in mathematics (Awofala, 2019; Ramirez *et al*., 2013; Ashcraft & Krause, 2007; Venkatesh, & Karimi, 2010; Pourmoslemi *et* al., 2013; Artemenko *et al*., 2015) and between primary teachers' mathematics teaching anxiety and students' performance in mathematics. The higher the mathematics anxiety of teachers, the lower their performance in mathematics. Also, the higher the mathematics teaching anxiety of teachers, the lower their effectiveness in teaching mathematics. Students of primary teachers with lower levels of mathematics anxiety had higher performance in mathematics. Students of primary teachers with lower levels of mathematics teaching anxiety had higher performance in mathematics. Students of primary teachers with higher levels of mathematics anxiety and mathematics teaching anxiety had lower performance in mathematics. Primary teachers with lower levels of mathematics anxiety and mathematics teaching anxiety have confidence in their skills and abilities to be effective teachers. For the participating primary teachers, their mathematics anxiety and mathematics teaching anxiety were found to have a statistically negative association with students' performance in mathematics. The primary teachers had higher mathematics anxiety and higher mathematics teaching anxiety and their students recorded lower performance in mathematics. Primary teachers who felt more anxious about mathematics and mathematics teaching were less likely to hold sophisticated beliefs in their ability to teach mathematics effectively. Conversely, primary teachers who felt less anxious about mathematics and mathematics teaching were more likely to hold strong sophisticated beliefs in their ability to teach mathematics effectively. Thus, mathematics anxiety and mathematics teaching anxiety are a cause of primary teachers' lack of confidence in teaching practices. Participation of primary teachers in mathematics methods courses may decrease their mathematics anxiety and mathematics teaching anxiety levels. Primary teachers with low mathematics anxiety and mathematics teaching anxiety are more confident to teach primary mathematics than primary teachers with moderate and high mathematics anxiety and mathematics teaching anxiety. Teaching mathematics effectively and with confidence requires that teachers hold low mathematics anxiety and low mathematics teaching anxiety. While the magnitudes of the correlations between mathematics anxiety and students' performance in mathematics and between mathematics teaching anxiety and performance in mathematics are not very strong, the significant association between mathematics anxiety and performance in mathematics and between mathematics teaching anxiety and performance in mathematics should be acknowledged. The negative significant association between mathematics anxiety and students' performance in mathematics on one hand and the negative significant association between mathematics teaching anxiety and students' performance in mathematics, on the other hand, show that the primary teachers with low mathematics anxiety and mathematics teaching anxiety have students who were more cognitively aligned to perform effectively in mathematics. Teachers with low mathematics anxiety and low mathematics teaching anxiety had more confidence in their abilities to teach mathematics effectively and also hold strong mathematical beliefs (Awofala & Sopekan, 2020). Low mathematics anxiety and low mathematics teaching anxiety in primary teachers are antidotes to low motivation to learn mathematics (Awofala *et* al., 2020; Awofala & Falolu, 2017) and negative productive disposition towards mathematics (Awofala, Lawal, Arigbabu & Fatade, 2022) which may stifle creativity in teachers (Awofala & Fatade, 2015).

The relationship between students' performance in mathematics and the predictor variables taken together was high as shown by the coefficient of multiple correlations (R = 0.501). Thus, the predictor variables investigated when taken together predicted to some extent students' performance in mathematics. Thus, the strength of the predictive power of the combined

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independent variables (Test anxiety, course anxiety, application anxiety, computation anxiety, social anxiety, content knowledge teaching anxiety, self-confidence teaching anxiety, attitudes toward mathematics teaching anxiety, and teaching knowledge anxiety) on the outcome variable was strong and significant to show the linear relationship between the ten predictor variables and the total variance in students' performance in mathematics. This result showed the need for primary teachers to have mastery of the contents of mathematics they intend to teach and adopt students' centered strategies such as cooperative learning (Awofala & Lawani, 2020; Olabiyi & Awofala, 2019) and personalization of instruction (Awofala, 2017a) capable of deflating their mathematics anxiety and mathematics teaching anxiety. Thus, they do not pass these debilitating elements onto their students irrespective of gender (Fatade *et* al., 2012; Awofala, 2011).

4. CONCLUSION

In this study, it is established that teachers' mathematics anxiety and mathematics teaching anxiety are good predictors of students' performance in mathematics. This result showed the need to counteract teachers' mathematics anxiety and mathematics teaching anxiety since teachers with these perturbing elements can transfer them to their students. Teachers with these disturbing elements may find it difficult to teach mathematics effectively in the classroom. Their ineffective teaching may impair students understanding of mathematics taught and this may snowball into low performance on the part of the students. Adequate attention should be given to teachers who show signs of anxiety towards mathematics and mathematics teaching to reduce their negative effects on students' performance in mathematics. However, there is a need for further research on mathematics teaching anxiety with in-service and pre-service teachers in Nigeria and elsewhere. Based on this study, it was thus, recommended that future studies in Nigeria and elsewhere should investigate the factor analytic structure of the mathematics teaching anxiety scale among in-service and pre-service teachers of mathematics. The 74.9% of variance in students' performance in mathematics unexplained by the current data showed that there might be other independent variables that might require further investigations about their contribution to the prediction of student's performance in mathematics.

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6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

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