ACTA DIDACTICA NAPOCENSIA

Volume 10, Number 2, 2017

ASSESSING PRESERVICE TEACHERS' MATHEMATICS COGNITIVE FAILURES AS RELATED TO MATHEMATICS ANXIETY AND PERFORMANCE IN UNDERGRADUATE CALCULUS

Adeneye O. A. Awofala, Helen N. Odogwu

Abstract: The study investigated mathematics cognitive failures as related to mathematics anxiety, gender and performance in calculus among 450 preservice teachers from four public universities in the South West geo-political zone of Nigeria using the quantitative research method within the blueprint of the descriptive survey design. Data collected were analyzed using the descriptive statistics of percentages, mean, and standard deviation and inferential statistics of factor analysis, independent samples t-test, and multiple regression analysis. Findings revealed that mathematics cognitive failure assessed by the mathematics cognitive failures questionnaire was a multi-dimensional construct (lack of concentration, motor function, memory, and distractibility). Mathematics anxiety level differences in cognitive failures in mathematics and performance in calculus among preservice teachers were significant. Cognitive dimension of mathematics anxiety, gender, affective dimension of mathematics anxiety, lack of concentration and motor function dimensions of mathematics cognitive failures made statistically significant contributions to the variance in preservice teachers' performance in calculus. Based on this baseline study, it was thus, recommended that future studies in Nigeria and elsewhere should investigate whether mathematics cognitive failures could be responsible for students' errors committed when solving problems in mathematics.

Key words: Mathematics cognitive failures, mathematics anxiety, performance in calculus, preservice teachers

1. Introduction

The term lapse of awareness is rooted in both clinical and cognitive psychology. In the clinical psychology lapse of awareness is termed dissociation while in cognitive psychology it is called cognitive failure. These two constructs encompass overlapping mental phenomena in which cognitive failures overlap with non-pathological dissociation (Bruce, Ray & Carlson, 2007). As first mooted by Broadbent, Cooper, FitzGerald and Parkes in 1982, cognitive failures refer to perceptual, attentional, memory, and action-related lapses of awareness. Cognitive failures refer to interference in the memory, distractibility and physical blunder (Wallace & Vodanovich, 2002) which cause failure in the performance of an action which a person is normally capable of executing (Wallace, Kass & Stanny, 2002). Cognitive failures may refer to as errors of cognition. Reason (1990) categorized human errors into three major classes: slips, lapses, and mistakes. Slips are defined as errors of execution; lapses as errors of storage; and mistakes as errors of planning. The Cognitive Failures Questionnaire (CFQ) developed by Broadbent et al. (1982) is an established self-report measure of individual differences in daily mental lapses with 25 questions relating to everyday errors such as the likelihood of not noticing signposts on the road or being confused right and left when giving directions. These questions are seen to reflect lapses in memory, perception, and attention. While the CFQ scores remain relatively constant over time (Broadbent et al, 1982), cognitive failures occur in occupational and non-occupational activities (Allahyari, Rangi, Khalkhali, & Khosravi, 2014). Occupational cognitive failures are bunches of mental lapses that occur at the working environment while non-occupational cognitive failures are clusters of failures that occur outside the working environment.

Received February 2017.

The literature is replete with inconclusive findings regarding the factor structure of the CFQ (Matthews, Coyle, & Craig, 1990; Pollina, Greene, Tunick, & Puckett, 1992; Wallace, 2004) although the CFQ had been thought to assess a single construct. The developers indicated that the CFQ assesses a single, stable trait-like construct with adequate psychometrics (Broadbent et al, 1982). This assertion has been queried (Larson, Alderton, Neideffer, & Underhill, 1997) and the question was asked ‘‘how many different types of cognitive failures do the CFQ measure?’’ (Bruce, Ray, & Carlson, 2007). In a confirmatory factor analysis of the CFQ, Wallace (2004) indicated that a four-factor solution yielded the best fit. Bruce, Ray and Carlson (2007) determined the factor structure of the CFQ uses both the exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). The result showed that all items of the CFQ loaded reasonably highly onto a single, general factor and the single-factor model fell short of standard criteria for fit indices. Thus, it was suggested that the CFQ lacked the psychometrics required for a theoretically meaningful elucidation of more than a single factor (Bruce, Ray & Carlson, 2007). Based on these inconclusive findings, it is recommended that more research be carried out on the factor structure of the CFQ.

In short scores on CFQ had been found to be positively correlated with increased distraction of attention in everyday living such as absent-mindedness while shopping (Reason & Lucas, 1984), increased number of car accidents (Larson & Merritt,1991) and minor injuries at work (Wallace & Vodanovich, 2003). It is evident that general cognitive failures correlated with workplace accidents (Arthur, Barrett & Alexander, 1991), a traffic domain (Larson & Merritt, 1991), minor injuries (O’Hare, Wiggins, Batt & Morrison, 1994; Larson, Alderton, Neideffer, & Underhill, 1997), stress (Broadbent et al, 1982) and fall injury and hospitalisation (Larson, Alderton, Neideffer, & Underhill, 1997). A significant positive correlation was also found between cognitive failures and task performance (Tipper & Baylis, 1999). More so, total CFQ scores were associated with driving error rates, but not with accidents (Allahyari et. al, 2008). Early studies on cognitive failures and anxiety showed that there existed a significant positive relationship between cognitive failures and anxiety (Broadbent et al, 1982). Studies also showed a meaningful relationship between cognitive failures, anxiety, psychological tension and affection disorders (Sullivan & Payne, 2007). CFQ scores had been found to be positively correlated with state anxiety symptoms even after controlling for the influence of trait anxiety and neuroticism (Merckelbach, Muris, Nijman, & de Jong, 1996), although there had been a significant association between CFQ scores and trait anxiety (Smith, Chappelow, & Belyavin, 1995). Simpson, Wadsworth, Moss and Smith (2005) found a significant positive correlation between clinical anxiety and cognitive failure. In a recent study, Berggren, Hutton and Derakshan (2011) showed that self-reported state anxiety correlated with CFQ scores. In another more recent study, Habib and Naz (2015) found out there was a significant positive correlation between CFQ scores and interpersonal relationship anxiety in children with dyslexia. More so, interpersonal relationship anxiety was found to be a significant predictor of cognitive failures and vice versa in children with dyslexia (Habib & Naz, 2015). All these point to the fact that different forms of anxiety (except mathematics anxiety yet to be studied) had a significant positive correlation with cognitive failures in both clinical and nonclinical populations.

It is startling nevertheless apparently true that up until this research was begun, no researcher had investigated the relationship between mathematics cognitive failures (MCF) and mathematics anxiety. It is posited here that math cognitive failure would be different from general cognitive failure, although the two constructs would overlap to a degree. Mathematics cognitive failures in this setting refer to perceptual, attentional, memory, and action-related lapses of awareness in relation to the study of mathematics. It is individual differences in proneness to errors in routine mathematical activity and problem solving. Mathematics cognitive failures refer to inabilities to successfully perform mathematical tasks that one might naturally be able to execute on a daily basis. Following the work of Broadbent at al. (1982), the present study developed a domain specific mathematics cognitive failures questionnaire and investigated its relation with mathematics anxiety and performance in the undergraduate calculus course. It is noted that cognitive failures require further studies and different measurement tools for specific domains (Allahyari, Rangi, Khosravi & Zayeri, 2011) and mathematics is a specific domain that requires attention. Accordingly, it is important that recent investigations focus on cognitive failures in mathematics education. This is so because many students commit errors while solving problems in mathematics and these errors reflect in both routine and non-routine problems. In mathematical errors are wrong answers due to planning. A mathematical error is an error committed by a person (student, teacher) who in a given task considers as true an untrue mathematical sentence or considers an untrue sentence as mathematically true (Legutko, 2008).

Calculus is one aspect of advance mathematics which students dread and often show poor performance. The poor performance is not unconnected to errors committed by students while trying to solve problems in calculus. Students often commit both procedural and conceptual errors when solving problems in calculus. Procedural errors are connected with procedural knowledge and conceptual errors are associated with conceptual knowledge. Procedural knowledge is defined as the mastery of computational skills and knowledge of procedures for identifying mathematical components, algorithms, and definitions. Conceptual knowledge relates to the knowledge of the underlying structure of mathematics–the relationships and interconnections of ideas that explain and give meaning to mathematical procedures (Eisenhart, Borko, Underhill., Brown, Jones, & Agard, 1993). Many students fail to show success in calculus because it is anxiety inducing and students would want to opt out if given the opportunity to do so. One debilitating construct in mathematics education is mathematics anxiety.

Although mathematics anxiety has been extensively studied in middle school and high school students, little is known about the emergence of mathematics anxiety in young and tertiary students. Few published studies investigating mathematics anxiety in tertiary level have focused on matriculating and undergraduate students (Pourmoslemi, Erfani & Firoozfar, 2013; Zakaria & Nordin, 2008). Mathematics anxiety often leads to avoidance of mathematics by those who experience it (Mahmood & Khatoon, 2011) and it is more than a dislike towards mathematics. Mathematics anxiety is a feeling of tension and anxiety that impedes with the handling of numbers and the solving of the mathematical problems in a wide variety of ordinary life and academic situations (Richardson & Suinn, 1972). According to Hamid, Shahrill, Matzin, Mahalle and Mundia (2013) mathematics anxiety is an intense emotional and irrational fear of math based on unrealistic feelings of frustration, hopelessness, and helplessness associated with repeated failure or lack of experience of success. Mathematics anxiety is associated with fear and apprehension to specific mathematics related situations (D'Ailly & Bergering, 1992) and is a sense of discomfort observed while working on mathematical problems (Hadfield & Trujillo, 1999; Ma, 2003). Jain and Dowson (2009) described mathematics anxiety as a result of an inability to handgrip frustration, excessive school absences, poor self-concept, internalized negative parental and teacher attitudes toward mathematics, and an emphasis on learning mathematics through the drill without real understanding. Mathematics anxiety is a performance based anxiety disorder that involves physiological stimulation, negative cognitions, and avoidance behaviours that lead to an affective drop in mathematics and mathematics related activities. Eden, Heine and Jacobs (2013) provided an overview of the current state of research concerning the development, defining factors and effects of mathematics anxiety, particularly with respect to young elementary school age level populations. The comprehensive review also touched the assessment instruments, potential risk-factors, consequences of mathematics anxiety, as well as approaches to intervention (Eden etal, 2013) in mathematics anxiety.

The negative relationship between mathematics anxiety and mathematics performance and achievement has long been detected (Dreger & Aiken, 1957; Engelhard, 1990; Green, 1990; Hembree, 1990; Tocci & Engelhard, 1991; Ma, 1999) in which students with higher levels of mathematics anxiety are inclined to have lower levels of mathematics performance (Ashcraft & Kirk, 2001; Ashcraft & Ridley, 2005; Ashcraft & Krause, 2007; Venkatesh, & Karimi, 2010; Pourmoslemi, Erfani & Firoozfar, 2013; Beall, Roebuck, & Penkalsky, 2015; Artemenko, Daroczy, & Nuerk 2015). Mathematics anxiety causes an "affective drop," a decline in performance when mathematics is performed under timed, high-stakes conditions, both in laboratory tests as well as in educational settings (Ashcraft & Moore, 2009). The vision of doing mathematics is enough to generate negative emotional reactions among students with high mathematics anxiety (Lyons & Beilock, 2010). Mathematics anxiety has a debilitating effect on college students' ''mathematical knowledge, mathematics grades and standardised test scores'' (Ramirez, Gunderson, Levine & Beilock, 2013;

Ashcraft & Krause, 2007). Many studies have viewed mathematics anxiety as a subject-specific exhibition of test anxiety (Bandalos, Yates, & Thorndike-Christ, 1995; Hembree, 1990) in which the theoretical model of test anxiety is assumed to back up mathematics anxiety (Hembree, 1990; Sarason, 1986).

Liebert and Morris (1967) identified two components of test anxiety, worry and emotionality. *Worry* is the cognitive component of anxiety, consisting of negative expectation and self-deprecatory thoughts about one's performance in an anxiety inducing situation (Wigfield & Meece, 1988). *Emotionality* is the affective component of anxiety, including feelings of nervousness, tension, dread, fear, and unpleasant physiological reactions to testing situations (Wigfield & Meece, 1988). According to Liebert and Morris (1967) these two components are empirically different, although they are correlated, and that worry relates more strongly than emotionality to poor test performance (Wigfield & Meece, 1988). Regarding the dimensionality of mathematics anxiety, Wigfield and Meece (1988) in confirmatory factor analyses provided evidence for two components: a negative affective reaction component and a cognitive component. The affective component of mathematics anxiety correlated more strongly and negatively than did the worry component to children's ability perceptions, performance perceptions, and mathematics performance. The worry component correlated more strongly and positively than did the affective component to the importance that children attach to mathematics and their reported ratings of actual effort expended in mathematics (Wigfield & Meece, 1988). In the same vein, Ho etal (2000) in a cross national study of the affective and cognitive dimensions of mathematics anxiety found that the results of confirmatory factor analyses supported the theoretical distinction between affective and cognitive dimensions of mathematics anxiety in all 3 national samples of China, Taiwan, and the United States. More so, across the 3 national samples, the affective factor of mathematics anxiety was significantly correlated to mathematics achievement in the negative direction. In Nigeria no study has empirically examined the factor structure of the Wigfield and Meece's mathematics anxiety questionnaire. For young children, Ramirez, Gunderson, Levine and Beilock (2013) found a negative relation between mathematics anxiety and mathematics achievement for children who were higher but not lower in working memory (WM).

Working memory (WM) is a cognitive process which allows a person to multitask, or simultaneously think about and hold information at the same time as completing other tasks, and is responsible for temporarily storing and manipulating information (Alloway, 2006; Klingberg, Forssberg, & Westerberg, 2002). Ashcraft and Kirk (2001) examined and found a negative relationship between mathematics anxiety and WM among undergraduate students. This implied that the presence of mathematics anxiety might compromise WM (Sevey, 2012). Although CFQ scores did not appear to predict performance in memory tasks (Wilkins & Baddeley, 1978), they have been distinguished to affect memory in tasks requiring the inhibition of unwanted memories (Groome & Grant, 2005). One justification for the association between CFQ scores and poor performance on tasks of selective attention may be that both replicate a failure to preserve task goals in WM (Berggren, Hutton & Derakshan, 2011). Loading WM via secondary tasks has been revealed to interrupt selective attention in a similar way to that told in the study of CFQ (Gazzaley, 2011). A few studies have found a relationship between cognitive failures and academic performance/achievement. Sadeghi, Abolghasemi, and Hajloo (2013) found out that cognitive failures explained only 8% of the variance in the academic performance of Developmental Coordination Disorder (DCD) students and among them, only the absent-mindedness- a dimension of cognitive failures had meaningful predictive power for the academic performance of DCD students. Ibironke, Awofala and Awofala (2015) found out that there was no significant relationship between cognitive failures and senior secondary school students' performance in biology. More so, a negatively weak correlation was found between students' cognitive failures and their body mass index (B.M.I).

This review has shown that the construct of mathematics cognitive failure is a fertile area of research in mathematics education since no study has investigated it in the literature. In addition the relation among mathematics cognitive failure, mathematics anxiety and performance in calculus is worth examining. Hence, the present study assessed preservice teachers' mathematics cognitive failures as related to mathematics anxiety and performance in undergraduate calculus.

1.1. Research Questions

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

1. What is the factor structure of the mathematics cognitive failures questionnaire among Nigerian preservice teachers?

2. What is the relationship between the mathematics cognitive failures and the general cognitive failures among Nigerian preservice teachers?

3. Is mathematics anxiety a factor in performance in calculus and perception of mathematics cognitive failures among Nigerian preservice teachers?

4. What is the relationship among the dimensions of mathematics cognitive failures (lack of concentration, motor function, memory and distractibility), dimensions of mathematics anxiety (affective and cognitive components) and performance in calculus of the Nigerian preservice teachers?

5. What are the composite and relative contributions of dimensions of mathematics cognitive failures (lack of concentration, motor function, memory and distractibility), mathematics anxiety (affective and cognitive components) and gender to the explanation of the variance in the preservice teachers' performance in undergraduate calculus?

2. Method

The study made use of quantitative research method within the blueprint of the descriptive survey design. The participants in this study were 450 preservice mathematics teachers (270 males and 180 females) from four Universities in the South-West geo-political zone of Nigeria. Their age ranged from 16 to 34 years with mean age of 21.8 years. The participants could also be categorised as 210 (46.67%) within the age bracket below 20 years and 240 (53.33%) within the age bracket 20-34 years. 100 (22.22%) were in first year [60 (60%) males, 40 (40%) females, *M*age = 19.4 years, *SD* = 2.3, age range: 16-25 years], 120 (26.67%) were in second year [80 (66.67%) males, 40 (33.33%) females, *M*age = 21.2 years, *SD* = 2.8, age range: 17-30 years], 110 (24.44%) were in third year [60 (54.55%) males, 50 (45.45%) females, *M*age = 22.3 years, *SD* = 3.1, age range: 18-32 years], and 120 (26.67%) were in fourth year [70 (58.33%) males, 50 (41.67%) females, *M*age = 21.3 years, *SD* = 2.9, age range: 19-34 years].

For the purpose of data collection, three instruments tagged Cognitive Failures Questionnaire (CFQ) adopted from Broadbent etal (1982), Mathematics Cognitive Failures Questionnaire (MCFQ) adapted from Broadbent etal (1982) and Mathematics Anxiety Questionnaire (MAQ) were used to collect primary data relating to cognitive failures, mathematics cognitive failures and mathematics anxiety respectively while secondary data relating to the preservice mathematics teachers' performance in calculus were retrieved from their records in the four Universities. The CFQ and MCFQ consisted of 25 items apiece anchored on a 5-point modified Likert scale ranging from: Very often -4, Quite often -3, Occasionally -2, Very rarely -1, to Never -0. Broadbent etal (1982) found out that the test retest correlation for the CFQ ranged between 0.803 (n=32) and 0.824 (n=57) within an average interval of 65 weeks and 21 weeks respectively and thus the CFQ can be said to be a stable measure. The internal consistency reliability coefficients of the CFQ and MCFQ were computed using the Cronbach alpha (α) with values of 0.97 and 0.94 respectively. The MCFQ being an adapted instrument was face validated by three experts in mathematics education for appropriateness for the study objective and the suggestions of the experts were incorporated into the MCFQ before its administration to the target sample. The MAQ consisted of 11 items on a 5-point modified Likert scale ranging from: Not at all -0, A little -1, A fair amount -2, Much -3 to Very much -4 adopted from Wigfield and Meece (1988). The items on the MAQ concerned with negative affective reactions to doing mathematics activities in school and on students' worries about their performance in mathematics. The alphas were .82 for the negative affective reactions scale and .76 for the worry scale (Wigfield & Meece, 1988). For the present study the internal consistency reliability coefficient of the MAQ was computed using the Cronbach alpha (α) with value of 0.94. Preservice teachers' mathematics anxiety scores were used to assign them into three groups: low mathematics anxiety group, moderate mathematics anxiety group and high mathematics anxiety group. The classification of the preservice teachers was made by using the percentiles of the anxiety scores. Preservice teachers whose scores fell between 33% and 67% were considered the moderate group. Low and high anxiety groups consisted of the preservice teachers whose scores were in the lower 33% and in the upper 33% of the distribution, respectively. In this study no preservice teachers' scores fell between 33% and 67%.

The authors together with four research assistants administered the CFQ, MCFQ and MAQ to the whole sample and in a regularly scheduled class and the author equally retrieved scores pertaining to the preservice mathematics teachers' performance in calculus from their records in the four Universities for the purpose of this study. Data collected were summarized and analyzed using principal components factor analysis, analysis of variance (ANOVA), Pearson's product moment correlation, and multiple regression analysis at 0.05 level of significance.

3. Results

3.1 Research Question One: What is the factor structure of the mathematics cognitive failures questionnaire among Nigerian preservice teachers?

For research question 1 the responses of the participants to the 25 items of the mathematics cognitive failures questionnaire were subjected to principal components factor analyses (PCA) to identify their underlying dimensions. The data screening processes were carried out and showed no missing values for the 450 participants. Subsequently, further screening showed no concern about normality, linearity, multicollinearity, and singularity. For example, scale scores were normally distributed with skewness and kurtosis values within acceptable ranges (e.g. skewness ranged from -.602 to 0.543, kurtosis ranged from -1.394 to .336) as Kline (1998) suggested using absolute cut-off values of 3.0 for skewness and 8.0 for kurtosis. The correlation matrix of the 25 items revealed that the correlations when taken overall were statistically significant as indicated by the Bartlett's test of sphericity, $\chi2$ = *14184*.89*; df=300; p*<.001 which tests the null hypothesis that the correlation matrix is an identity matrix. The Kaiser-Meyer-Olkin measure of sampling adequacy (MSA) fell within acceptable range (values of .60 and above) with a value of .895. Each of the variables also exceeded the threshold value (.60) of MSA which ranged from .740 to .892. Finally, most of the partial correlations were small as indicated by the anti-image correlation matrix. These measures all led to the conclusion that the set of 25 items of the mathematics cognitive failures questionnaire was appropriate for PCA and since no particular number of components was first hypothesized the criterion was set to eigenvalues greater than one (Kaiser, 1960; Tabachnick & Fidell, 2007). The initial unrotated PCA resulted in a factor model of four dimensions as indicated by the eigenvalues exceeding unity while the scree plot also showed a factor model of four dimensions. However, based on its pattern of factor loadings, this unrotated factor model was theoretically less meaningful and as such was difficult to interpret. Therefore, the analysis proceeded to rotate the factor matrix orthogonally using varimax rotation to achieve a simple and theoretically more meaningful solution. The rotation resulted in a factor model of four dimensions as suggested by the scree plot and eigenvalues exceeding unity. However, one item in factor 3 should have loaded on factor 4, one item in factor 4 should have loaded on factor three, one item in factor three was found inadequate in terms of its wordings while one item in factor 3 had the same meaning and interpretation with another item in factor 4. So, four items were discarded, leaving behind 21 items.

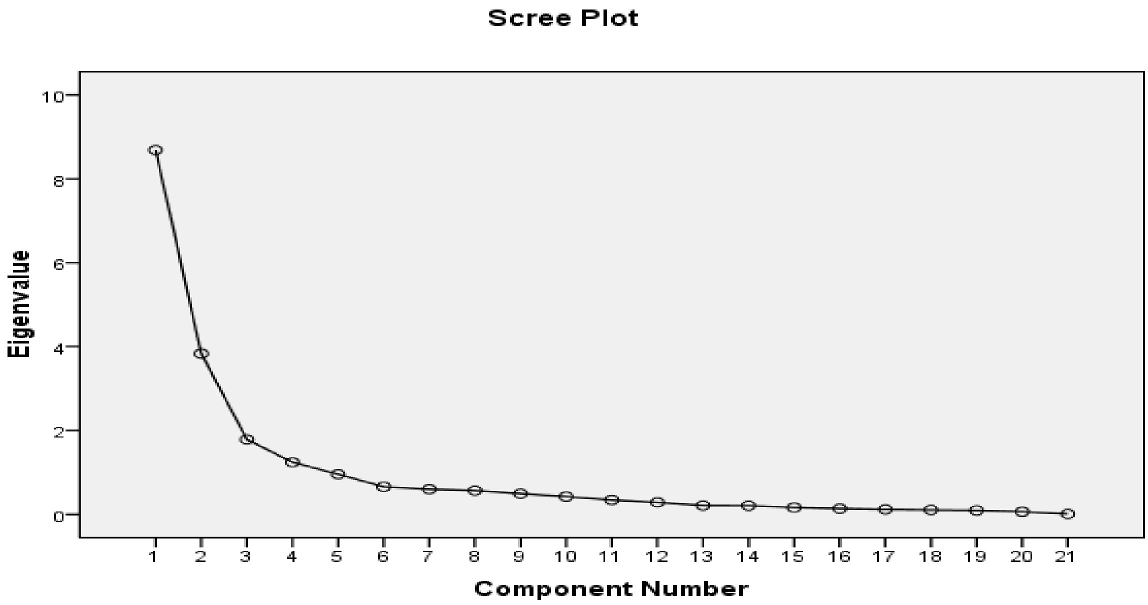

Figure. 1. *Cattell scree plot showing number of components and eigen-values of the correlation matrix*

Table 1. *Mean and standard deviation and summary of factor loadings by principal components analysis for the orthogonal four factor model*

A. Lack of concentration **Factor 1**	**M**	**SD**	**Factor loading**	**h^2**
1. Do you read a mathematics textbook and find you haven't been thinking about it and must read it again?	3.427	1.258	.658	.559
2. Do you fail to notice the basic mathematics operations when solving mathematics problems?	3.013	1.328	.698	.842
3. Do you fail to listen in a mathematics class when you are being taught?	3.2467	1.318	.637	.804
Sub-total	**3.2289**	**1.3013**		
B. Motor function **Factor 2**				
4. Do you bump into mathematics class and find it difficult to cope with?	3.140	1.218	.615	.765
5. Do you leave mathematics assignments unattended to because you don't know it?	3.140	1.277	.724	.776
6. Do you find yourself suddenly wondering whether you've solved a mathematics problem correctly?	3.387	.848	.851	.848
7. Do you have trouble making up your mind on a mathematics problem?	3.060	1.035	.863	.836
Sub-total	**3.1818**	**1.0945**		
C. Memory **Factor 3**				
8. Do you find you forget why you read a mathematics textbook?	2.993	1.237	.812	.862
9. Do you find you forget whether you've done a mathematics assignment?	3.180	1.185	.726	.830
10. Do you contribute in a mathematics class and realize afterwards that it might be taken as wrong	3.093	1.198	.747	.743

answer?				
11. Do you lose your temper in a mathematics class for not answering a mathematics question and regret it?	2.933	1.177	.819	.749
12. Do you fail to work through the solution of a mathematics problem which you know the answer?	3.660	1.102	.750	.676
13. Do you find you choose the wrong method for a mathematics problem that you have frequently solved in the past?	3.280	.881	.701	.561
Sub-total	**3.1898**	**1.1300**		
D. Distractibility Factor 4				
14. Do you forget where you put a mathematics textbook that you need now?	2.980	1.159	.741	.647
15. Do you find it difficult to remember what you were taught in a mathematics class?	3.047	1.055	.846	.727
16. Do you daydream when you ought to be solving mathematics problems?	3.047	1.294	.770	.729
17. Do you find you forget how to solve familiar mathematics problems?	3.260	.984	.707	.709
18. Do you start solving a mathematics problem at home and get distracted into doing another thing (unintentionally)?	3.193	1.089	.821	.701
19. Do you find you forget what you came to the mathematics class to learn?	3.073	1.085	.771	.715
20. Do you drop pen when you are supposed to be using it in a mathematics class?	3.067	1.095	.732	.659
21. Do you find you can't think of anything to say in a mathematics class?	2.927	1.213	.743	.614
Sub-total	**3.0743**	**1.1218**		
Total	**3.1687**	**1.1619**		

In this study, all the communalities for the factor analysis satisfied the minimum requirement of being larger than 0.50, in fact these ranged from 0.559 to 0.862. Figure 1 above is the scree plot which graphs the eigenvalue against the component number and is suggestive of a four component model.

Table 1 displayed the factor loadings for the orthogonal four-factor model of the mathematics cognitive failures questionnaire. All items loaded .615 and above on their primary factor; none of the secondary loadings exceeded .30. Together the four factors accounted for 74.03% of the total variance. The first factor accounted for 41.358% of the variance (eigenvalue= 8.685) and consisted of three lack of concentration items. The second factor accounted for 18.250% of the variance (eigenvalue = 3.832) and consisted of four motor function items. The third factor accounted for 8.505% of the variance (eigenvalue = 1.786) and consisted of six memory items. The fourth factor accounted for 5.918% of the variance (eigenvalue = 1.243) and consisted of eight distractibility items. The internal consistency reliabilities for the subscales are: lack of concentration (α = .860), motor function (α = .881), memory (α = .913) and distractibility (α = .912), and the internal consistency reliability for the entire scale (α = .926) was considered very high and conceptually meaningful (Curtis & Singh, 1997). Thus, the four measures represent empirically separable and internally consistent mathematics cognitive failures constructs. The four weeks test- retest reliabilities of .901, .840, .864, .892, and .901 for the entire scale, lack of concentration, motor function, memory, and distractibility were computed, respectively.

3.2 Research Question Two: What is the relationship between the mathematics cognitive failures and the general cognitive failures among Nigerian preservice teachers?

Table 2: *Pearson moment correlation of mathematics cognitive failures and preservice teachers' general cognitive failures*

		Mathematics Cognitive failures	General Cognitive failures
Mathematics Cognitive failures	Pearson (r)	1	.654*
	Significance (p)		.000
	N	450	450
	Mean	66.147	76.973
	SD	15.347	17.665
	R^2		.423

*Significance at p<.01(2 tailed)

Table 2 indicated that there was a significant positive relationship between mathematics cognitive failures and pre-service-teachers' general cognitive failures (r=0.654, N=450, p=.000, R^2=.423). This relationship was a bit high and it therefore means that mathematics cognitive failures and general cognitive failures are significantly positively related. The variance contribution of mathematics cognitive failures as measured by coefficient of determination to pre-service teachers' general cognitive failures was 42.3%.

3.3 Research Question Three: Is mathematics anxiety a factor in performance in calculus and perception of math cognitive failures among Nigerian preservice teachers?

Table 3 below shows the descriptive statistics of mean and standard deviation and t-test values on perception of mathematics cognitive failures score and performance in calculus score by high and low mathematics anxious preservice teachers. With respect to the aggregate mathematics cognitive failures score, the low anxiety group recorded a lower mean score (M=53.27, SD=10.87) than their high anxiety counterparts (M=72.02, SD=13.39). However, this difference in mean score was statistically significant (t_{448}=-14.58, p=.000). Table 3 below shows that the preservice teacher low anxiety group recorded lower mean score (M=8.55, SD=4.25) in lack of concentration than their high anxiety counterparts (M=10.20, SD=2.88) and this difference was statistically significant (t_{448}=-4.82, p=.000). In Table 3, the preservice teacher low anxiety group recorded lower mean score (M=10.85, SD=3.19) in motor function than their high anxiety counterparts (M=13.58, SD=3.76). The difference was statistically significant (t_{448}=-7.49, p=.000). With respect to memory factor, the preservice teacher low anxiety group recorded lower mean score (M=14.85, SD=4.46) than their high anxiety counterparts (M=21.10, SD=5.09). However, this difference in mean score was statistically significant (t_{448}=-12.54, p=.000). Table 3 reveals that preservice teacher low anxiety group recorded lower mean score (M=19.02, SD=4.22) in distractibility than their high anxiety counterparts (M=27.14, SD=6.66). This difference in mean score was statistically significant (t_{448}=-13.29, p=.000). With respect to performance in calculus, the preservice teacher low anxiety group recorded higher mean score (M=61.62, SD=10.55) than their high anxiety counterparts (M=53.14, SD=16.17). However, this difference in mean score was statistically significant (t_{448}=5.70, p=.000). Thus, we concluded that mathematics anxiety level was a significant factor in preservice teachers' performance in calculus, perception of mathematics cognitive failures, and even at the mathematics cognitive failures subscale levels.

Table 3. *Independent samples t-test analysis of preservice teachers' performance in calculus and perception of mathematics cognitive failures (MCF) according to mathematics anxiety level*

	Math Anxiety Level	N	M	SD	Df	t	p
Lack of Concentration	Low	141	8.55	4.25	448	-4.82*	.000
	High	309	10.20	2.88			
Motor function	Low	141	10.85	3.19	448	-7.49*	.000
	High	309	13.58	3.76			
Memory	Low	141	14.85	4.46	448	-12.54*	.000
	High	309	21.10	5.09			

Distractibility	Low	141	19.02	4.22	448	-13.29*	.000
	High	309	27.14	6.66			
MCF	Low	141	53.28	10.87	448	-14.58*	.000
	High	309	72.02	13.39			
Performance score	Low	141	61.62	10.55	448	5.70*	.000
	High	309	53.14	16.17			

*Significance at p<.01

3.4 Research Question Four: What is the relationship among the dimensions of mathematics cognitive failures (lack of concentration, motor function, memory and distractibility), dimensions of mathematics anxiety (affective and cognitive components) and performance in calculus of the Nigerian preservice teachers?

The results in Table 4 below shows the relationships among the mathematics cognitive failures, mathematics cognitive failures subscales, mathematics anxiety, mathematics anxiety subscales and performance in calculus. Table 4 shows that there was a significant negative correlation between the preservice teachers' performance in calculus and mathematics anxiety (Pearson r=-.104, $p<.05$), cognitive dimension of mathematics anxiety (Pearson r=-.184, $p<.01$) and lack of concentration dimension of mathematics cognitive failures (Pearson r=-.139, $p<.01$).

Table 4. *Correlations matrix for the relationship between mathematics cognitive failures dimensions, mathematics anxiety dimensions and preservice teachers' performance in calculus.*

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1. Concentration	1								
2. Motor function	.646**	1							
3. Memory	.638**	.640**	1						
4. Distractibility	.213**	.303**	.372**	1					
5. Affective	.290**	.382**	.525**	.612**	1				
6. Cognitive	.207**	.278**	.242**	.422**	.723**	1			
7. MCF	.720**	.770**	.845**	.723**	.638**	.400**	1		
8. MA	.277**	.367**	.447**	.579**	.959**	.889**	.586**	1	
9. Performance	-.139**	.015	-.062	.006	-.043	-.184**	-.048	-.104*	1
Mean	9.69	12.73	19.14	24.59	22.59	13.97	66.15	36.57	55.79
SD	3.45	3.80	5.69	7.09	6.21	3.85	15.35	9.38	15.15
N	450	450	450	450	450	450	450	450	450

**Significance at p<.01 *Significance at p<.05

As can be gleaned from Table 4, there was a significant positive correlation among dimensions of mathematics cognitive failures and dimensions of mathematics anxiety. Mathematics cognitive failures (Pearson r=-.048, $p=.312$) and its subscale of motor function (Pearson r=.015, $p=.756$), memory (Pearson r=-.062, $p=.190$) and distractibility (Pearson r=.006, $p=.898$) did not correlate significantly with performance in calculus. More so, the affective component of mathematics anxiety had a negative relationship with performance in calculus, but the correlation was not significant (Pearson r=-.043, $p=.360$).

3.5 Research Question Five: What are the composite and the relative contributions of dimensions of mathematics cognitive failures (lack of concentration, motor function, memory and distractibility), mathematics anxiety (affective and cognitive components) and gender to the explanation of the variance in the preservice teachers' performance in undergraduate calculus?

The results in Table 5 below shows that the independent variables (lack of concentration, motor function, memory, distractibility, affective and cognitive components of mathematics anxiety and gender) jointly contributed a coefficient of multiple regression of .341 and a multiple correlation square of .117 to the prediction of preservice teachers' performance in calculus. By implication, 11.7% of the total variance of the dependent variable (performance in calculus) was accounted for by the combination of the seven 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 ($F_{(7, 449)}$ = 8.33; *p*<.001). The results of the relative contributions of the independent variables to the prediction of preservice teachers' performance in calculus was that cognitive component of mathematics anxiety was the potent significant negative contributor to the prediction of preservice teachers' performance in calculus (β = -.353, *t* = -5.19, *p*<.001), while motor function dimension of mathematics cognitive failures made the next significant positive contribution to the prediction of the dependent variable (β =.238, *t* = 3.68, *p*<.001). Lack of concentration dimension of mathematics cognitive failures (β =-.234, *t* = -3.61, *p*<.001) and gender (β =.145, *t* = 3.20, *p*<.001) did make significant negative and positive contributions respectively to the prediction of preservice teachers' performance in calculus. Affective component of mathematics anxiety (β =.210, *t* = 2.48, *p*=.013) made the next significant positive contribution to the prediction of the dependent measure. Memory (β =-.098, *t* = -1.35, *p*=.177) and distractibility (β =.044, *t* = .770, *p*=.442) dimensions of mathematics cognitive failures did not make any positive or negative contributions to the prediction of preservice teachers' performance in calculus.

Table 5. *Model summary, coefficient and t-value of multiple regression analysis of mathematics cognitive failures dimensions, mathematics anxiety dimensions, gender and the outcome measure (performance in calculus)*

Model summary
Multiple R =.341
Multiple R^2 =.117
Multiple R^2 (adjusted) =.103
Standard error estimate =14.36
$F_{(7, 449)}$=8.33, p<.001

Model	Unstandardised coefficient		Standardised Coeff	t	Sig
	B	Std Error	Beta		
Constant	58.00	3.88		14.96	.000
Concentration	-1.027	.284	-.234	-3.61	.000
Motor function	.946	.257	.238	3.68	.000
Memory	-.262	.194	-.098	-1.35	.177
Distractibility	.094	.122	.044	.770	.442
Affective	.512	.206	.210	2.48	.013
Cognitive	-1.39	.268	-.353	-5.19	.000
Gender	4.48	1.40	.145	3.20	.001

Afterwards, a stepwise regression analysis was used to determine the contribution of each of these variables in predicting performance in calculus. A reduced model explaining the predictive capacity of the five variables (cognitive dimension of mathematics anxiety, gender, affective dimension of mathematics anxiety, lack of concentration and motor function dimensions of mathematics cognitive failures) on performance in calculus is outlined in Table 6 below.

Table 6. *Summary of stepwise regression results with cognitive, affective, concentration, motor function and gender entered for final model explaining performance in calculus*

Model	**Independent variables**	**B**	**SEB**	***β***	**t**	**p**	**R**	**R^2**	**F**	**p**
1	Constant	65.92	2.65		24.90	.000	.184	.034	15.76	.00
	Cognitive	-.725	.183	-.184	-3.97	.000				
2	Constant	60.44	3.25		18.59	.000	.227	.051	12.10	.00
	Cognitive	-.741	.181	-.188	-4.09	.000				
	Gender	4.08	1.42	.132	2.86	.004				
3	Constant	57.62	3.38		17.06	.000	.261	.068	10.85	.00
	Cognitive	-1.27	.260	-.324	-4.89	.000				
	Gender	4.03	1.41	.131	2.86	.005				
	Affective	.456	.162	.187	2.82	.005				
4	Constant	61.24	3.55		17.26	.000	.295	.087	10.64	.00
	Cognitive	-1.28	.258	-.325	-4.95	.000				

	Gender	4.22	1.40	.137	3.01	.003				
	Affective	.561	.164	.230	3.43	.001				
	Concentration	-.638	.208	-.145	-3.07	.002				
5	Constant	57.70	3.65		15.83	.000	.334	.112	11.18	.00
	Cognitive	-1.29	.260	-.327	-5.04	.000				
	Gender	4.64	1.39	.150	3.34	.001				
	Affective	.453	.165	.186	2.75	.006				
	Concentration	-1.19	.259	-.271	-4.59	.000				
	Motor function	.851	.243	.214	3.50	.001				

Model 1, which includes only cognitive dimension of mathematics anxiety scores, is accounted for 3.4% of the variance in preservice teachers' performance in calculus. The inclusion of gender into Model 2 resulted in additional 5.1% of the variance being explained. This means that gender alone accounted for 1.7% of the variance in preservice teachers' performance in calculus. The inclusion of affective component of mathematics anxiety into Model 3 resulted in additional 6.8% of the variance being explained. This means that affective component alone accounted for 1.7% of the variance in preservice teachers' performance in calculus. The inclusion of lack of concentration dimension of mathematics cognitive failures into Model 4 resulted in additional 8.7% of the variance being explained. This means that lack of concentration alone accounted for 1.9% of the variance in preservice teachers' performance in calculus. The inclusion of motor function into Model 5 resulted in additional 11.2% of the variance being explained. This means that motor function alone accounted for 2.5% of the variance in preservice teachers' performance in calculus.

4. Discussion

The results of the present study have shown six main findings. These findings relate to establishing the factor structure of the mathematics cognitive failures questionnaire with preservice teachers; determining the relationship between the mathematics cognitive failures and the general cognitive failures among preservice teachers; determining whether differences existed between low and high anxious preservice teachers in perception of mathematics cognitive failures and performance in calculus; ascertaining the relationships among dimensions of mathematics cognitive failures, mathematics anxiety dimensions and performance in calculus among preservice teachers and ascertaining the composite and the relative contributions of mathematics cognitive failures dimensions, mathematics anxiety dimensions and gender to the prediction of preservice teachers' performance in calculus.

The results of the present study showed that mathematics cognitive failure as measured by mathematics cognitive failures questionnaire is a multi- dimensional construct. The exploratory factor analysis using the principal components analysis showed a four factor structure underlying the questionnaire. The four interpretable factor structures are subsequently labelled: Lack of concentration (with 3 items), Motor function (with 4 items), Memory (with 6 items) and Distractibility (with 8 items) and each subscale had adequate internal consistency reliability. This is in sharp contrast to the general cognitive failures questionnaire which its proponents claimed to be a uni-dimensional construct (Broadbent et al, 1982). It should be noted that the mathematics cognitive failure is still in its early stage of research and so more researches are needed in the refinement of this construct across cultures. In the present study, the preservice teachers showed a high level of mathematics cognitive failures (Mean=3.1687, SD=1.1619).

The finding relating to the relationship between mathematics cognitive failures and general cognitive failures showed that in the present study the mathematics cognitive failures had a significant positive relationship with the general cognitive failures among preservice teachers. The not so high correlation between mathematics cognitive failures and general cognitive failures showed that the two constructs are related but different. This can be likened to the relationship between mathematics anxiety and test anxiety (Wigfield & Meece, 1988) in which mathematics anxiety is related but different from test anxiety.

The results shown in Table 3 indicated that mathematics anxiety level was a factor in preservice teachers' performance in calculus and mathematics cognitive failures and its dimensions. The low and high mathematics anxious preservice teachers recorded different mean scores in performance in calculus and on mathematics cognitive failures and its dimensions. Thus, mathematics anxiety level differences in mathematics cognitive failures and performance in calculus as shown in this study were significant. However, since no study has ever determined the influence of mathematics anxiety level on mathematics cognitive failures, this study failed to make reference to previous study. The implication of the present study finding regarding mathematics anxiety level is that mathematics anxiety level differences in mathematics cognitive failures and performance in calculus are very important. As can be inferred from this study preservice teachers with a high rate of mathematics cognitive failure are most likely to report a high incidence of more debilitating affective symptom of mathematics anxiety. The influence of mathematics anxiety level on performance in calculus showed that as mathematics anxiety increases performance in calculus reduces for the preservice teachers. This coincided with the popular parlance that there is an inverse relationship between mathematics anxiety and performance in mathematics (Ramirez etal, 2013; Ashcraft & Krause, 2007; Venkatesh, & Karimi, 2010; Pourmoslemi, Erfani & Firoozfar, 2013; Beall, Roebuck, & Penkalsky, 2015; Artemenko, Daroczy, & Nuerk 2015).

The results displayed in Table 5 show that 11.9% of the variance in preservice teachers' performance in calculus was accounted for by the seven predictor variables (lack of concentration, motor function, memory, distractibility, affective and cognitive components and gender) taken together. The relationship between performance in calculus and the predictor variables taken together were high as shown by the coefficient of multiple correlation (R = .341). Thus, the predictor variables investigated when taken together predicted to some extent performance in calculus among preservice teachers involved in the study. The observed ($F_{(7, 449)} = 8.33$; $p<.001$) is a reliable evidence that the combination of the dimensions of mathematics cognitive failures, dimensions of mathematics anxiety and gender in the prediction of preservice teachers' performance in calculus from all indications did not occur by chance with 88.3% of the variance in performance in calculus unexplained by the current data. Thus, there might be other independent variables which may require further investigations about their contribution to the prediction of preservice teachers' performance in calculus and the degree of prediction jointly made by the seven independent variables of this study could be substantive enough to assert that preservice teachers' performance in calculus is predictable by a combination of the dimensions of mathematics cognitive failures, dimensions of mathematics anxiety and gender. Thus, the strength of the predictive power of the combined independent variables (lack of concentration, motor function, memory, distractibility, affective and cognitive components and gender) on the outcome variable was strong and significant to show the linear relationship between the seven predictor variables and the total variance in preservice teachers' performance in calculus. According to the standardized coefficients the regression model is as follows: Performance in Calculus$_{predicted}$ = 58.00 - 0.234 lack of concentration + 0.238 motor function - 0.098 memory + 0.044 distractibility +0.210 affective – 0.353 cognitive + 0.145 gender +14.36.

On the relative contribution of each of the independent variables to the explanation of variance in preservice teachers' performance in calculus, the present study revealed that only five (cognitive dimension of mathematics anxiety, gender, affective dimension of mathematics anxiety, lack of concentration and motor function dimensions of mathematics cognitive failures) out of the seven independent variables made statistically significant contribution to the variance in preservice teachers' performance in calculus. Cognitive dimension of mathematics anxiety was the best predictor of performance in calculus and accounted for 3.4% of the variance in preservice teachers' performance in calculus. This was followed by motor function dimension of mathematics cognitive failures which alone accounted for 2.5% of the variance in preservice teachers' performance in calculus. This was followed by lack of concentration which alone accounted for 1.9% of the variance in preservice teachers' performance in calculus. This was followed by gender and affective component of mathematics anxiety which individually accounted for 1.7% apiece of the variance in preservice teachers' performance in calculus. Memory and distractibility dimensions of mathematics cognitive failures did not contribute meaningfully to the prediction of preservice teachers' performance in calculus.

5. Conclusion

The MCFQ was found to be a valid and reliable measure of preservice teachers' mathematics cognitive failures levels; therefore, it may be used by different professionals to detect and deal with mathematics cognitive failures. First, mathematics educators may use it as a screening tool to discover high-risk students in their mathematics courses. Second, counselors may use it as a placement tool to isolate specific areas of the problem in mathematics cognitive failures which may lend it to different intervention strategies that might be implemented. Third, investigators may use the instrument as a research tool to study the associations between mathematics cognitive failures and other vital factors such as mathematics anxiety. It is worthy of note that the MCFQ appears to be a promising instrument for measuring mathematics cognitive failures as distinct from the general cognitive failures propounded by Broadbent and others in 1982. The MCFQ does seem to measure lack of concentration, motor function, memory and distractibility in mathematics in preservice teachers in this study. A more fulfilling evidence in this study is that MCFQ increases the vulnerability to mathematics anxiety and the fact that mathematics anxiety is a factor in mathematics cognitive failures and its dimensions is worthy of showcasing. This is important in view of the fact that mathematics anxiety has its influence on those who show low cognitive performance in mathematics. More importantly, motor function and lack of concentration dimensions of mathematics cognitive failures showed evidence of predicting preservice teachers' performance in calculus. It remains to be verified whether mathematics cognitive failures could be responsible for students' errors committed when solving problems in mathematics. It is postulated here that mathematics cognitive failures may be related to both procedural and conceptual errors in mathematics often experienced by students. This is a guess that needs to be verified. Like the general cognitive failures, the mathematics cognitive failures did not reflect temporary state as the test-retest over a period of four weeks showed a stable score even as circumstances changed. The present study investigated preservice teachers' mathematics cognitive failures using individual self-assessment questionnaire which is often criticized for promoting measurement error. People may over or understate their level of mathematics cognitive failures in order to conform to societal standards. However, it is my candid opinion that the present study is vital in exposing the level of mathematics cognitive failures among preservice teachers as the study findings could serve as a baseline for conducting future studies in mathematics cognitive failures in Nigeria and elsewhere.

References

[1] Allahyari, T, Rangi, N. H, Khosravi, Y. & Zayeri, F. (2011). Development and evaluation of a new questionnaire for rating of cognitive failures at work. *International Journal of Occupational Hygiene, 3*(1), 6–11.

[2] Allahyari, T,. Rangi, N. H., Khalkhali, H., & Khosravi, Y. (2014). Occupational cognitive failures and safety performance in the workplace, *International Journal of Occupational Safety and Ergonomics* (*JOSE*), *20*(1), 175–180.

[3] Allahyari, T., Saraji, G. N., Adl, J., Hosseini, M., Iravani, M., Younesian, M., & Kass, S. J. (2008). Cognitive failures, driving errors and driving accidents. *International Journal of Occupational Safety and Ergonomics* (*JOSE*), *14*(2), 149–158.

[4] Alloway, T. P. (2006). How does working memory work in the classroom? *Educational Research and Reviews*, *1*(4), 134-139.

[5] Artemenko, C., Daroczy, G & Nuerk, H-C. (2015) Neural correlates of math anxiety – an overview and implications. *Frontiers in Psychology, 6*, 1-8. doi: 10.3389/fpsyg.2015.01333.

[6] Arthur, W, Barrett, G. V, & Alexander, R. A. (1991). Prediction of vehicular accident involvement: a meta-analysis. *Human Performance, 4*(2), 89-105.

[7] Ashcraft, M. H. & Kirk, E. P. (2001). The relationships among working memory, math anxiety, and performance. *Journal of Experimental Psychology-General*, *130*(2), 224–37. doi:10.1037/0096-3445.130.2.224

[8] Ashcraft, M. H. & Ridley, K. S. (2005). Math anxiety and its cognitive consequences: A tutorial review. In J. I. D. Campbell (Ed.), Handbook of Mathematical Cognition (pp. 315–30). New York: Psychology Press.

[9] Ashcraft, M. H., & Moore, A. M. (2009). Mathematics anxiety and the affective drop in performance. *Journal of Psychoeducational Assessment, 27,* 197-205. doi:10.1177/0734282908330580.

[10] Ashcraft, M.H., & Krause, J.A. (2007). Working memory, math performance, and math anxiety. *Psychonomic Bulletin & Review*, *14*(2), 243-248.

[11] Bandalos, D. L., Yates, K., & Thorndike-Christ, T. (1995). Effects of math self-concept, perceived self-efficacy, and attributions for failure and success on test anxiety. *Journal of Educational Psychology, 87,* 611-623. doi:10.1037/0022-0663.87.4.611

[12] Beall, J. D., Roebuck, T., & Penkalsky, P., (2015). The relationship among math anxiety, mathematical performance, and math education in undergraduate nursing students. *Honors Research Projects.* Paper 76.

[13] Berggren, N, Hutton, S. B. & Derakshan, N. (2011). The effects of self-report cognitive failures and cognitive load on antisaccade performance. *Frontiers in Psychology*, *2*, 1-5, doi: 10.3389/fpsyg.2011.00280.

[14] Broadbent, D.E., Cooper, P.F., FitzGerald, P., & Parkes, K.R. (1982). The cognitive failures questionnaire (CFQ) and its correlates. *British Journal of Clinical Psychology*, *21*, 1-16.

[15] Bruce, A. S., Ray, W. J. & Carlson, R. A. (2007). Understanding cognitive failures: What's dissociation got to do with it? *American Journal of Psychology*, *120*(4), 553–563.

[16] D'Ailly, H., & Bergering, A. J. (1992). Mathematics anxiety and mathematics avoidance behaviour: a validation study of two factors. *Educational and Psychological Measurement*, *52*(2), 369-378.

[17] Dreger, R. M., & Aiken, L. R. (1957). Identification of number anxiety. *Journal of Educational Psychology*, *47*, 344-351. doi:10.1037/h0045894

[18] Eden, C., Heine, A., & Jacobs, A. M. (2013). Mathematics anxiety and its development in the course of formal schooling—A review. *Psychology*, *4*(6A2), 27-35. doi:10.4236/psych.2013.46A2005.

[19] Eisenhart, M., Borko, H., Underhill., R., Brown, C., Jones, D., & Agard, P. (1993). Conceptual knowledge fall through the cracks: Complexities of learning to teach mathematics for understanding. *Journal for Research in Mathematics Education*, *24*(1), 8–40. doi:10.2307/749384.

[20] Engelhard, G. Jr.(1990). Math anxiety, mothers' education, and the mathematics performance of adolescent boys and girls: Evidence from the United States and Thailand. *Journal of Psychology*, *124*, 289-298.

[21] Gazzaley, A. (2011). Influence of early attentional modulation on working memory. *Neuropsychologia*, *49*, 1410–1424.

[22] Green, L. T. (1990). Test anxiety, mathematics anxiety, and teacher comments: Relationships to achievement in mathematics classes. *The Journal of Negro Education, 59*(3), 320-335.

[23] Groome, D., & Grant, N. (2005). Retrieval-induced forgetting is inversely related to everyday cognitive failures. *British Journal of Psychology*, *96*, 313–319.

[24] Habib, A., & Naz, F. (2015). Cognitive failure, teacher's rejection and interpersonal relationship anxiety in children with dyslexia. *Pakistani Journal of Medical Sciences*, *31*(3), 662-666. doi: http://dx.doi.org/10.12669/pjms.313.7065

[25] Hadfield, O. D., & Trujillo, K. M. (1999). Tracing the roots of mathematics anxiety through indepth interviews with preservice elementary teachers. *College Student Journal, 33*(2), 219-232.

[26] Hamid, M. H. S., Shahrill, M., Matzin, R., Mahalle, S., & Mundia, L. (2013). Barriers to mathematics achievement in Brunei secondary school students: Insights into the roles of mathematics anxiety, self-esteem, proactive coping, and test stress. *International Education Studies*, *6*(11), 1-14. doi:10.5539/ies.v6n11p1.

[27] Hembree, R. (1990). The nature, effects, and relief of mathematics anxiety. *Journal for Research in Mathematics Education*, *21*(1), 33–46; doi:10.2307/749455

[28] Ho, H-Z., Senturk, D., Lam, A. G., Zimmer, J. M., Hong, S., Okamoto, Y. Chiu, S-Y., Nakazawa, Y., & Wang, C-P (2000). The affective and cognitive dimensions of math anxiety: A cross-national study. *Journal for Research in Mathematics Education*, *31*(3), 362-379

[29] Ibironke, O. A., Awofala, A. A., & Awofala, A. O. A. (2015). Academic achievement of student in biology: The role of sex, body mass index, and cognitive failures. *Journal of Education in Developing Areas*, *23*(2), 587-598.

[30] Jain, S., & Dowson, M. (2009). Mathematics anxiety as a function of multidimensional self-regulation and self-efficacy. *Contemporary Educational Psychology, 34,* 240-249. doi:10.1016/j.cedpsych.2009.05.004.

[31] Kaiser, H. F. (1960). The application of electronic computers to factor analysis. *Educational and Psychological Measurement, 20,* 141-151. doi: 10.1177/001316446002000116.

[32] Kline, R. (1998). *Principles and practice of structural equation modeling*. New York: Guilford Press.

[33] Klingberg, T., Forssberg, H., & Westerberg, H. (2002). Training of working memory in children with ADHD. *Journal of Clinical and Experimental Psychology, 24*(6), 781-791.

[34] Larson, G. E, & Merritt, C. R. (1991). Can accidents be predicted? An empirical test of the cognitive failures questionnaire. *Applied Psychology: An International Review, 40*, 37–45.

[35] Larson, G. E., Alderton, D. L., Neideffer, M., & Underhill, E. (1997). Further evidences on dimensionality and correlates of the cognitive failures questionnaire. *British Journal of Psychology, 88,* 29–38.

[36] Legutko, M. (2008). An analysis of students' mathematical errors in the teaching research process. In B. Czarnocha (Ed.), *Handbook for mathematics teaching: Teacher experiment. A tool for research* (pp. 141–152). Rzeszów: University of Rzeszów.

[37] Liebert, R. M., & Morris, L. W. (1967). Cognitive and emotional components of test anxiety: A distinction and some initial data. *Psychological Reports, 20*, 975-978.

[38] Lyons, I. M., & Beilock, S. L. (2010, November). Mathematics anxiety: Separating the math from the anxiety. Poster presented at the annual Psychonomics meeting in St. Louis, MO.

[39] Ma, X. (1999). A meta-analysis of the relationship between anxiety toward mathematics and achievement in mathematics. *Journal for Research in Mathematics Education*, *30*(5), 520–40. doi:10.2307/749772

[40] Ma, X. (2003). Effect of early acceleration of students in mathematics on attitude toward mathematics and mathematics anxiety. *Teachers College Record*, *105*(3), 438-464.

[41] Mahmood, S & Khatoon, T (2011). Development and validation of the mathematics anxiety scale for secondary and senior secondary school students. *British Journal of Arts and Social Sciences 2*(2), 169-179.

[42] Matthews, G., Coyle, K., & Craig, A. (1990). Multiple factors of cognitive failure and their relationships with stress vulnerability. *Journal of Psychopathology and Behavioral Assessment, 12,* 49–65.

[43] Merckelbach, H., Muris, P., Nijman, H., & de Jong, P. J. (1996). Self-reported cognitive failures and neurotic symptomatology. *Personality and Individual Differences*, *20*(6), 715–724.

[44] O'Hare, D, Wiggins, M., Batt, R, & Morrison, D. (1994). Cognitive failure analysis for aircraft accident investigation. *Ergonomics, 37*(11), 1855–1869.

[45] Pollina, L. K., Greene, A. L., Tunick, R. H., & Puckett, J. M. (1992). Dimensions of everyday memory in young adulthood. *British Journal of Psychology, 83,* 305–321.

[46] Pourmoslemi, A., Erfani, N. & Firoozfar, I. (2013). Mathematics anxiety, mathematics performance and gender differences among undergraduate students. *International Journal of Scientific and Research Publications*, *3*(7), 1-6.

[47] Ramirez, G., Gunderson, E. A., Levine, S. C., & Beilock, S. L. (2013). Math anxiety, working memory, and math achievement in early elementary school, *Journal of Cognition and Development*, *14*(2), 187-202. doi:10.1080/15248372.2012.664593.

[48] Reason, J. (1990). Human error. New York, NY, USA: Cambridge University Press.

[49] Reason, J. T. & Lucas, D. (1984). Absent-mindedness in shops: its incidence, correlates and consequences. *British Journal of Clinical Psychology, 23,* 121–131.

[50] Richardson, F. C., & Suinn, R. M. (1972). The mathematics anxiety rating scale. *Journal of Counseling Psychology, 19,* 551-554. doi:10.1037/h0033456

[51] Sadeghi, H., Abolghasemi, A., & Hajloo, N. (2013). Comparison of cognitive failures and academic performance among the students with and without developmental coordination disorder *International Journal of Psychology and Behavioral Research*, *2*(2), 79-85.

[52] Sarason, I . G. (1986). Test anxiety, worry, and cognitive interference. In R. Schwarzer (Ed.), *Self-related cognitions in anxiety and motivation* (pp. 19-33). Hillsdale, NJ: Erlbaum.

[53] Sevey, B. C. (2012). *Mathematics anxiety, working memory, and mathematics performance: Effectiveness of a working memory intervention on reducing mathematics anxiety*. An unpublished PhD Thesis, Miami University, Oxford.

[54] Simpson, S. A., Wadsworth, E. J. K., Moss, S. C. & Smith, A. P. (2005). Minor injuries, cognitive failures and accidents at work: incidence and associated features. *Occupational Medicine, 55*(2), 99–108. doi:10.1093/occmed/kqi035.

[55] Smith, A., Chappelow, J., & Belyavin, A. (1995). Cognitive failures, focused attention, and categoric search. *Applied Cognitive Psychology*, *9*(7), S115–S126.

[56] Sullivan, B. & Payne, T. W. (2007). Affective disorders and cognitive failures: A comparison of seasonal and no seasonal depression. *American Journal of Psychiatry*, *164,*1663–1667.

[57] Tabachnick, B. G. & Fidell, L. S. (2007). *Using multivariate statistics*. 5th edition. Boston, MA, Allyn & Bacon.

[58] Tipper, S. P., & Baylis, G. C. (1987). Individual differences in selective attention: the relation of priming and interference to cognitive failure. *Personality and Individual Differences*, *8*, 667–675.

[59] Tocci, C. M., & Engelhard, G., Jr. (1991). Achievement, parental support, and gender differences in attitudes toward mathematics. *Journal of Educational Research*, *84*, 280-286.

[60] Venkatesh, K. G., & Karimi, A. (2010). Mathematics anxiety, mathematics performance and overall academic performance in high school students. *Journal of the Indian Academy of Applied Psychology*, *36*(1), 147-150.

[61] Wallace, J. C, Kass, S. J, & Stanny, C. (2002). Cognitive failures questionnaire revisited: correlates and dimensions. *The Journal of General Psychology*, *129*(3), 238–256.

[62] Wallace, J. C. & Vodanovich, S. J. (2002). Can accidents and industrial mishaps be predicted? Investigating workplace performance and cognitive failure. *Journal of Business and Psychology, 17,* 503-514.

[63] Wallace, J. C. (2004). Confirmatory factor analysis of the cognitive failures questionnaire: Evidence for dimensionality and construct validity. *Personality and Individual Differences*, *37*(2), 307–324.

[64] Wallace, J. C., & Vodanovich, S. J. (2003). Can accidents and individual mishaps be predicted? Further investigation into the relationship between cognitive failure and reports of accidents. *Journal of Business and Psychology, 17,* 503–513. doi:10.1023/A:1023452218225

[65] Wigfield, A., & Meece, J. L. (1988). Math anxiety in elementary and secondary school students. *Journal of Educational Psychology, 80*, 210-216.

[66] Wilkins, A. J., & Baddeley, A. D. (1978). Remembering to recall in everyday life: an approach to absent-mindedness, in *Practical Aspects of Memory*, eds M. M. Fruneberg, P. E. Morris, and R. N. Sykes (London: Academic Press), 27–34.

[67] Zakaria, E., & Nordin, M. N. (2008). The effects of mathematics anxiety on matriculation students as related to motivation and achievement. *Eurasia Journal of Mathematics Science and Technology Education, 4,* 27-30.

Authors

Adeneye O. A. Awofala, Department of Science and Technology Education, Faculty of Education, University of Lagos, Lagos, Nigeria, e-mail: aawofala@unilag.edu.ng

Helen N. Odogwu, Department of Science and Technology Education, Faculty of Education, University of Lagos, Lagos, Nigeria, e-mail:helenaodogwu@yahoo.com

Acknowledgement

Thanks to the preservice mathematics teachers that took part in the study. We also thank the anonymous reviewers for their comments and suggestions in improving the work.