

# MATHEMATICS ANXIETY AND MATHEMATICS BELIEFS AS CORRELATES OF EARLY CHILDHOOD PRE-SERVICE TEACHERS' NUMERACY SKILLS

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**Abstract:** The purpose of this study was to investigate mathematics anxiety and mathematics beliefs as correlates of early childhood pre-service teachers' numeracy skills in Nigeria. A cross-sectional survey research design within quantitative methodology was adopted for the study involving 320 early childhood pre-service teachers from the University of Lagos. Three valid and reliable instruments were used for data collection and the collected data were analysed using mean, standard deviation, Pearson moment correlation and multiple regression analysis at 5% level of significance. Results showed that the majority of the early childhood pre-service teachers had high mathematics anxiety and high mathematical beliefs. While mathematical beliefs had significant positive correlations with early childhood pre-service teachers' numeracy skills, mathematics anxiety had a negative correlation with numeracy skills. Mathematical beliefs were a good predictor of early childhood pre-service teachers' numeracy skills. Based on these findings it was concluded that early childhood teacher education programme should include strategies to eliminate mathematics anxiety and foster constructivist mathematical beliefs capable of promoting early childhood pre-service teachers' numeracy skills.

**Keywords:** Mathematics anxiety, mathematical beliefs, early childhood pre-service teachers, numeracy skills.

## 1. Introduction

Many countries of the world are increasingly putting more emphasis on early childhood education with attendant increase in the admission rates into kindergartens (Karatas, Guven, Öztürk, Arslan, & Gürsoy, 2017). For instance, countries like United Kingdom, France, Belgium, and Norway have above 90% of age 3 children in preschools (OECD, 2015). These countries are not only preoccupied with evolving and maximizing educational programmes for their teeming population of young children but are also offering training programmes for preschool teachers and early childhood pre-service teachers (National Association for the Education of Young Children [NAEYC], 2001; OECD, 2011) to enable them function well in the kindergartens. As a mark of honour for the preschool, the National Council of Teachers of Mathematics [NCTM] (2000) incorporated it into the standards for school mathematics. This is done for two key reasons: First, exposing preschoolers to quality and meaningful mathematics at a very tender age may be one way to foster mathematical proficiency (Awofala, 2017) in them and get them ready for future mathematics at the primary school level. In this way difficulties arising from teaching and learning of mathematics at the other levels of education may be reduced to the barest minimum as the preschoolers would have gained conceptual understanding of the early mathematics which could serve as a strong foundation for future mathematics learning. Second, the extant literature revealed that preschoolers have natural curiosity for mathematics (Heinkle, 2000; Denton & West, 2002) which when sustained could foster their informal mathematical skills and intuitive mathematical thinking in preparation for their future learning of mathematics at ease.

No doubt learning mathematical skills is an intricate endeavour that is not only intellectually challenging but emotionally puzzling. Mathematical skills are very important in everyday human endeavor and deficiencies in mathematical performance could lead to adverse effect in various spheres like education,

daily routine and career. This effect can be seen in the area of not being able to make knowledgeable resolutions on monetary matters which could have a multiplier consequence on people's emotional and bodily well-being (Butterworth, 2010; Kucian & von Aster, 2015; Paulos, 1988). Thus, making well-informed decisions based on numerical abilities are fast becoming ubiquitous in our everyday life (Peters, Västfjäll, Slovic, Mertz, Mazzocco, & Dickert, 2006) to the extent that possession of numeracy skills is commanding not only for an individual but for the society in general. Current developments have impacted on how to describe and characterize the concept of numeracy methodically (Cokely, Galesic, Schulz, Ghazal, & Garcia-Retamero, 2012; Reyna, Nelson, Han, & Dieckman, 2009; Schwartz, Woloshin, Black, & Welch, 1997). Numeracy refers to the ability to comprehend, utilize, compute, deploy, deduce results, and converse mathematical facts (Awofala & Anyikwa, 2014). Concerning the adult setting, numeracy denotes the practical or purposeful utilization of mathematics to the point of proficiency (Awofala & Anyikwa, 2014; Awofala, 2017).

Nonetheless, it is quite disheartening to note that less than 40% of Nigerians are numerate with a very large percentage of the population suffering from innumeracy (Awofala & Anyikwa, 2014). Unexpectedly in the developed countries such as the USA, large percentage of the adult population show lack of numerical skills in dealing with numbers (Peters, 2012) while in the United Kingdom roughly 25% of the population swim in the pool of innumeracy (Parsons & Bynner, 2005). This high level of innumeracy in the world population is a threat to the socio-economic well-being of nations and the world at large (Butterworth, 2010). This low numeracy skill is not unconnected to individual showing undesirable attitudes and sentiments toward mathematics (Lake & Kelly, 2014). These nerve-racking feelings toward mathematics (Awofala & Awolola, 2011) seem to be common among early childhood pre-service teachers thereby causing severe anxiety, and consequently making them to shun the teaching of some mathematical concepts. The perturbing emotional variable which tends to hurt mathematics skills at the primary level is mathematics anxiety (Skagerlund, Östergren, Västfjäll, & Träff, 2019). The extant literature has come up with diverse characterizations of mathematics anxiety, yet, common to most definitions is the resounding opinion that mathematics anxiety causes an adverse emotive reaction amidst some people (Awofala & Odogwu, 2017; Suárez-Pellicioni, Núñez-Peña, & Colomé, 2016). 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 (Awofala & Odogwu, 2017). It is popular that mathematics anxiety produces a debilitating effect that seems to advance with age into adulthood. In essence, it is crucial to nurture a productive learning milieu in the preschool years so that children will not develop mathematics anxiety into adulthood. Evidence suggests that early childhood pre-service teachers can transfer their mathematics anxiety to their pupils (Awofala & Akinoso, 2017) with its damaging and negative impact on mathematical performance well-researched and established (Awofala & Odogwu, 2017; Suárez-Pellicioni, Núñez-Peña, & Colomé, 2016). The precise mechanisms through which mathematics anxiety obstructs and affects numeracy skills in early childhood pre-service teachers stay unsettled. It has been established that not less than 11% of university students and 17% of the population have mathematics anxiety (Richardson & Suinn, 1972; Ashcraft, & Moore, 2009). This high widespread rate is frightening noting the obstructive effect of mathematics anxiety on mathematical ability.

Several studies have identified causes of mathematics anxiety to include: undesirable attitude transfer from teachers, intellectual factors, and past failure in mathematics (Lindskog, Winman, & Poom, 2017) in which mathematics anxiety inhibits, distort and deplete working memory resources that consequently hamper mathematical skills (Ashcraft & Faust, 1994). Research has shown clearly that mathematics anxiety weakens number processing abilities (Lindskog, Winman, & Poom, 2017; Maloney, Ansari, & Fugelsang, 2011) but what is not clear is whether mathematics anxiety weakens the entire aspect of mathematics to the same level in early childhood pre-service teachers. One aspect of mathematical ability that is rarely researched concerning mathematics anxiety is numeracy (Skagerlund, Östergren, Västfjäll, & Träff, 2019) and it is startlingly to note that little is well-known regarding the contrivances by which mathematics anxiety impact numeracy skills in early childhood pre-service teachers. This is one of the foci of the study and not forgetting the tendency for mathematics anxiety to have implications for early childhood preservice teacher practice in numeracy. While researchers have developed numeracy skill tests such as the Berlin Numeracy Test (Cokely et al, 2012) and the abbreviated numeracy test (Weller, Dieckmann, Tusler, Mertz, Burns, & Peters, 2013) to assess adult numeracy, it

remains to be understood how mathematics anxiety influences numeracy. Numeracy has been used to predict normative decision-making skills in adult (Skagerlund et al, 2019) and to measure risk associated with medical domain (Schwartz, Woloshin, Black, & Welch, 1997).

The other focus of the present study is to examine mathematics beliefs as predictive of early childhood pre-service teachers' numeracy skills. Mathematics belief is acclaimed to be associated with teaching practice in mathematics (Aslan, Ogul, & Tas, 2013) and is defined as individual verdicts and implicit norms and assumptions about the nature of mathematics and teaching and learning mathematics deduced from experiences (Kagan, 1992; Raymond, 1997). Mathematics belief has three key philosophical formations indicated as problem-solving, instrumentalist, and Platonist. In the Platonist formation of beliefs, mathematics is viewed as a static but unified body of certain rules. Instrumentalist sees mathematics as consisting of exact operation, rules and skills. The problem-solving dimension sees mathematics as a vigorous and ethnic production that can be cultivated with invention (Ernest, 1991). Teachers' activities in the classrooms are creations of their beliefs (Zakaria & Maat, 2012) with an argument regarding the constancies amid teachers' practices and their beliefs. This issue is somehow complex as some authors have found consistency between teachers' beliefs and classroom practices (Peterson, Fennema, Carpenter & Loef, 1989; Kupari, 2003), while other studies agreed to the contradictions between beliefs and practices (Brown, 1986; Beswick, 2005) in mathematics education. Teachers' mathematics beliefs are affected by prior experiences at school, teachers' present practice and teacher education courses (Raymond, 1993) in which teachers' beliefs influence students' learning of mathematics (Kagan, 1992) and consequently affect students' perceptions of mathematics (Yesil-Dagli, Lake & Jones, 2010). A synthesis of literature regarding pre-service teachers' beliefs (Kane, Sandretto & Heath, 2002) revealed that: students are admitted into teacher education programmes with prior beliefs which hinged on their past experiences at pre-tertiary levels; these beliefs are strong and resilient to alteration or modification; these beliefs serve as sifters to new knowledge, accommodating only what is harmonious with present beliefs; and beliefs are present in an inferred or hidden form and are arduous to communicate.

Mathematics teachers' beliefs have been found to affect students' achievement in mathematics (Aslan, Ogul, & Tas, 2013) in which mathematics teachers who hold more traditional beliefs are more inclined to engage in traditional practices like performance and obtaining correct answers (Stipek, Givvin, Salmon & MacGyvers, 2001). To date, no study had assessed the relation between early childhood pre-service teachers' mathematics beliefs and their numeracy skills. Aslan et al (2013) found that elementary teachers' beliefs about mathematics had a significant influence on children's number and operation and geometric shapes achievement. The more confident teachers are not only in their knowledge of mathematics but also mathematical ability, the greater they prioritize the usefulness of teaching mathematics in preschool and early primary school (Geist, 2015).

In line with the review of related literature, it is noted that there is scarcity of studies concerning mathematics anxiety and mathematics beliefs as correlates of early childhood preservice teachers' numeracy skills. So this study investigated mathematics anxiety and mathematics beliefs as correlates of early childhood preservice teachers' numeracy skills in Nigeria.

### **1.1. Purpose of the study**

The purpose of the present study was to investigate mathematics anxiety and mathematics beliefs as correlates of early childhood preservice teachers' numeracy skills in Nigeria.

### **1.2. Research Questions**

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

RQ1. What is the level of mathematics anxiety among Nigerian early childhood pre-service teachers?

RQ2. What is the level of mathematics beliefs among Nigerian early childhood pre-service teachers?

RQ3. What are the relationship between early childhood pre-service teachers' numeracy skills, beliefs about mathematics and mathematics anxiety?

RQ4. What are the composite and relative contributions of each factor of beliefs about math (affective and behavioural engagement in mathematical learning, confidence and beliefs regarding one's personal competence in math, mathematical beliefs, and beliefs about mathematical problem solving) and each factor of mathematics anxiety (emotionality and worry) to the explanation of the variance in the early childhood pre-service teachers' numeracy skills?

## 2. Methods

The participants were 320 (84 males and 234 females) early childhood pre-service teachers at the University of Lagos, Nigeria. The ages of the pre-service teachers ranged from 19 to 30 years, with 80% of them 20 years or less and 20% between 21 and 30 years inclusive. This distribution of ages is characteristic of the University of Lagos early childhood teacher education intakes with high proportions of "recent school leavers". All of the participants had studied mathematics at the Senior Secondary School Certificate level in which mathematics is a cross-cutting core subject at this level in Nigeria. Three instruments namely: Numeracy Self-Assessment Questionnaire (NSAQ), Mathematics Anxiety Questionnaire (MAQ) and Mathematics Beliefs Questionnaire (MBQ) were administered during class time at the close of the respondents' last Montessori mathematics course in 2018. A cross-sectional survey research design within quantitative methodology was considered most apt for this study because it helped in collecting data at one point in time from a sample selected to represent a larger population (Owens, 2002). In general surveys are prevalent because of their flexibility, effectiveness and generalizability in tackling enormous challenges, and in particular when the objective is to describe the beliefs, viewpoints and perceptions of the participants. One major disadvantage of the survey is that it does not allow the investigator to dig deeper into issues as would be possible in an interview (Mertler & Charles, 2005). In the present study, the NSAQ and MAQ had been validated for Nigerian use (Awofala & Anyikwa, 2014; Awofala & Akinoso, 2017) while the MBQ was adopted from Gómez-Chacón and García-Madruga (2009).

All three questionnaires were trial tested with a smaller sample of early childhood pre-service teachers in a different university in south-west Nigeria earlier in 2018 and their Cronbach alpha coefficients were calculated as 0.85 for NSAQ, 0.86 for MAQ, and 0.82 for MBQ. According to the literature the NSAQ had three interpretable factor structure named as numeracy in everyday life, numeracy in workplace tasks, and numeracy in mathematical tasks (Awofala & Anyikwa, 2014). The MAQ had two dimensions viz worry (Cronbach  $\alpha=0.80$ ) and emotionality (Cronbach  $\alpha=0.90$ ) (Awofala & Akinoso, 2017) while the MBQ had four factors namely: affective and behavioural engagement in mathematical learning (Cronbach  $\alpha=0.85$ ), confidence and beliefs regarding one's personal competence in math (Cronbach  $\alpha=0.86$ ), mathematical beliefs (Cronbach  $\alpha=0.90$ ), and beliefs about mathematical problem solving (Cronbach  $\alpha=0.82$ ). All the questionnaires employed Modified Likert Scales. The NSAQ consisted of 24 items while the MBQ contained 13 items to which the respondents were required to respond undecided-0, strongly agree-4, agree-3, disagree-2, and strongly disagree-1 for positively worded statement while the reverse was the case for all negatively worded statement with undecided remaining as the starting point in both cases. The MAQ consisted of 11 items to which the participants were requested to respond Not at all -0, A little -1, A fair amount -2, Much -3 and Very much -4. Data collected with the questionnaires were summarized and analysed using frequency, percentage, mean, standard deviation, Pearson moment correlation, and multiple regression analysis.

## 3. Results

### 3.1. Research Question One: What is the level of mathematics anxiety among Nigerian early childhood pre-service teachers?

In the mathematics anxiety scale, the score ranged from 0 to 4. A score of 2 is the middle point so higher scores indicate high mathematics anxiety. Of 320 early childhood pre-service teachers, 178 (55.63%) had scores greater than 2 ( $M=2.72$ ,  $SD=0.50$ , score range: 2.03-3.92, 95%  $CI=2.64-2.79$ ), 138 (43.13%) had scores less than 2 ( $M=1.33$ ,  $SD=0.43$ , score range: 0.20-1.98, 95%  $CI=1.26-1.40$ ), while 4 (1.24%) had scores equaled 2 ( $M=2$ ,  $SD=0$ , score range: 2.00, 95%  $CI=2.00$ ). A large proportion of these early childhood pre-service teachers had high mathematics anxiety. However, the overall  $M=2.11$ ,  $SD=0.83$ , score range: 0.20-3.92, and 95%  $CI=2.02-2.20$  for the entire sample showed high mathematics anxiety

of early childhood pre-service teachers. Table 1 showed the descriptive statistics of the items in the MAQ. There were five items in the *Emotionality* subscale, and they talked about mathematics promoting being at ease and relax, mathematics test causing nervousness and uneasiness, mathematics test being scary, feeling dread, and feeling scared to take advanced mathematics. The means of the five items indicate that early childhood pre-service teachers’ emotionality in mathematics was less than anticipated and this could impact their studying of mathematics.

Table 1 Descriptive statistics of MAQ items

Label Full	Item Statement	M	SD
<b>Emotionality</b>			
	1. When I am in math class, I usually feel relaxed and at ease.	1.64	0.78
	2. When I am taking a math test, I usually feel nervous and uneasy.	2.23	0.89
	3. Taking math tests scares me.	2.12	0.82
	4. I dread having to do math.	1.94	0.92
	5. It scares me to think that I will be taking harder or more advanced math.	2.22	0.94
<b>Worry</b>			
	6. When the teacher asks you math questions, how much do you worry that you will do poorly?	2.06	0.98
	7. When the teacher shows the class how to do a math problem, how much do you worry that other students might understand the problem better than you?	1.92	0.96
	8. In general, how much do you worry about how well you will do in school?	2.17	0.95
	9. If you are absent from school and you miss a math assignment, how much do you worry that you will fall behind?	2.27	0.82
	10. In general, how much do you worry about how well you do in math?	2.28	0.70
	11. Compared to other students, how much do you worry about your performance in math?	2.28	0.97
<b>Total</b>		<b>2.11</b>	<b>0.83</b>

The six items in the *Worry* subscale talked about the degree of worry that one would do poorly in mathematics, the worry that colleagues would do better in mathematics than me, worrying about one’s performance in school, worrying about falling behind in mathematics as a result of being absent from school, worrying about doing well in mathematics, and worrying about poor performance when compared one’s result with colleagues.

**3.2. Research Question Two: What is the level of mathematics beliefs among Nigerian early childhood pre-service teachers?**

In the mathematical beliefs questionnaire, the score ranged from 0 to 4. A score of 2 is the middle point so higher scores indicate high mathematical beliefs. Of 320 early childhood pre-service teachers, 292 (91.25%) had scores greater than 2 ( $M=2.89, SD=0.43$ , score range: 2.06-3.77, 95%  $CI= 2.84-2.94$ ), 26 (8.13%) had scores less than 2 ( $M=1.68, SD=0.22$ , score range: 1.15-1.96, 95%  $CI= 1.59-1.77$ ), while 2 (0.63%) had scores equaled 2 ( $M= 2, SD=0$ , score range: 2.00, 95%  $CI=2.00$ ). A large proportion of these early childhood pre-service teachers had high mathematical beliefs. However, the overall  $M=2.79, SD=0.53$ , score range: 1.15-3.77, and 95%  $CI= 2.73-2.85$  for the entire sample showed high mathematical beliefs of early childhood pre-service teachers.

Table 2 showed the descriptive statistics of the items in the MBQ. There were three items in the *Affective and behavioural engagement in mathematical learning* subscale, and they talked about working hard in

mathematics, making mistakes in mathematics and correcting them, and inventing new problems in mathematics. The means of the three items indicate that early childhood pre-service teachers' affective and behavioural engagement in mathematical learning was highly desirable and this could impact their studying of mathematics.

Table 2 Descriptive statistics of MBQ items

Label Full	Item Statement	M	SD
<b>Affective and behavioural engagement in Mathematical learning</b>			
	1. I work hard in Math (subject).	3.07	0.78
	2. If I make mistakes, I work to correct them.	3.22	0.86
	3. I like to invent new problems.	2.42	0.55
<b>Confidence and beliefs regarding one's personal competence in math</b>			
	4. I learn math quickly.	2.53	0.82
	5. When I am asked to solve math problems, I get nervous.	2.69	0.73
	6. I feel confident when I study or work on math.	2.56	0.92
	7. I feel happy when I solve math problems.	2.62	0.49
<b>Mathematical Beliefs</b>			
	8. Math allows us to understand the world we live in better.	2.78	0.89
	9. Math consists of concepts and procedures that we have to memorize.	3.04	0.93
	10. Everyone can learn math.	2.85	0.97
<b>Beliefs about mathematical problem solving</b>			
	11. When I cannot solve a math problem quickly, I keep on trying.	2.95	0.81
	12. I prefer challenging tasks in order to learn new things.	2.86	0.82
	13. Math should not place much importance on problem-solving.	2.46	0.80
<b>Total</b>		<b>2.79</b>	<b>0.82</b>

The four items in the *confidence and beliefs regarding one's personal competence in mathematics* subscale talked about learning mathematics quickly, getting nervous when asked to solve mathematics problems, feeling confident when studying mathematics, and feeling happy when solving mathematics. The means of the four items show that early childhood pre-service teachers' confidence and beliefs regarding one's personal competence in mathematics was highly commendable and this could impact their studying of mathematics. The three items in the *mathematical beliefs* subscale talked about mathematics helping understand the world, mathematics consisting of concepts and procedures that one has to memorise, and that everyone can learn mathematics. The means of the three items show that early childhood pre-service teachers' mathematical beliefs was highly commendable and this could impact their studying of mathematics. Three items in the *beliefs about mathematical problem-solving* subscale talked about keeping on trying the mathematics problem that is proving difficult, preferring challenging tasks in mathematics to learn new things, and mathematics should not place much importance on problem-solving. The means of the three items indicate that early childhood pre-service teachers' beliefs about mathematical problem solving was highly commendable and this could impact their studying of mathematics.

### 3.3. Research Question Three: What are the relationships among early childhood pre-service teachers' numeracy skills, beliefs about mathematics and mathematics anxiety?

The results in Table 3 below showed the relationships among the numeracy skills, beliefs about mathematics and mathematics anxiety of early childhood pre-service teachers. Table 3 showed that there was a significant positive correlation between the early childhood pre-service teachers' total numeracy skills and numeracy in everyday tasks ( $r=.76, p<.01$ ), numeracy in workplace tasks ( $r=.79, p<.01$ ), numeracy in mathematical tasks ( $r=.80, p<.01$ ), affective and behavioural engagement in mathematical learning ( $r=.37, p<.01$ ), confidence and beliefs regarding one's personal competence in math ( $r=.37, p<.01$ ), mathematical beliefs ( $r=.41, p<.01$ ), beliefs about mathematical problem solving ( $r=.28,$

$p < .01$ ), and mathematical beliefs total ( $r = .54, p < .01$ ). But total numeracy skills of early childhood pre-service teachers had a significant negative correlation with emotionality ( $r = -.17, p = .002$ ), worry ( $r = -.16, p = .005$ ), and total mathematics anxiety ( $r = -.18, p = .001$ ). Other significant negative and positive correlations among numeracy skills, mathematics anxiety and mathematical beliefs of early childhood pre-service teachers can be gleaned from Table 3 below.

Table 3. Correlations matrix for the relationship between numeracy skills and its dimensions, mathematical beliefs and its dimensions and early childhood pre-service teachers' mathematics anxiety and its dimensions

	1	2	3	4	5	6	7	8	9	10	11	12
1. NUT	1											
2. NUE	.76*	1										
3. NWP	.79*	.39*	1									
4. NMT	.80*	.40*	.47*	1								
5. ABE	.37*	.29*	.30*	.29*	1							
6. CBP	.37*	.21*	.37*	.29*	.23*	1						
7. MB	.41*	.35*	.35*	.28*	.20*	.26*	1					
8. BMP	.28*	.07	.30*	.27*	.20*	.26*	.34*	1				
9. MBT	.54*	.35*	.50*	.42*	.58*	.64*	.72*	.69*	1			
10. EMO	-.17*	.05	-.24*	-.21*	-.20*	.08	.023	.006	-.03	1		
11. WOR	-.16*	.07	-.25*	-.18*	-.11	-.07	.096	.030	-.008	.64*	1	
12. MAT	-.18*	.07	-.27*	-.22*	-.16*	.003	.068	.021	-.02	.90*	.92*	1
Mean	3.07	3.38	2.89	2.93	2.91	2.60	2.89	2.75	2.79	2.03	2.19	2.11
SD	0.61	0.77	0.77	0.81	0.73	0.74	0.93	0.81	0.53	0.87	0.96	0.83

\*Correlation is significant at the .01 level (2-tailed). Note that NUT=numeracy total, NUE=numeracy in everyday task, NWP=numeracy in workplace tasks, NMT=numeracy in mathematical tasks, ABE= affective and behavioural engagement in mathematical learning, CBP= confidence and beliefs regarding one's personal competence in math, MB=mathematical beliefs, BMP=beliefs about mathematical problem solving, MBT=mathematical beliefs total, EMO= emotionality, WOR=worry, and MAT=mathematics anxiety total.

**3.4. Research Question Four: What are the composite and relative contributions of each factor of beliefs about math (affective and behavioural engagement in mathematical learning, confidence and beliefs regarding one's personal competence in math, mathematical beliefs, and beliefs about mathematical problem solving) and each factor of mathematics anxiety (emotionality and worry) to the explanation of the variance in the early childhood pre-service teachers' numeracy skills?**

The results in Table 4 below showed that the independent variables (affective and behavioural engagement in mathematical learning (ABE), confidence and beliefs regarding one's personal competence in math (CBP), mathematical beliefs (MB), beliefs about mathematical problem solving (BMP), emotionality (EMO) and worry (WOR)) jointly contributed a coefficient of multiple regression of .583 and a multiple correlation square of .340 to the prediction of early childhood pre-service teachers' numeracy skills. By implication, 34.0% of the total variance of the dependent variable (numeracy skills) was accounted for by the combination of the six 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 ( $F_{(6, 313)} = 26.82; p < .001$ ).

The results of the relative contributions of the independent variables to the prediction of early childhood pre-service teachers' numeracy skills was that mathematical beliefs was the most potent significant positive contributor to the prediction of early childhood pre-service teachers' numeracy skills ( $\beta = .30, t = 5.90, p = .000$ ), while affective and behavioural engagement in mathematical learning made the next significant positive contribution to the prediction of the dependent variable ( $\beta = .22, t = 4.48, p = .000$ ). Confidence and beliefs regarding one's personal competence in mathematics made the next significant positive contribution to the prediction of the dependent variable ( $\beta = .22, t = 4.41, p = .000$ ). Beliefs about mathematical problem solving ( $\beta = .08, t = 1.50, p = .13$ ), emotionality ( $\beta = -.10, t = -1.58, p = .12$ ), and worry ( $\beta = -.09, t = -1.39, p = .17$ ) did not make any significant negative or positive contribution to the prediction of early childhood pre-service teachers' numeracy skills. According to the standardized

coefficients the regression model is as follows: Numeracy skills  $_{predicted} = 1.58 + 0.22ABE + 0.22CBP + 0.30MB + 0.08BMP - 0.10EMO - 0.09WOR$ .

Table 4. Model summary, coefficient and t-value of multiple regression analysis of mathematics anxiety dimensions, mathematical beliefs dimensions, and the outcome measure (numeracy skills)

Model summary					
Multiple R= .583					
Multiple R <sup>2</sup> = .340					
Multiple R <sup>2</sup> (Adjusted) = .327					
Standard Error of Estimate= .503					
$F_{(6, 313)}=26.82, p<.001$					
Model	Unstandardized coefficients		Standardized coeff.	t	Sig
	<b>B</b>	<b>Std Error</b>	<b>Beta</b>		
Constant	1.58	.18		9.03	.000
ABE	.19	.04	.22	4.48	.000
CBP	.18	.04	.22	4.41	.000
MB	.20	.03	.30	5.90	.000
BMP	.06	.04	.08	1.50	.134
EMO	-.07	.04	-.10	-1.58	.115
WOR	-.05	.04	-.09	-1.39	.167

Note that ABE= affective and behavioural engagement in mathematical learning, CBP= confidence and beliefs regarding one's personal competence in math, MB=mathematical beliefs, BMP=beliefs about mathematical problem solving, EMO= emotionality, and WOR=worry.

#### 4. Discussion

Majority of the early childhood pre-service teachers in this study had high mathematics anxiety ( $N=178$  (55.63%),  $Mean=2.72$ ,  $SD=0.50$ ) while 138 (43.13%) of the early childhood pre-service teachers showed low mathematics anxiety ( $Mean=1.33$ ,  $SD=0.43$ ) and only 4 representing 1.24% of the early childhood pre-service teachers had moderate mathematics anxiety ( $Mean=2$ ,  $SD=0.00$ ). The high mathematics anxiety in the entire sample might be a result of their previous debilitating engagement with mathematics. It has been established that majority of Nigerian students showed high level of mathematics anxiety (Awofala & Odogwu, 2017) and this might not be unconnected to their undesirable attitude transferred from their teachers, intellectual factors, and past failure in mathematics (Lindskog, Winman, & Poom, 2017). Majority of secondary school students showed poor performance in mathematics (Awofala, 2017) and mathematics anxiety has been fingered as a possible cause (Awofala, 2008) aside poor teaching methodology (Awofala, Arigbabu & Awofala, 2013) and negative attitudes towards mathematics (Awofala, 2016). In the present study, a large proportion of the early childhood pre-service teachers had high mathematical beliefs ( $N=292$  (91.25%),  $Mean=2.89$ ,  $SD=0.43$ ) while 26 (8.13%) of the early childhood pre-service teachers showed low mathematical beliefs ( $Mean=1.68$ ,  $SD=0.22$ ) and only 2 representing 0.63% of the early childhood pre-service teachers had moderate mathematical beliefs ( $Mean=2$ ,  $SD=0.00$ ). The high mathematical beliefs of the early childhood pre-service teachers indicated that they have their personal beliefs when it comes to the issue of mathematics teaching and learning as all of them were at one time or the other had experience with mathematics as students at the pre-tertiary levels. This high mathematical beliefs also showed the unique importance of mathematics activities in schools. This high mathematical beliefs corroborated the finding of Gómez-Chacón, García-Madruga, Rodríguez, Vila, and Elosúa (2011) in which they found that high school science students in Spain had high mathematical beliefs.

The result of significant correlation between mathematical beliefs and numeracy obtained in this study showed that there is a direct positive association between numeracy and mathematical beliefs. The negative correlation between numeracy and mathematics anxiety attests to the assertion that there is an inverse relationship between numeracy and mathematics anxiety. In short, both dimensions (worry and emotionality) of mathematics anxiety had a negative correlation with total numeracy skills in this study. So, the higher the numeracy skills of early childhood pre-service teachers, the higher their mathematical beliefs and the lower their mathematics anxiety.

The results obtained in Table 4 above showed that 34% of the variance in early childhood pre-service teachers' numeracy skills was accounted for by the six predictor variables (affective and behavioural



engagement in mathematical learning, confidence and beliefs regarding one's personal competence in math, mathematical beliefs, beliefs about mathematical problem solving, emotionality, and worry) taken together while 66% of the variance in numeracy skill could not be substantiated by the current data. This showed that there might be other independent variables which may require further investigations about their contribution to the prediction of early childhood pre-service teachers' numeracy skills. That mathematical beliefs predicted early childhood pre-service teachers numeracy skills agreed with the finding of Gómez-Chacón et al (2011) who found that mathematical beliefs predicted students' achievement in mathematics.

## 5. Conclusion

This present study has underscored particularly thought-provoking conundrums when looking at the associations involving early childhood pre-service teachers' numeracy skills, mathematical beliefs, and mathematics anxiety. Although the associations between numeracy skills and mathematical beliefs are positive, direct, and striking, of more interest is the dependability of the negative association of mathematics anxiety to numeracy skills of early childhood pre-service teachers. Thus, the higher the mathematics anxiety, the lower the numeracy skills of early childhood pre-service teachers. While mathematics anxiety did not predict early childhood pre-service teachers' numeracy skills, it is important to note that mathematics anxiety had a negative correlation with numeracy skills. This latter result shows the need to reduce early childhood pre-service teachers' mathematics anxiety as this could interfere in their teaching of mathematics in schools. Appropriate instructional pedagogies capable of reducing or eliminating fear of mathematics in early childhood pre-service teachers should be applied to teaching them and foster constructivist mathematical beliefs. This is important because teachers who have fear for mathematics have been known to transfer their mathematics anxiety to their students (Awofala & Akinoso, 2017). Educators need to provide an enabling environment free of mathematics anxiety for early childhood pre-service teachers as they engage in the learning of mathematics they will be required to teach. The paucity of research on mathematics anxiety and mathematical beliefs as correlates of numeracy skills among early childhood pre-service teachers showed the need for stakeholders in the research community to engage in this fruitful endeavour to further generalize the findings of this study. In conclusion, early childhood teacher education programme in Nigeria should include strategies to eliminate mathematics anxiety and foster constructivist mathematical beliefs capable of promoting early childhood pre-service teachers' numeracy skills.

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