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Construction of Mathematics Attitude Scale Using Factor Analysis

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Abstract
This study was a correlational type aimed at constructing and validating a Mathematics attitude scale using factor analysis. The sample for this study consisted of 1500 JSS 3 and SSS 2 students selected from 50 schools in Oyo and Ekiti States, using multistage sampling technique. The test items were generated from three sources. These are: - statements of students, (drawn from ten states) on their attitude towards Mathematics; information from available literature and the researcher's experience as a Mathematics teacher. A total of 115 items were generated and subjected to preliminary analysis and factor analysis. The preliminary analysis involved checking for sample size adequacy using Kaiser-Mayer-Olkin (KMO) measure of sampling adequacy as well as data screening to remove irrelevant, redundant and unclear items. To this end, Bartlett's test of sphericity was done while the determinant of the R-matrix provided information on the existence of multicollinearity and singularity. Item- total correlation was also done to remove items with correlation below 0.4. The KMO was 0.948 while Bartlett's test was significant at 0.000 implying that the R-matrix was not an identity matrix and that the pattern of correlations was relatively compact and hence appropriate for factor analysis. Factor analysis was done using the fifty-six (56) items selected after data screening. Oblique rotation was done. Thirteen items did not load on any of the factors, two overlapped while one was not directly-related. Thus there were 40 items which loaded on ten (10) factors. Convergent validity was ascertained using inter-factor correlation. Cronbach's α was used as the measure of reliability coefficient for the entire scale (r =0.925). It was concluded that the scale was valid and reliable for measuring students attitude toward Mathematics and hence recommended for teachers to utilize the scale to measure the attitude of their students' to facilitate positive attitude towards Mathematics.
Keyword: Construction, Mathematics, Attitude, Scale, Factor Analysis

1. Introduction

School curriculum as of now places a premium on Mathematics. According to Bolaji (2005), Mathematics is a compulsory subject at the primary and secondary school levels not because the students are expected to become mathematicians but because of its application in everyday life. Toumasis (1993) noted that Mathematics knowledge is essential, not only for effectiveness in the society but also for making useful contribution towards the development of one's environment. According to Yara (2009), every individual needs the knowledge of Mathematics in other to live a useful life and be an effective member of the society. This knowledge of Mathematics as a subject affects all aspects of human life in various degrees. The social, economic, political, geographical, scientific and technological aspect of man is centered on numbers.

The inter-relationship between Mathematics, development and advancement of humans shows the importance of Mathematics. Science and technology are heavily dependent on Mathematics. Mathematics is seen as the language used to describe the problems arising in most branches of science and technology (Yara, 2009). Students' achievements in Mathematics in high school have been form to have a significant effect on their performance in college (Ismail and Awang, 2008.Various efforts at developing Science and Mathematics education in Nigeria led to the admission policy of ratio 60:40 in favour of science oriented courses to humanities in the universities. Various research had been undertaken to investigate trends in Mathematics achievement and the factors influencing Mathematics learning and performance (House and Telese, 2008). Unfortunately, despite all successive efforts to improve the teaching and learning of Mathematics, it has been observed that students' performance in Mathematics is dismal. (Falayajo, 1998; Obaitan and Rasheed, 2010).

There is a general public outcry about the poor performance in secondary school Mathematics. Various reasons have been linked with these poor performance and various programmes had been carried out in other to solve these problems. Stakeholders in learning outcomes in this area have suggested various instructional strategies that could improve students' performance in Mathematics. Improving instruction in Mathematics education has been a major topic of interest for Teachers, Researchers, Administrators and the public (Popoola, 2004).

Unfortunately, the ideal strategies and techniques capable of ameliorating these problems seem to be difficult to attain in our classroom today. The poor state of Mathematics in the country was brought to a sharp focus and was partly seen as long-term effect of playing down on affective domain such as attitude, interest, value and others in Mathematics lessons suitable for some educational concepts. According to Bolaji (2005),

many Mathematics teachers tend to overlook the affective domain in their teaching to the detriment of the learners. Similarly, Adebule (2004) explained that various factors affecting the teaching and learning of Mathematics in Nigeria especially at the secondary school level include political, economics and academic problems. He stressed further that the academic problems include students' unparalleled hatred, indifference and poor attitude toward Mathematics among others.

Attitude plays an important role in the learning of any school subject including Mathematics. This is so because it torches the cognitive, affective and behavioural tendencies of the learner. The way an individual thinks, perceives, feels, values and acts toward Mathematics will definitely influence his or her achievement in Mathematics. However, Fakeye (2010), noted that students' failure in Mathematics is not only attributable to their negative attitude towards the subject but is also related to the poor attitude of some Mathematics' teachers to work and their enthusiasm as they teach the subject. He further noted that there is a strong relationship between attitude and achievement in Mathematics. Therefore any attempt to improve the teaching and learning of Mathematics cannot be very meaningful if the issues of learner and teacher attitudes are not considered. A first step in dealing with attitude is the proper assessment of such attitudes. The focus of this study therefore is the construction of a valid and reliable instrument for measuring students attitude towards Mathematics.

1.1 Statement of the Problem

The prevalent poor performances among secondary school students in Nigeria especially in Mathematics in both internal and external examination has been a source of concern to the nation. Research points to the fact that the attitude of a student to a particular subject area influences his/her achievement in the subject. One of the factors responsible for this trend in Mathematics achievement is the attitude of students toward Mathematics. Most of the instruments available locally, for measuring attitude towards Mathematics are statements collectively labeled ''Attitude toward Mathematics scale'' which students present as part of the instruments for their projects and thesis. There is a need to have a standard, valid and reliable instrument for measuring attitude in terms of developing a test for measuring attitude towards Mathematics. As attitude towards Mathematics appears to feature in many of the studies in learning outcomes in Mathematics. In view of this, this work was focused on construction and factor analysis of Mathematics attitude scale for Secondary School Students.

1.2 Purpose of the Study

A major area to be addressed in the issue of low level of achievement in Mathematics is that of the attitude of students towards Mathematics. We have to properly assess the attitudes as a prelude to working out modalities for improving on them. The objective of this research therefore is to take time to construct a concise, standard, valid and reliable instrument that will be used to measure attitude towards Mathematics. The instrument will be validated using factor analysis in order to get more insight into the structure of attitude toward Mathematics.

1.3 Research Questions

The research questions that guided the factor analysis are given below.

1. Is the sample size adequate to provide a stable factor solution?
2. Do the test items show convergent validity?
3. What are the principal components (factors) of attitude towards Mathematics?
4. What are the factor loadings for each principal component after rotation?
5. What are the convergent validity indices of the identified factors of Mathematics attitude scale?
6. Is the Mathematics attitude scale reliable?

2. Review of Literature

2.1 Attitude Formation and Attitude Change

Unlike personality, attitudes are expected to change as a function of experience. Kaya, (2005) have argued that heredity variables may affect attitudes, but believes that may do so indirectly. For example, if one inherits the disposition to become an extrovert, this may affect one's attitude to certain styles of music. There are numerous theories of attitude formation and attitude change. Persuasion is the process of changing attitudes. Two aspects of persuasion process have received special attention: the source of the message and the message itself. A message tends to be more persuasive if its source is credible. Source credibility is high when the source is perceived as knowledgeable and is trusted to communicate this knowledge accurately. Attractiveness of the source has also a definite impact in the process of persuasion. For example, individuals who are asked to endorse products for advertisers are almost always physically attractive or appealing in other ways. Another example, physically attractive people are more likely to persuade others to sign a petition (Kaya, 2005).

2.2 Attitude and Achievement in Mathematics

Attitude as a concept is concerned with an individual way of thinking, acting and behaving. It has very serious implications for the learner, the teacher, the immediate social group with which the individual learner relates and the entire school system. Attitudes are formed as a result of some kind of learning experiences. They may also be learned simply by following the example or opinion of parent, teacher or friend. This is mimicry or imitation, which also has a part to play in the teaching and learning of Mathematics. In this respect, the learner draws from his teachers' disposition to form his own attitude, which may likely affect his learning outcomes (Yara, 2009).
Similarly, Yara (2009) reported that teachers' attitude towards teaching significantly predict students' attitude as well as achievement in Mathematics. He stated further that teachers' attitude towards the teaching of Mathematics plays a significant role in shaping the attitude of students towards the learning of Mathematics.

2.3 Factor Analysis

Factor analysis is a statistical procedure used to uncover relationships among many variables. This allows numerous inter-correlated variables to be condensed into fewer dimensions, called factors. In the context of this research, the variables are the degree of agreement with various specific statements about beliefs, feeling and behaviour tendencies towards Mathematics. Through intercorrelation of these items, clusters of related attitude components form clusters (factor). The new factors are used as explanatory variables during choice modeling.

2.3.1 Purposes of Factor Analysis

There are two main applications of factor analytic techniques. These are to: reduce the number of variables, and to detect structure in the relationships between variables, that is, to classify variables.

2.3.2 Factor Analysis Procedure

The details of steps in factor analysis are outlined below:
Test assumptions; Select type of analysis ; Extraction (Principle Axis Factoring (PAF) /Principle Components (PC); Rotation (Orthogonal/Oblique); Determine number of factors; Identify which items belong in each factor; Drop items as necessary and repeat steps 3 to 4; Name and define factors; Examine correlations amongst factors and analyze internal reliability.

3. Methodology

3.1 Research Design.

The study is a correlation study aimed at constructing Mathematics attitude scale for secondary school students using factor analysis. A sample survey was used to collect statement of students attitude towards Mathematics.

3.2 Population

The target population for this study comprises Junior Secondary School three and Senior Secondary School two Students in both public and private schools of Ekiti and Oyo State. The choice of this group of students was based on premise that:
(i) majority of the students will be able to read printed materials with little assistance from the research assistant or researcher;
(ii) by JSS 3, the students would have formed what can rightly be said to be their attitude to Mathematics.

3.3 Sample and Sampling Procedure

The sample for the study comprises one thousand five hundred (1500) students. The sample was selected using multi-stage cluster sampling procedure.
1. At the first stage, south western zone was stratified along six states from which two states were randomly selected in Oyo and Ekiti states.
2. At the second stage, proportional stratified sampling technique were used to select nine (9) local government from Oyo and Ekiti state, six (6) local government out of thirty-three (33) local government in Oyo – state and three (3) local government out of sixteen (16) local government in Ekiti – state.
3. At the third stage, simple random sampling was used to select a total of 50 schools from the selected LGA. 25 from junior schools and 25 from Senior schools. Thereafter, thirty (30) students were randomly selected from each of the selected schools making a total of 1500 students. This set of students were made to answer the questions in the questionnaire.

3.4 Instruments

3.4.1 Generation of the Test Items

The items for the attitude scale were generated from three (3) sources. viz:

i. The item pool of students' statement about their attitude towards Mathematics collected by Obaitan

(1980-2010) as part of an ongoing research. The data were collected from ten states (10) states; namely, Kogi, Oyo, Osun, Edo, Rivers, Abia, Imo, Anambra, Ogun and Lagos. The selection of the items was done through empirical criterion key. Items were retained if more than twenty percent of the respondents listed it in their response to an open ended questionnaire.

ii. Literature search.

iii. From the researcher, based on her experience as a secondary school Mathematics teacher.

A four (4) point Likert scale was developed using these items. A score of four (4) indicated the maximum possible positive score for an item while a score of one (1) was assigned the worst possible negative response.

3.5 Data Collection Procedure

The researcher made use of trained research assistance to collect the data in Oyo-state. But the researcher personally visited all the selected schools in Ekiti-State to collect the data with the help of a research assistance. Clear instructions were prepared for the respondents. They were requested to go through the general instructions first and then to respond to the test items. The researcher herself was also there to guide the respondents properly. The respondent were asked to answer the questions as honestly as possible. The students were made to indicate their opinion by making a tick in the box they think it best represented their feelings. No time limit was enforced for the completion of the attitude test. The analysis of data was based on the response of the students who had scores in all the variable under study.

3.6 Procedure for Data Analysis

The data analysis was in two **(2)** phases viz:

i. Preliminary analysis to check out the fitness of the data for factor analysis;

ii. The factor analysis.

1. Preliminary Analysis

This involved screening of the data and checking the adequacy of the sample size.

- Inter-item correlation (R-matrix) was done to check for case of singularity and multicollinearity.
- The presence of such items is suggesting by the value of the determinant of the R-matrix. A determinant of less than 0.00001 is an indication of the presence of multicollinearity or singularity.
- The matrix was inspected to delete such items (i.e those having a correlation of .8 and above with other items).
- One of each pair in this category was dropped since it would be unnecessary duplication.
- Kaiser-Meyer-Olkin measure of sampling adequacy was to asses sample size adequacy. The interpretation was as follows:- A score close to one (1) is an indication that the data is suitable for factor analysis. A bench mark of 0.5 and above was set as benchmark for this study.
- Bartlett's test of sphericity was done to check if the R- matrix is not an identity matrix.
- There was analysis based on item total correlation. Items that had low correlation ($r < .4$) were removed. (item measuring the same trait should correlate well).

2. The Main Analysis

- The method of factor extraction was principal component analysis.
- There was a check for eigenvalues, communality, component matrix, and scree plot.
- The axis was rotated using both orthogonal and oblique rotation. (They both yielded 10-factors each).
- The result for the oblique rotation was preferred. This is because the factors of the attitude scale are expected to be correlated.
- The test items that loaded on each factor were identified. Only test items with factor loading exceeding .4 were retained for each factor.
- The factors were named.
- Item-total correlation matrix of the items in each of the sub-scale of the final scale was done to determine the new communality mean and the reliability coefficient of the sub scale if item deleted.
- Inter-factor correlation was also done to find out if they correlate (i.e. the correlation coefficient should be moderate).
- Finally the internal consistency reliability coefficient of the final attitude scale was determined.

4. Result and Discussion

Preminary Analysis

1. Sample Size adequacy

4.1 Research Question One
Is the sample size adequate to provide a stable factor solution?
Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was used to check this out. The result is on table 4.1 .

Table 4.1 Sampling Adequacy of Mathematics Attitude Scale

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.948
Bartlett's Test of Sphericity	Approx. Chi-Square	5.351E4
	Df	6555
	Sig.	.000

Determinant = 1.01×10^{-16}
Kaiser-Meyer-Olkin Measure of Sampling Adequacy = 0.948 (i.e.KMO >.5) indicates that the patterns of correlations are relatively compact and so factor analysis should yield distinct and reliable factors.

4.2 Research Question Two
Do the test items show convergent validity?
To test this research question, it was subjected to items-total correlation analysis. The result is shown on the table below.

Table 4.2 : Validity Index of the Items of Mathematics Attitude Scale

Items	R(i)(T-i)	Items	R(i)(T-i)	Items	R(i)(T-i)
1	0.443	21	0.482	41	0.501
2	0.416	22	0.454	42	0.549
3	0.402	23	0.413	43	0.493
4	0.412	24	0.454	44	0.458
5	0.479	25	0.488	45	0.477
6	0.428	26	0.406	46	0.505
7	0.404	27	0.434	47	0.493
8	0.434	28	0.425	48	0.466
9	0.521	29	0.451	49	0.505
10	0.436	30	0.466	50	0.423
11	0.466	31	0.424	51	0.409
12	0.433	32	0.430	52	0.445
13	0.436	33	0.494	53	0.587
14	0.512	34	0.434	54	0.400
15	0.521	35	0.409	55	0.474
16	0.453	36	0.436	56	0.407
17	0.536	37	0.405		
18	0.484	38	0.553		
19	0.422	39	0.479		
20	0.406	40	0.495		

****Correlation is significant at the 0.001 level (2-tailed)**

Table 4.2 above showed that the item validity coefficient vary from 0.400 to 0.587(α = 0.001). The values clearly indicate that the items of the scale were meanifully related and contributed to the construct being measured. Hence the Mathematics attitude scale has significant validity coefficient.

II Factor Analysis
4.3 Research Question Three
What are the principal components (factors) of attitude towards Mathematics?
Factor analysis extraction was done to show the components of mathematics attitude scale. Table 4.3 lists the eigenvalues associated with each linear component (factor) before extraction, after extraction and after rotation.

Table 4.3 Principal Components of Mathematics Attitude Scale

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	14.386	25.690	25.690	14.386	25.690	25.690	7.922
2	3.255	5.812	31.502	3.255	5.812	31.502	5.323
3	2.311	4.127	35.630	2.311	4.127	35.630	5.390
4	1.929	3.445	39.075	1.929	3.445	39.075	6.241
5	1.423	2.542	41.617	1.423	2.542	41.617	4.401
6	1.298	2.318	43.935	1.298	2.318	43.935	5.790
7	1.164	2.078	46.014	1.164	2.078	46.014	3.669
8	1.127	2.012	48.026	1.127	2.012	48.026	4.091
9	1.090	1.946	49.972	1.090	1.946	49.972	7.203
10	1.035	1.849	51.821	1.035	1.849	51.821	3.856
11	.993	1.774	53.594				
12	.970	1.732	55.326				
13	.911	1.627	56.953				
14	.888	1.586	58.539				
15	.880	1.572	60.111				
16	.839	1.499	61.610				
17	.811	1.447	63.058				
18	.784	1.401	64.458				
19	.768	1.372	65.830				
20	.751	1.341	67.171				

Extraction Method: Principal Component Analysis.

Before extraction, 56 linear components within the data set were identified. The most important twenty factors are shown on table 4.3. There are ten (10) factors with eigenvalues above 1.0.They are the factors that should be retained. Before rotation, factor 1 explains 25.690% of total variance, factor 2 explains 5.812% of total variance, factor 3 explains 4.127% of total variance, and also factor 4 explains 3.445% of total variance up to factor 10 which explain 1.849% of the total variance). The table shows that the first few factors explain relatively large amounts of variance (especially factor1) whereas subsequent factors explain only small amounts of variance. After rotation, the total variance cannot be display, because when component are correlated, sum of squared loadings cannot be added to obtain a total variance.

4.4 Research Question Four

What are the factor loadings for each principal component after rotation?

Table 4.4 showing the factor loading of Mathematics attitude scale after rotation?

Table 4.4 Factor Loading of Mathematics Attitude Scale after Rotation

	Component									
	1	2	3	4	5	6	7	8	9	10
a1	.631									
109	.599									
111	.591									
85	.555									
110	.552									
82	.494									
83	.484									
86										
37		.728								
38		.684								
47		.590								
27		.583								
48		.450								
57		.448								
45		.413								
19										
72			.744							
71			.722							
70			.668							
60				.737						
62				.725						
61				.642						
59				.556						
55				.492						
58										
10					.650					
13					.606					
1					.567					
21										
20										
29						-.649				
30						-.590				
28						-.559				
51						-.411				
41										
50										
34										
44										
53							-.585			
54				.424			-.532			
46							-.403			
49										
98								.736		
101								.731		
114								.511		
96									.710	
94									.659	
92									.571	
95									.446	
89									.446	
90										
102										
87										
66										-.662
69										-.643
67										-.595

Extraction method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.
Rotation converged in 53 iterations.
Table 4.4. Shows the rotated component matrix (also called the rotated factor matrix in factor analysis) which is a matrix of the factor loadings for each variable onto each factor. There are several things to consider about the format of this matrix. First, factor loadings less than 0.4 have not been displayed. Before rotation, most variables loaded highly onto the first factor and the remaining factors didn't really get much loading.

Ten factors emerged after the Oblique rotation. The Pattern Matrix shows the factor loading on table 4.4 above. (Items that did not load on any of the factor were discarded). 43 attitude statements were identified after oblique rotation. Two pairs of the statements under factor one (1) overlap; one item out of each pair was retained. Also one item under factor six (6) is not directly related to the others. It was discarded. Thus the final scale has forty (40) items. The factors were named along with the test items that loaded on each factor.

Group Name and Description of Factor
The next step is to look at the content of questions that load onto the same factor and try to identify common themes.
Factor 1: Apathy towards Mathematics
1. I become unhappy when I am told to do Mathematics in my chosen career.
2. Any time I see Mathematics questions I feel unhappy.
3. I don't like reading Mathematics text or notebooks.
4. I will feel like not furthering my education because of Mathematics.
5. I will feel that I will not be able to get a good job or admission into higher institution if I am told that I need Mathematics in the chosen career or admission.

Factor 2 :Favourable disposition towards Mathematics
1. When I am expecting my Mathematics result I expect a high mark.
2. I feel that I will pass when expecting my Mathematics examination result.
3. I feel very happy during Mathematics lesson.
4. I feel very happy just before a Mathematics examination or test.
5. I feel like listening to my Mathematics teacher during Mathematics lesson.
6. I want my Mathematics teacher to come for the Mathematics classes.
7. I feel like sitting down in the front during Mathematics lesson

Factor 3: Impression about Mathematics teacher
1. My Mathematics teacher is too harsh.
2. My Mathematics teacher refuses to answer questions asked by the students during Mathematics lessons.
3. My Mathematics teacher's method of teaching is bad.

Factor 4: Activities not facilitating learning
1. I play with my friend during Mathematics lessons.
2. I chat with my friend during Mathematics lessons.
3. I copy my friend's note during Mathematics lesson.
4. I don't listen to my teacher during Mathematics lesson.
5. I feel like playing in the class when my Mathematics teacher does not come to the class.

Factor 5: Belief about Mathematics
1. People fail Mathematics because they do not make enough effort.
2. I know that I can never pass Mathematics except by mistake.
3. Mathematics is a very difficult subject.

Factor 6: Unwillingness to make effort
1. I feel like coping somebody's work during a Mathematics examination or test.
2. I feel like sitting at the back so as to copy from my note book during Mathematics examination or test.
3. When a Mathematics test or examination is approaching, I wish strongly that it will be cancelled.

Factor 7: Rejection of the Mathematics teachers
1. I feel so happy when my Mathematics teacher does not come to the class.
2. I feel like dancing when my Mathematics teacher does not come to the class.
3. I look forward to my Mathematics teacher leaving the class during Mathematics lesson.

Factor 8: Perseverance
1. When I am given a difficult Mathematics assignment, I look at related examples and try to solve the problem.
2. When I find a topic or assignment difficult, I find somebody to teach or explain it to me.
3. When a topic or exercise is difficult I look for a textbook that will enable me understand it.

Factor 9: Unwillingness to do assignments

1. When I am given a difficult Mathematics assignment, I copy the solution from my friend.
2. I do not do my Mathematics assignment if I find it difficult.
3. I copy from my friend when we are given Mathematics assignment
4. I am unhappy with my Mathematics teacher if I find my Mathematics assignment difficult.
5. I do my Mathematics assignments, but I do not submit them to the teacher when am supposed to

Factor10: Activities facilitating learning

1. I pay attention to my teacher during Mathematics lesson.
2. I ask question when I don't understand something during Mathematics lesson.
3. I answer the teacher's question during Mathematics lesson.

The correlation between the ten (10) factors is significant at α=0.000 (1-tailed). This table contains the Pearson correlation coefficient between all pairs of factors. This correlation matrix was use to check the pattern of relationships between the factors. The correlation between the factors ranges between 0.213 to 0.622 meaning that the factors correlate well, meaning that there exists relationship among the factors. In other word the items in the extracted factors are likely to be measuring the same trait.

4.5 Research Question Five

What are the convergent validity indices of the identified factors of the Mathematics Attitude Scale ?

Table 4.5 shows the Correlation analysis of sub-scale of Mathematics attitude scale

		factor1	factor2	factor3	factor4	factor5	factor6	factor7	factor8	factor9	factor10
Correlation	factor1	1.000	.397	.463	.484	.473	.521	.476	.611	.622	.333
	factor2	.397	1.000	.225	.360	.323	.360	.294	.432	.387	.617
	factor3	.463	.225	1.000	.373	.365	.314	.347	.363	.461	.213
	factor4	.484	.360	.373	1.000	.286	.469	.560	.401	.517	.343
	factor5	.473	.323	.365	.286	1.000	.350	.342	.375	.409	.267
	factor6	.521	.360	.314	.469	.350	1.000	.441	.349	.486	.294
	factor7	.476	.294	.347	.560	.342	.441	1.000	.375	.477	.265
	factor8	.611	.432	.363	.401	.375	.349	.375	1.000	.500	.396
	factor9	.622	.387	.461	.517	.409	.486	.477	.500	1.000	.341
	factor10	.333	.617	.213	.343	.267	.294	.265	.396	.341	1.000
Sig. (1-tailed)	factor1		.000	.000	.000	.000	.000	.000	.000	.000	.000
	factor2	.000		.000	.000	.000	.000	.000	.000	.000	.000
	factor3	.000	.000		.000	.000	.000	.000	.000	.000	.000
	factor4	.000	.000	.000		.000	.000	.000	.000	.000	.000
	factor5	.000	.000	.000	.000		.000	.000	.000	.000	.000
	factor6	.000	.000	.000	.000	.000		.000	.000	.000	.000
	factor7	.000	.000	.000	.000	.000	.000		.000	.000	.000
	factor8	.000	.000	.000	.000	.000	.000	.000		.000	.000
	factor9	.000	.000	.000	.000	.000	.000	.000	.000		.000
	factor10	.000	.000	.000	.000	.000	.000	.000	.000	.000	

a. Determinant = .022

4.6 Research Question Six:

Is the Mathematics attitude scale reliable?

Table 4.6 Reliability Coefficient of the final scale.

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.925	.925	40

Table 4.6 shows that the 40 items that constitute the sub-scale of Mathematics attitude scale are highly reliable. This shows that all the sub- scale of Mathematics attitude scale are reliable.

The final scale of Mathematics attitude scale is shown on appendix one. This final scale contained 40 items with 10 sub-scales.

5. Recommendations

Based on the findings in this study, the scale is recommended to be used to collect data on attitude towards Mathematics in Nigerian secondary schools. The scale can also be used by researchers in Education and psychology who may be willing to measure the attitude of secondary school students toward Mathematics.

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APPENDIX ONE

Table 4.7 FINAL SCALE OF MATHEMATICS ATTITUDE SCALE
INTERNATIONAL CENTRE FOR EDUCATIONAL EVALUATION
UNIVERSITY OF IBADAN, IBADAN.
SCHOOL: _____

SCHOOLTYPE: FGC ☐ **STATE SCHOOL** ☐ **PRIVATE SCHOOL** ☐

CLASS: _____ **SEX: MALE** ☐ **FEMALE** ☐

DIRECTION

The following statements are meant to find out your current attitude towards Mathematics. For each statement, choose the response that is closest to what you think or do. Put a tick ( ) against the option that best describe

you. Be as truthful as possible. There is no right or wrong answer.

Example:

	most of the time	half of the time	less than half of the time	almost never
I do not attend my Mathematics lesson				

If you do not attend your Mathematics lesson most of the time you will tick ‘‘most of the time’

No	Statement				
	Apathy towards Mathematics	Strongly Agree	Agree	Disagree	Strongly disagree
1	I become unhappy when I am told to do Mathematics in my chosen career				
2	Any time I see Mathematics questions I feel unhappy				
3	I don't like reading Mathematics text or notebook.				
4	I will feel like not furthering my education because of Mathematics.				
5	I will feel that I will not be able to get a good job or admission into higher institution if am told to do Mathematics in chosen career or admission.				
	Favourable disposition toward Mathematics	most of the time	half of the time	less than half of the time	almost never
6	When I am expecting my Mathematics result I expect a high mark.				
7	I feel that I will pass when expecting my Mathematics examination result.				
8	I feel very happy during Mathematics lesson.				
9	I feel very happy just before a Mathematics examination or test.				
10	I feel like listening to my Mathematics teacher during Mathematics lesson.				
11	I want my Mathematics teacher to come for the Mathematics classes.				
12	I feel like sitting down in the front during Mathematics lesson				
	Impression the about Mathematics teacher	Strongly Agree	Agree	Disagree	Strongly disagree
13	My Mathematics teacher is too harsh.				
14	My Mathematics teacher refuses to answer questions asked by the students during Mathematics lessons.				
15	My Mathematics teacher's method of teaching is bad.				
	Belief about Mathematics				
16	People fail Mathematics because they do not make enough effort.				
17	I know that I can never pass Mathematics except by mistake.				
18	Mathematics is a very difficult subject.				
	Activities not facilitating learning	most of the time	half of the time	less than half of the time	almost never
19	I play with my friend during Mathematics lessons.				
20	I chat with my friend during Mathematics lessons.				
21	I copy my friend's note during the Mathematics lesson.				

22	I don't listen to my teacher during Mathematics lesson				
23	I feel like playing in the class when my Mathematics teacher does not come to the class.				
	Unwillingness to make effort	most of the time	half of the time	less than half of the time	almost never
24	I feel like coping somebody's work during a Mathematics examination or test.				
25	I feel like sitting at the back so as to copy from my notes during Mathematics examination or test.				
26	When a Mathematics test or examination is approaching, I wish strongly that it will be cancelled.				
	Rejection of the Mathematics teachers				
27	I feel so happy when my Mathematics teacher does not come to the class.				
28	I feel like dancing when my Mathematics teacher does not come to the class.				
29	I look forward to my Mathematics teacher leaving the class during Mathematics lesson.				
	Perseverance	most of the time	half of the time	less than half of the time	almost never
30	When I am given a difficult Mathematics assignment, I look at related examples and try to solve the problem.				
31	When I find a topic or assignment difficult, I find somebody to teach or explain it to me.				
32	When a topic or exercise is difficult I look for a textbook that will enable me understand it				
	Unwillingness to do assignments	most of the time	half of the time	less than half of the time	almost never
33	I copy solution to Mathematics assignments from my friend if I find it difficult				
34	I do not do my Mathematics assignment if I find it difficult.				
35	I copy from my friend when we are given Mathematics assignment				
36	I won't be happy with my Mathematics teacher if I find my Mathematics assignment difficult.				
37	I do my Mathematics assignments, but I do not submit them to the teacher when am supposed.				
	Activities facilitating learning				
38	I pay attention to my teacher during Mathematics lesson.				
39	I ask question when I don't understand something during Mathematics lesson.				
40	I answer the teacher's question during Mathematics lesson.				

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