International Journal on Teaching and Learning Mathematics
2020, Vol. 3, No. 2, pp. 54-66
P-ISSN: 2621-2188, E-ISSN: 2621-2196

Examining components of attitudes towards mathematics among senior secondary school students in Nigeria

Adeneye O. A. Awofala

University of Lagos, Department of Science and Technology Education, Faculty of Education, Nigeria

A R T I C L E I N F O
Original Article
doi: 10.18860/ijtlm.v3i2.9496

Keywords:
Components of attitudes towards mathematics, gender, senior secondary school students.

A B S T R A C T
The study investigated the components of attitudes towards mathematics among 1500 senior secondary school students from 20 co-educational public schools in Lagos State of Nigeria using the quantitative research method within the blueprint of the descriptive survey design of an ex-post-facto type. Data collected using the component of attitudes toward mathematics scale (Cronbach alpha coefficient α=0.96) were analysed using the descriptive statistics of frequency count, percentage, mean, and standard deviation and inferential statistics of independent samples t-test and factor analysis. Findings revealed that senior secondary school students' level of components of attitudes toward mathematics was at a moderate level. Components of attitudes towards mathematics scale was a multi-dimensional construct consisting of cognitive, behavioural and affective elements. Gender differences in components of attitudes towards mathematics among senior secondary school students were significant and in favour of the males. Based on this study, it was thus, recommended that future studies in Nigeria and elsewhere should investigate further the confirmatory factor analytic structure of the components of attitudes towards mathematics scale among senior secondary school students.

*Corresponding author.
E-mail: aawofala@unilag.edu.ng

How to cite: Awofala, A. O. A. (2020). Examining components of attitudes towards mathematics among senior secondary school students in Nigeria. *International Journal on Teaching and Learning Mathematics*, *3*(2), 54-66.

1. INTRODUCTION

There is no doubt that the affective domain in mathematics education is rarely evaluated when compared with the cognitive domain. One credible clarification for this is that evaluation techniques of students' learning in mathematics are mostly done towards the attainment of intellectual abilities with little or no penchant for affective abilities (Awofala, Arigbabu & Awofala, 2013). This upholds the fact that attitude as a key paradigm in the affective domain is hardly measured in school mathematics examination. Reasonably, the valuation of students' attitudes towards mathematics is shown in cautiously experimental studies with the hope of offering solutions to students' uninspiring and meagre performance/achievement in mathematics. Thus, mathematics educators are gingered towards creating novel methods that can be influenced to advance students' achievement in the cognitive domain. Largely, in mathematics education, pedagogical methods are examined with the hope of nurturing and increasing students' learning outcomes. Attitude is an important learning outcome in mathematics education (Awofala, 2016a) and is defined as proclivity and disposition that chaperon a person's behaviour and induce him or her to an act that can be appraised as either positive or negative (Awofala, 2016a). Mathematics learning is not only a function of rational thought and reasoning, it is hooked on the attitudes of the students towards mathematics (Kele & Sharma, 2014; Awofala, Lawal, Isiakpere, Arigbabu & Fatade, 2020; Awofala, 2017a). Attitudes can be categorised into three components of cognitive, behavioural and affective that students show towards mathematics (Han & Carpenter, 2014). The affective element is the mood and sensations of likes and dislikes connected with mathematics learning (Ingram, 2015) and is the foundation motivating the commitment of students towards mathematics (Sanchal & Sharma, 2017). Three types of learning shape the affective element of attitudes towards mathematics: observational conditioning, classical conditioning, and operant conditioning (Lineros & Hinojosa, 2012).

Classical conditioning is a type of learning that occurs via recurring experiences with environs and stimuli (Mensah, Okyere, & Kuranchie, 2013; Lineros & Hinojosa, 2012). In pedagogical instruction in mathematics, students who are treated to a variety of stimuli such as exercises and concepts will show growth in attitudes towards mathematics. The operant conditioning refers to the belief that students have predispositions to replicate behaviours that create positive impacts rather than behaviours that produce negative impacts (Mensah et al., 2013; Lineros & Hinojosa, 2012). During pedagogical discourse in mathematics, students who are motivated with incentives at the expiration of mathematical tasks will regard such tasks as pleasurable and will be motivated to engage in such analogous tasks. However, students who are rewarded with punishments for not completing mathematical tasks might connect such tasks with spiteful emotions, which might dissuade and demotivate them from doing more of such tasks. The observational conditioning is when students deploy their evaluations towards other people's engagements and their imports to inspire their emotions, thoughts and deeds (Mensah et al., 2013). In the course of pedagogical instruction in mathematics, students form attitudes towards mathematics via observations of diverse teachers' actions and deeds in the classroom.

The cognitive element deals with the students thinking and belief about mathematics (Mensah et al., 2013; Awofala, 2016a). It is the belief that mathematics will create desire or undesired effects (Mensah et al., 2013). The cognitive element not only shows students' confidence in their mathematical abilities but also indicates their awareness of the significance of mathematics in their practical lives. The beliefs formed from the cognitive element affect the affective element and produce a mentality that grows into constant over time and inspires students' emotions towards mathematics learning (Ingram, 2015; Zan & Di Martino, 2007). Thus, the affective and cognitive elements of attitudes towards mathematics are correlated and profoundly intermingle with each other (Di Martino & Zan, 2011). The behavioural element is the predisposition to react in a certain way towards mathematics learning (Mensah, Okyere & Kuranchie, 2013) and it is affected by the affective element. The behavioural element deals with the students' actions and responses towards mathematics, which may be verbal or non-verbal. These actions and responses, which may be positive or negative, are thought to be more reliable if they occur repeatedly. Contrastingly, with cognitive and affective elements, which cannot be seen with our eyes, the behavioural element can be conspicuously seen. For instance, students who resolutely engage mathematics tasks would repeatedly exhibit positive attitudes towards mathematics (Di Martino & Zan, 2001). However, being confident in doing mathematics is associated with being efficacious in mathematics, which is considered positive comportment. Not being confident in mathematics may breed failure, which is considered a negative emotion. Thus, the behavioural element affects the cognitive element of attitudes towards mathematics as well. Students who fathom the significance of mathematics in practical lives will feel motivated, self-assured and attached to mathematics learning (Attard, 2012). Succinctly, the three elements of attitudes towards mathematics, confidence, the significance of mathematics and engagement are correlated (Mensah et al., 2013). Regardless of this finding, there is little empirical evidence on the factor structure of the components of attitudes towards mathematics scale (Klinger, 2006). In Nigeria, this is a gap that this study would like to fill, as cross-cultural validations of scales are necessary for maintaining acceptability. This study would be contributing to knowledge by examining the psychometric properties of the components of attitudes towards mathematics scale since 2006 when it was first conceptualized. No study had investigated the factor-analytic structure of the scale in a new setting like Nigeria considered to be a pluralistic society.

In teaching mathematics at the secondary school level gender might be an important element. Although all students exhibit tension and experience problems in learning mathematics, female candidates tend to feel more uneasiness in coping with mathematics. Undeniably, female folks are more likely to underrate their capabilities and to exhibit more negative attitudes towards mathematics than did the male folks (Awofala et al., 2013). However, the extant literature is rich in contradictory results regarding gender differences in attitudes towards mathematics. For example, Awofala et al. (2013) found a significant main effect of gender on students' attitudes towards mathematics in favour of the male folks. The male students showed more positive attitudes towards mathematics than did their female counterparts. Chiesi and Primi (2015) study showed that female folks did not differ in their abilities but showed less confidence and more negative attitudes when compared to men in a quantitative discipline. Others have found no significant effect of gender on students' attitudes towards mathematics (Awofala, 2016a; Mohd, Mahmood, & Ismail, 2011). Thus, these contradictory results warrant further scrutiny in this study.

This study is important in that it would provide empirical evidence regarding the factor structure of the components of attitude towards mathematics scale. In addition, this study would reveal the level of the components of attitudes towards mathematics among senior secondary school students in Nigeria. It would also show whether gender difference exists in components of attitudes towards mathematics among senior secondary school students in Nigeria.

The purposes of this study were three folds. First, the study determined the level of the components of attitude towards mathematics among senior secondary school students. Second, the study investigated the factor structure of the components of attitude towards mathematics scale among senior secondary school students. Third, the study determined whether the components of attitudes toward mathematics differ as a function of gender. Specifically in this study, the following research questions were addressed:

RQ1. What is the level of the components of attitude towards mathematics among senior secondary school students?

RQ2. What is the factor structure of the components of attitude towards mathematics scale?

RQ3. Is there any significant ef
fect of gender on components of attitudes towards mathematics among Nigerian senior secondary school students?

2. METHOD

The study made use of a quantitative research method within the blueprint of the descriptive survey design of an ex-post-facto type. This is because the existing status of the independent variables was only determined during data collection without any manipulation of the variables by the researcher. The target population for the study comprised public senior secondary school year three mathematics students in education Districts II and III of Lagos State, Nigeria. The multi-stage sampling technique was used. First, simple random sampling was used to select educational Districts II and III out of the six educational districts in Lagos State. Second, purposive sampling was used to select schools to participate based on three (3) conditions: (a) schools that have qualified mathematics teachers (i.e graduates) who have been consistent with the school for at least three years, (b) schools that have been presenting candidates in external examinations such as the Senior School Certificate Examinations (SSCE) and National Examinations Council (NECO) for mathematics, and (c) schools should be public and coeducational. Based on the aforementioned criteria, 15 schools in education District II and 10 schools in education District III met the criteria. Thereafter, 12 schools were randomly selected from the 15 schools in education District II and eight schools were randomly selected from the 10 schools in education District III. Each of the schools has three arms for mathematics and intact classes were used for the study. A total of one thousand five hundred (1500) consisting of 800 males and 700 females Senior Secondary year three mathematics students were involved in the study. Their ages ranged from 14 to 20 years with a mean age of 17 years 3 months and standard deviation of 1 year 4 months. For data collection, one instrument tagged the Components of Attitudes Toward Mathematics Scale (CATMS) was used to collect data in this study.

The Components of Attitudes Toward Mathematics Scale (CATMS) – a 29-item questionnaire used by Klinger (2006) contained attitude statements in the affective, cognitive, and behavioural domains. The scale includes items that assess affective (11 items), cognitive (7 items), and behavioural (11 items) domains. These items were graded on a modified five-point Likert scale: (0 undecided, 1 strongly disagree, 2 disagree, 3 agree, and 4 strongly agree). The reliability coefficient (Cronbach Alpha) has been calculated using a sample group of 200 students from one senior secondary school not part of the study schools in education District II of Lagos State, Nigeria. The reliability value for CATMS as a whole was 0.962. The number of items and reliability value for each dimension of the CATMS are as follows: affective (11 items, $\alpha = .934$), cognitive (7 items, $\alpha = 0.890$), and behavioural (11 items, $\alpha = 0.951$). The items in each of the three dimensions of CATMS showed adequate internal consistency reliabilities, with Cronbach's alpha coefficients above the cut-off points of .80 recommended by Henson (2001). The researcher together with 10 research assistants personally administered the CATMS to the sample in a regularly scheduled class period. The participants were told that their participation was voluntary and that their responses would be treated with the utmost confidentiality. Data collected were analysed with the descriptive statistics of frequency count, percentage, mean and standard deviation and inferential statistics of independent samples t-test and factor analysis at 0.05 level of significance.

3. RESULTS AND DISCUSSION

Research Question One: What is the level of the components of attitude towards mathematics among senior secondary school students?

Table 1. Senior secondary school students' components of attitudes towards mathematics and summary of factor loadings by principal components analyses for the orthogonal three-factor model

S/N	Components of attitudes	SA/A	SD/D	U	M	St.D	FL
1	**The affective attitude in mathematics** I find mathematics a very interesting and exciting subject	1095(73.0)	96(6.4)	309(20.6	2.628	1.499	.656
2	I feel confident in solving problems in mathematics.	1241(82.7)	129(8.6)	130(8.7)	3.073	1.197	.838
3	I am afraid to take a mathematics course*.	510(34.0)	740(49.3)	250(16.7)	1.777	1.157	.736
4	I did not enjoy my mathematics classes at school*.	326(21.7)	879(58.6)	295(19.7)	1.850	1.352	.787
5	I feel helpless whenever I solve a mathematics problem*.	234(15.6)	1095(73.0)	171(11.4)	1.607	1.037	.693
6	I think mathematics is boring and dull*	165(11.0)	1115(74.3)	220(14.7)	1.567	0.873	.783
7	I hate maths*.	150(10.0)	1050(70.0)	300(20.0)	1.360	1.111	.784
8	I dread mathematics as if it is a contagious disease*.	404(26.9)	961(64.1)	135(9.0)	2.043	1.283	.786
9	I am always anxious in a mathematics class*.	510(34.0)	881(58.7)	109(7.3)	2.060	1.003	.639

10	How I wish mathematics would be completely deleted from my course*	219(14.6)	966(64.4)	315(21.0)	1.527	1.055	.864
11	I am uncomfortable with the thought of taking a math subject*.	420(28.0)	881(58.7)	199(13.3)	1.927	1.012	.917
	Sub-total				1.824	1.043	
12	**The behavioural attitude in math** Doing mathematics trains you to be disciplined.	859(57.3)	350(23.3)	291(19.3)	2.378	1.441	.700
13	I am ashamed to join in any discussion that involves mathematics*.	244(16.4)	881(58.7)	375(25.0)	1.643	1.186	.727
14	Learning mathematics trains you to be systematic.	1275(85.0)	95(6.3)	130(8.7)	3.073	1.177	.698
15	I am hesitant about attending mathematics classes*.	645(43.0)	650(43.3)	205(13.7)	2.333	1.281	.763
16	Mathematics stimulates me.	920(61.3)	270(18.0)	310(20.7)	2.353	1.389	.683
17	I seek help whenever I find difficulties in mathematics	1074(71.6)	255(17.0)	171(11.3)	2.907	1.323	.823
18	I hesitate to enrol in a course with mathematics requirements*.	636(42.4)	630(42.0)	234(15.7)	2.243	1.315	.689
19	I am patient when I do maths and I usually persevere until I get the answer	1050(70.0)	255(17.0)	195(13.0)	2.820	1.357	.782
20	.I am willing to share my insights about solving mathematical problems.	975(65.0)	220(14.7)	305(20.3)	2.517	1.473	.770
21	Doing mathematics makes you think logically.	1044(69.6)	330(22.0)	126(8.4)	2.900	1.276	.915
22	I try to understand the solutions of my peers/classmates in mathematics.	990(66.0)	125(8.3)	385(25.7)	2.463	1.578	.651
	Sub-total				2.512	1.345	
23	**The cognitive attitude in math** Mathematics is so difficult that only those who are gifted can understand*.	250(16.7)	1050(70.0)	199(13.3)	1.550	1.171	.562
24	I believe life can go on without mathematics*.	255(17.0)	885(59.0)	360(24.0)	1.597	1.265	.747
25	I think mathematics is irrelevant*.	290(19.3)	1015(67.7)	195(13.0)	1.680	1.078	.645
26	A good mathematics training is a big advantage in entering any line of work	1115(74.3)	201(13.4)	185(12.3)	2.850	1.403	.617
27	I would like to work in a mathematics-related field.	756(50.4)	444(29.6)	300(20.0)	2.260	1.397	.575
28	I feel responsible for finding and checking errors in my solutions in maths.	945(63.0)	185(12.3)	370(24.7)	2.333	1.535	.652
29	I think mathematics is challenging.	821(54.7)	420(28.0)	259(17.3)	2.363	1.378	.788
	Sub-total				**2.090**	**1.318**	
	Total				**2.142**	**1.235**	

* Reverse-scored item; FL=Factor Loading; Low Level: 0.00-1.99; Moderate Level: 2.00-2.99; High Level: 3.00-4.00

Table 1 above showed the overall components of attitudes towards mathematics among mathematics senior secondary school students. The actual numbers and percentages for responses to each statement were shown in the table. The percentages were in parenthesis. Table 2 showed that the senior secondary school students in the present study had a moderate level of components of attitudes towards mathematics (Mean=2.142, SD= 1.235). About affective attitude in mathematics among senior secondary school mathematics students (M=1.824, SD= 1.043), 73% agreed/strongly agreed that: I find mathematics a very interesting and exciting subject (item 1). More than 80% agreed/strongly agreed that: I feel confident in solving problems in mathematics (item 2) and less than 50% disagreed/strongly disagreed that: I am afraid to take a mathematics course (item 3). Less than 60% disagreed/strongly disagreed that: I did not enjoy my mathematics classes at school (item 4) and less than 80% disagreed/strongly disagreed that: I feel helpless whenever I solve a mathematics problem (item 5). Less than 80% disagreed/strongly disagreed that: I think mathematics is boring and dull (item 6), 70% disagreed/strongly disagreed that: I hate mathematics (item 7) and less than 65% disagreed/ strongly disagreed that: I dread mathematics as if it is a contagious disease (item 8). Less than 60% disagreed/strongly disagreed that: I am always anxious in a mathematics class (item 9), less than 65% disagreed/strongly disagreed that: how I wish mathematics would be completely deleted from my course (item 10), and less than 60% disagreed/strongly disagreed that: I am uncomfortable with the thought of taking a mathematics subject (item 11).

With behavioural attitude in mathematics among senior secondary school mathematics students (M=2.51, SD= 1.34), 57% agreed/ strongly agreed that: doing mathematics trains you to be disciplined (item 1) and 59% disagreed/strongly disagreed that: I am ashamed to join in any discussion that involves mathematics (item 2). 85% agreed/strongly agreed that: learning mathematics trains you to be systematic (item 3), 43.3% agreed/strongly agreed that: I am hesitant about attending mathematics classes (item 4), and 61.3% agreed/strongly agreed that: mathematics stimulates me (item 5). 71.6% agreed/strongly agreed that: I seek help whenever I find difficulties in mathematics (item 6), 42.7% agreed/strongly agreed that: I hesitate to enrol in a course with mathematics requirements (item 7) and 70% agreed/strongly agreed that: I am patient when I do mathematics and I usually persevere until I get the answer (item 8). 65% agreed/strongly agreed that: I am willing to share my insights about solving mathematical problems (item 9), 69.6% agreed/strongly agreed that: doing mathematics makes you think logically (item 10) and 66% agreed/strongly agreed that: I try to understand the solutions of my peers/classmates in mathematics (item 11).

Concerning senior secondary students cognitive attitude in mathematics (M= 2.09, SD= 1.328), 70% disagreed/strongly disagreed that: mathematics is so difficult that only those who are gifted can understand (item 1) and 59% disagree/strongly disagreed that: I believe life can go on without mathematics (item 2). 67.7% disagreed/strongly disagreed that: I think mathematics is irrelevant (item 3), 74.3% agreed/strongly agreed that: a good mathematics training is a big advantage in entering any line of work (item 4) and 50.4% agreed/strongly agreed that: I would like to work in a mathematics-related field (item 5). 63% agreed/strongly agreed that: I feel responsible for finding and checking errors in my solutions in mathematics (item 6) and 54.7% agreed/strongly agreed that: I think mathematics is challenging (item 7).

Research Questions Two: What is the factor structure of the components of attitudes towards mathematics scale?

The Components of Attitudes Towards Mathematics Scale (CATMS) was adopted from Klinger (2005) without any information regarding its factor analytic structure. Since this study adopted it in a new setting with different cultural settings it is wise that factor analytic structure is ascertained. Thus, this study subjected the 29 items CATMS to principal components factor analyses (PCA) with varimax rotation to extract its common factors. The data screening processes for the CATMS were carried out and showed no missing values for the 1500 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 -.30 to .56, kurtosis ranged from -1.01 to .58) as Kline (1998) suggested using absolute cut-off values of 3.0 for skewness and 8.0 for kurtosis. Initial inspection of the correlation matrix of the 29 items revealed that the correlations, when taken overall, were statistically significant as indicated by Bartlett's test of sphericity, χ^2 = *2.206E3; df=406; 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 an acceptable range (values of .60 and above) with a value of .84. Each of the variables also exceeded the threshold value (.60) of MSA which ranged from .75 to .93.

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 29 items of CATMS was appropriate for PCA. The initial pre-rotation resulted in three factors with eigenvalues greater than 1 (Kaiser, 1960; Tabachnick & Fidell, 2007), accounting for approximately 35.82% and 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 to achieve a simple and theoretically more meaningful solution. Varimax rotation was used for the orthogonal solution. By rotating three factors, the total percentage of variance accounted for remained at 35.82%. An examination of Cattell's (1966) scree test produced a three-factor solution (Figure 1). This seemed to support the original theory on which the instrument is based which had proposed three factors. For interpretational clarity, a salient loading (Gorsuch, 1983, p. 208) of 0.40 was selected as one that is sufficiently high to assume the existence of an item-factor relationship. The first factor, which accounted for 21.51% of the variance (eigen value=6.24), was labelled Affective attitudes towards mathematics and this factor included 11 items. The second factor, Behavioural attitudes towards mathematics had 11 items and accounted for 7.73% of the variance (eigenvalue=2.24). The third factor, Cognitive attitudes towards mathematics had 7 items and accounted for 6.58% of the variance (eigenvalue=1.91). In this study, all the communalities for the factor analysis satisfied the minimum requirement of being larger than 0.50. These ranged from 0.57 to 0.84. Figure 1 below is the Scree plot which graphs the eigenvalue against the component number and is suggestive of a three-component model.

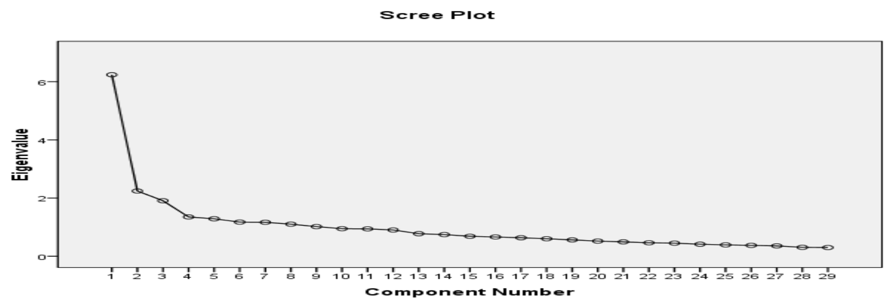

Figure 1. Cattell scree plot showing the number of components and eigenvalues of the correlation matrix.

Table 1 displayed the factor loadings for the orthogonal three-factor model of the CATMI. All items loaded .50 and above on their primary factor and none of the secondary loadings exceeded .30. The items identified that loaded significantly on factors 1 to 3 were verified for internal reliability. Cronbach's alpha coefficients of 0.84, 0.81, 0.85 and 0.78 were found for factors 1, 2, and 3 respectively. Since the sources of self-efficacy scale separated into 3 latent factors identified to possess a minimum of 1.0 eigenvalues, statistically, significantly reliable and non-overlapping subscales based on these 3 factors were used in subsequent data analyses. The following models were obtained:

$F_1=0.66a_{11}+0.84a_{12}+0.74a_{13}+0.79a_{14}+0.69a_{15}+0.78a_{16}+0.78a_{17}+0.78a_{18}+0.64a_{19}+0.86a_{1m}+0.78a_{1n}$

$F_2=0.70a_{21}+0.73a_{22}+0.70a_{23}+0.76a_{24}+0.68a_{25}+0.82a_{26}+0.69a_{27}+0.78a_{28}+0.77a_{29}+0.92a_{2m}+0.65a_{2n}$

$F_3=0.56a_{31}+0.75a_{32}+0.65a_{33}+0.62a_{34}+0.58a_{35}+0.65a_{36}+0.79a_{37}$

Where aij are the items that loaded significantly high on factor i, i and j are unique for each model because no item indicates a factorial complexity of two or more. The factor fi was then regressed on the students' mathematics achievement scores.

Research Question Three: Is there any significant influence of gender on components of attitudes towards mathematics among Nigerian senior secondary school students?

Table 2. Independent samples t-test analysis of senior secondary school students' components of attitudes towards mathematics according to gender

	Gender	N	M	SD	Df	t	p
Affective	Female	700	20.99	7.45	1498	2.47*	.014
	Male	800	21.79	4.87			
Behavioural	Female	700	27.71	9.42	1498	.428	.668
	Male	800	27.55	4.20			
Cognitive	Female	700	14.26	6.98	1498	2.43*	.015
	Male	800	14.96	4.05			
Attitudes	Female	700	62.96	20.51	1498	2.67*	.012
	Male	800	65.31	9.16			

*Significance at p<.01

Table 2 below showed the descriptive statistics of mean and standard deviation and t-test values on senior secondary school students' components of attitudes towards mathematics according to gender. Concerning the aggregate components of attitudes towards mathematics score, the female group recorded a lower mean score (M=62.96, SD=20.51) than their male counterparts (M=65.31, SD=9.16). However, this difference in mean score was statistically significant (t_{1498}= 2.67, p=.012).

Table 2 below showed that the female senior secondary school students recorded lower mean score (M=20.99, SD=7.45) in affective than their male counterparts (M=21.79, SD=4.87) and this difference was statistically significant (t_{1498}= 2.47, p=.014). In Table 2, the male senior secondary school students recorded a slightly lower mean score (M=27.55, SD=4.20) in behavioural than their female counterparts (M=27.71, SD=9.42). The difference was statistically not significant (t_{1498}= 0.428, p=.668). Concerning cognitive factor, the female senior secondary school students recorded lower mean score (M=14.26, SD=6.98) than their male counterparts (M=14.96, SD=4.05). However, this difference in mean score was statistically significant (t_{1498}= 2.43, p=.015). Thus, we concluded that gender was a significant factor in senior secondary school students' aggregate components of attitudes toward mathematics. However, at the subscale levels of the components of attitudes toward mathematics gender had a significant influence on affective and cognitive dimensions whereas gender had no significant influence on the behavioural dimension.

The results of the present study revealed that components of attitudes toward mathematics are a multi-dimensional construct. The exploratory factor analysis using the principal components analyses revealed a three-factor structure underlying the scale. The three interpretable factor structures coincided with the factor structure theoretically envisioned by Klinger (2005) and are subsequently labelled: Affective component (with 11 items), Behavioural component (with 11 items), and Cognitive component (with seven items) and each subscale had adequate internal consistency reliability. This outcome showed the multidimensionality of the components of attitude towards mathematics scale. This agreed with the submission that attitude is a multidimensional construct (Awofala et al., 2020). The senior secondary school students in the present study had moderate components of attitudes toward mathematics (Mean=2.142, SD= 1.235). This connotes that these students have a combination of both positive and negative attitudes toward mathematics. This finding was in partial agreement with previous findings (Mata, Monteiro, & Peixoto, 2012) which showed that, in general, students held positive attitudes towards mathematics in Portugal. Corroborating the present finding, Garner-O'Neale & Cumberbatch (2015) found that the overall chemistry undergraduates' attitudes toward mathematics were moderate in Barbados. Also, findings from Singapore had shown that the level of attitudes toward mathematics among junior college students was positive in which the students enjoyed mathematics, were confident about their ability to do mathematics and saw the value of mathematics (Yee, 2010). This was contrary to the findings of Lim-Teo, Ahuja and Lee (2000) in Singapore which revealed that junior college students exhibited negative attitudes toward the calculus-an aspect of mathematics.

The results of the present study showed that gender was a factor in senior secondary school students' components of attitudes towards mathematics. The male and female senior secondary school students recorded different mean scores in components of attitudes towards mathematics. Thus, gender differences in components of attitudes towards mathematics as shown in this study were significant. The implication of the present study finding regarding gender is that gender differences in components of attitudes towards mathematics are very important. Thus gender-based differences may be due to the individual's perception of own abilities, socio-cultural practices and the sex-role stereotyping (Recber, Isiksal, & Koç 2018; Schiefele & Csikszentmihalyli, 1995) that males are better in mathematics than females. In this study, the females recorded higher behavioural attitude in mathematics than males, lower affective attitude in mathematics than males, and lower cognitive attitude in mathematics than males.

One factor that influences girls' lack of participation in science and mathematics-related careers is their attitudes towards mathematics. This concern has led researchers into a variety of studies that identified gender differences that could influence the number of girls in science and mathematics-related careers (Oakes, 2000). In the US, boys tend to hold more positive attitudes toward mathematics than girls (Kahle, 2003; Kurth, 2007) and this disparity in gender seems to prevail as pupils move from the primary school to the high school level (Kanai & Norman, 1997). Also in the US, Meyer and Koehler (1990) found gender disparities, favouring males, in students' self-confidence in learning mathematics, perceived usefulness of mathematics, perceptions of mathematics as a male domain and students' attributions to success or failure in mathematics. While it is evident that gender differences in attitudes toward mathematics in the primary grade do not exist (Hoang, 2008), gender differences start to show up in attitudes toward mathematics in the middle grades and boys tend to find mathematics interesting and enjoyable than girls (Lockheed, Thorpe, Brooks-Gumn, Casserly, & McAloon, 2005; Oakes, 2000; Eshun, 2004). This is contrary to the submission of some researchers (Awofala et al., 2020; Mohd, Mahmood, & Ismail, 2011; Köğce, Yıldız, Aydın, & Altındağ, 2009; Nicolaidou & Philippou, 2003) that gender has no significant influence on students' attitudes toward mathematics. Specifically, Awofala et al. (2020) found that gender was not a factor in attitudes towards mathematics homeschooling during the period of COVID 19 pandemic in Nigeria.

Hoang (2008) found that boys consistently reported slightly more positive attitudes toward mathematics than did girls. Recber, Isiksal, and Koç (2018) found that girls reported significantly more positive attitudes toward mathematics than boys in Turkey. It is evident, compared to girls, boys are more likely to choose careers related to mathematics (Watt, 2007), feel more confident and suffer less from mathematics anxiety (Ai, 2002; Hannula, 2002; Awofala & Odogwu, 2017; Awofala & Akinoso, 2017) and have higher self-concept in mathematics (Kyriacou & Goulding, 2006). Also, boys do not suffer from gender stereotyping where mathematics is viewed as a male domain (Awofala, 2008a, 2008b; Mohamed & Waheed, 2011; Awofala & Lawani, 2020; Awofala, 2017b), and have more male mathematical role models as examples to follow (Lee & Anderson, 2014). In Africa, conflicting reports on gender differences in attitudes toward mathematics have been established. Awofala (2016b) found no significant influence of gender on Nigerian pre-service mathematics teachers' attitudes toward mathematics even at the subscale level of self-confidence, enjoyment, motivation, and value of mathematics. Asante (2012) in Ghana stated that, when compared with boys, "girls lacked confidence, had debilitating causal attribution patterns, perceived mathematics as a male domain, and were anxious about mathematics" (p. 2). More so, Asante (2012) found that boys had more positive attitudes towards mathematics than girls. Awofala (2017a) found no significant effect of gender on Nigerian pre-service chemistry teachers' attitudes toward mathematics.

4. CONCLUSION

This study has shown that the components of attitudes towards mathematics scale are a multidimensional construct consisting of three interpretable factor structure namely affective, cognitive, and behavioural elements. Besides, gender was a factor in senior secondary school students' components of attitudes towards mathematics with males showing more positive attitudes than females. Lastly, the senior secondary school students in the present study had moderate components of attitudes toward mathematics. Based on these findings, future researchers should investigate the confirmatory factor analysis of the components of attitudes towards mathematics scale with diverse senior secondary school students. This will enable further generalization of the results of this study. Teachers of mathematics should be more concern with teaching strategies that are appropriate for not only teaching mathematics but also engendering positive attitudes towards mathematics learning. This is because students who show positive attitudes towards mathematics will find mathematics interesting and will be motivated to persevere in solving even more difficult mathematics problems.

REFERENCES

Ai, X. (2002). Gender differences in growth in mathematics achievement: Three-level longitudinal and multilevel analyses of individual, home, and school influences. *Mathematical Thinking and Learning*, *4*(1), 1-22. doi.org/10.1207/S15327833MTL0401_1.

Asante, K. (2012). Secondary students' attitudes toward mathematics. *IFE PsychologIA*, *20*(1), 121–133.

Attard, C. (2012). Engagement with mathematics: What does it mean and what does it look like? *Australian Primary Mathematics Classroom, 17*(1), 9–12.

Awofala, A. O. A. & Akinoso, S. O. (2017). Assessment of psychometric properties of mathematics anxiety questionnaire by preservice teachers in the south-west, Nigeria. *ABACUS: The Journal of the Mathematical Association of Nigeria*, *42*(1), 355-369.

Awofala, A. O. A. & Lawani, A. O. (2020). Increasing mathematics achievement of senior secondary school students through differentiated instruction. *Journal of Educational Sciences*, *4(1)*, 1-19.

Awofala, A. O. A. (2008a). Women and the learning of mathematics. *African Journal of Historical Sciences in Education, 2*(1), 195–213.

Awofala, A. O. A. (2008b): Sex, blood type and the relationship between mathematics self-efficacy and achievement in senior secondary school. *African Journal of Historical Sciences in Education, 2*(2), 94 – 104.

Awofala, A. O. A. (2016a). Examining pre-service mathematics teachers' attitudes toward mathematics. *Nigerian Journal of Curriculum Studies, 23*, 292-300.

Awofala, A. O. A. (2016b). Effect of personalisation of instruction on students' motivation to learn mathematics word problems in Nigeria. *Turkish Journal of Computer and Mathematics Education, 7*(3), 486-509. DOI: 10.16949/turkbilmat.267339.

Awofala, A. O. A. (2017a). Attitudes towards mathematics as predictors of preservice teachers' achievement in senior secondary school chemistry. *Bulgarian Journal of Science and Education Policy (BJSEP), 11*(2), 384-416.

Awofala, A. O. A. (2017b). Assessing senior secondary school students' mathematical proficiency as related to gender and performance in mathematics in Nigeria. *International Journal of Research in Education and Science (IJRES), 3*(2), 488-502. DOI: 10.21890/ijres.327908.

Awofala, A. O. A., Arigbabu, A. A. & Awofala, A. A. (2013). Effects of framing and team individualised instructional strategies on senior secondary school students' attitudes toward mathematics. *Acta Didactica Napocensia, 6*(1), 1-22.

Awofala, A. O. A., Lawal, R. F., Isiakpere, B. J., Arigbabu, A. A., & Fatade, A. O. (2020). COVID-19 pandemic in Nigeria and attitudes towards mathematics homeschooling among pre-tertiary students. *Nigerian Online Journal of Educational Sciences and Technology, 1*(2), 57-70.

Cattell, R.B. (1966). The scree test for the number of factors. *Multivariate Behavioral Research, 1*, 245–276.

Chiesi, F. & Primi, C. (2015). Gender differences in attitudes toward statistics: Is there a case for a confidence gap?. Konrad Krainer; Nada Vondrová. CERME 9 - Ninth Congress of the European Society for Research in Mathematics Education, Feb 2015, Prague, Czech Republic. pp.622-628, Proceedings of the Ninth Congress of the European Society for Research in Mathematics Education.

Di Martino, P., & Zan, R. (2011). Attitude towards mathematics: A bridge between beliefs and emotions. *The International Journal on Mathematics Education, 43*(4), 471–482.

Eshun, B. (2004). Sex-differences in the attitude of students towards Mathematics in secondary schools. *Mathematics Connection*, *4*, 1–13. Doi.org/10.4314/mc.v4i1.21495.

Garner-O'Neale, L & Cumberbatch, A. (2015). Attitudes of chemistry undergraduate students towards mathematics at the UWI, cave hill campus. *Caribbean Educational Research Journal*, *3*(2), 33-45.

Gorsuch, R. L. (1983). *Factor analysis*. Mahwah, NJ: Lawrence Erlbaum.

Han, S. Y., & Carpenter, D. (2014). Construct validation of student attitude toward science, technology, engineering and mathematics project-based learning: The case of Korean middle-grade students. *Middle Grades Research Journal, 9*(3), 27–41.

Hannula, M. (2002). Attitude towards mathematics: Emotions, expectations and values. *Educational Studies in Mathematics* 49, 25-46. doi.org/10.1023/A:1016048823497.

Henson, R. K. (2001). Understanding internal consistency reliability estimates: A conceptual primer on coefficient alpha. *Measurement and Evaluation in Counseling and Development, 34*, 177–189.

Hoang, T. N. (2008). The effects of grade level, gender, and ethnicity on attitude and learning environment in mathematics in high school. *International Electronic Journal of Mathematics Education*, *3*(1), 47-59.

Ingram, N. (2015). Students' relationships with mathematics: Affect and identity. In M. Marshman, V. Geiger, & A. Bennison (Ed.), *Mathematics education in the margins* (Proceedings of the 38th annual conference of the Mathematics Education Research Group of Australasia) (pp. 301–308). Sunshine Coast, Australia: MERGA.

Kahle, J. B. (2003). *The disadvantaged majority: Science education for women*. (ERIC document reproduction service No. ED 242 561).https://files.eric.ed.gov/fulltext/ED242561.pdf

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

Kanai, K., & Norman, J. (1997). Systemic reform evaluation: Gender differences in student attitudes toward science and mathematics. *In Proceedings of the 1997 Annual International Conference of the AETS*. *ERIC ED* (Vol. 405220).

Kele, A., & Sharma, S. (2014). Students' beliefs about learning mathematics: Some findings from the Solomon Islands. *Teachers and Curriculum, 14*, 33–44.

Kline, R. (1998). *Principles and practice of structural equation modelling*. New York: Guilford Press.

Klinger, C. M. (2006). Challenging negative attitudes, low self-efficacy beliefs and math-anxiety in pre-tertiary adult learners. In M. Horne, and B. Marr, (Eds) *Connecting voices: Practitioners, researchers and learners in adult mathematics and numeracy* (pp. 164-171).

Köğce, D., Yıldız, C., Aydın, M. & Altındağ, R., (2009). Examining elementary school students' attitudes towards mathematics in terms of some variables. *Procedia Social and Behavioral Sciences,* 1(1), 291-295.

Kurth, K. (2007). *Factors which influence female's decision to remain in science* (Exit Project S 591). South Bend, IN Indiana University. (ERIC document reproduction service No. ED288739). https://eric.ed.gov/?id=ED288739.

Kyriacou, C., & Goulding, M. (2006). *A systematic review of strategies to raise pupils' motivational effort in Key Stage 4 mathematics*. London: EPPI Centre, Institute of Education.

Lee, K. J., & Anderson, J. A. (2014). Who is really interested in mathematics? An investigation of lower secondary students' mathematical role models. In J. Anderson, M. Cavanagh, & A. Prescott (Eds.), *Curriculum in focus: Research guided practice*.(Proceedings of the 36th Annual Conference of the Mathematics Education Research Group of Australasia, pp. 397-404). Sydney: MERGA.

Lim-Teo, S. K., Ahuja, O. P., & Lee, P. Y. (2000). Attitude of junior college and tertiary students to calculus. *PRIMUS, 10*(2), 123-142.

Lineros, J., & Hinojosa, M. (2012). Theories of learning and student development. *National Forum of Teacher Education Journal*, *22*(3), 1–5.

Lockheed, M.E., Thorpe, M., Brooks-Gunn, J., Casserly, P., & McAloon, A. (2005). *Sex and ethnic differences in middle school mathematics science and computer science. What do we know?* Princeton, NJ: Educational Testing Service.

Mata, M., Monteiro, V., & Peixoto, F. (2012). Attitudes towards mathematics: Effects of individual, motivational, and social support factors. *Child Development Research*, *2012*, 1-10. http://dx.doi.org/10.1155/2012/876028.

Mensah, J. K., Okyere, M., & Kuranchie, A. (2013). Student attitude towards mathematics and performance: Does the teacher attitude matter? *Journal of Education and Practice, 4*(3), 132–139.

Meyer, M.R., Koehler, M.S. (1990). International influences on gender differences in mathematics. In: Fennema, E., & G.C. Leder (Eds.), *Mathematics and gender*. (pp. 60-95). New York, NY: Columbia University Press.

Mohamed, L & Waheed, H. (2011). Secondary students' attitude towards mathematics in a selected school of Maldives. *International Journal of Humanities and Social Science*, *1*(15), 277–281.

Mohd, N., Mahmood, T. F. P. T., & Ismail, M. N. (2011). Factors that influence students in mathematics achievement. *International Journal of Academic Research, 3*(3), 49-54.

Nicolaidou, M., & Philippou, G. (2003). Attitudes towards mathematics, self-efficacy and achievement in problem-solving. In *European Research in Mathematics Education III* (pp.1-11). Pisa: University of Pisa.

Oakes, J. (2000). Opportunities, achievement, and choice: Women and minority students in science and mathematics. *Review of Research in Education, 16*, 153-222.

Recber, S. Isiksal, M. & Koç, Y. (2018). Investigating self- efficacy, anxiety, attitudes and mathematics achievement regarding gender and school type. *Anales de Psicología, 34*(1), 41-51. doi.org/10.6018/analesps.34.1.229571

Sanchal, A., & Sharma, S. (2017). Students' attitudes towards learning mathematics: impact of Teaching in a sporting context. *Teachers and Curriculum, 17*(1), 89-98.

Schiefele, U., & Csikszentmihalyi, M. (1995), Motivation and ability as factors in mathematics experience and achievement. *Journal for Research in Mathematics Education, 26*(2), 163-181.

Tabachnick, G., & Fidell, L. (2007). *Using multivariate statistics* (5th ed.). Boston, MA: Pearson Education, Inc.

Watt, H. M. G. (2007). A trickle from the pipeline: Why girls under participate in maths. *Professional Educator*, 6(3), 36-41.

Yee, L. S. (2010). Mathematics attitudes and achievement of junior college students in Singapore. In L. Sparrow, B. Kissane, & C. Hurst (Eds.), *Shaping the future of mathematics education: Proceedings of the 33rd annual conference of the Mathematics Education Research Group of Australasia* (pp. 681-689). Fremantle: MERGA.

Zan, R., & Martino, P. D. (2007). Attitudes towards mathematics: Overcoming positive/negative dichotomy. *The Montana Mathematics Enthusiasts Monograph*, *3*, 157-168.