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# Development and Validation of a Self-concept and Attitude Scale for Senior Secondary School Students in Nigeria

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***Authors' contributions***

*This work was carried out in collaboration between both authors. Authors EBK and STK designed the study, wrote the protocol and author EBK supervised the work. Authors EBK and STK carried all statistical analysis. Authors EBK and STK managed the analyses of the study. Author STK wrote the first draft of the manuscript. Author STK managed the literature researches and Author EBK edited the manuscript. Authors EBK and STK read and approve the final manuscript.*

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## ABSTRACT

This study developed and validated a scale for measuring self-concept and attitude of secondary school students in Nigeria. The scale is a self-descriptive or self-report type of scale which was developed for the purpose of measuring students' self-concept and attitude toward mathematics at the senior secondary school level. The construction of the scale was done considering the generally accepted principles and procedures for scale development. At the initial stage of the development, a pool of 300 items was generated and after sorting them out and subjecting them to experts' judgment, 60 items emerged. The items were then administered on the sampled students from the population. The students' response scores were then subjected to item–total correlation analysis, Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test for cohesion of items. The items were also subjected to item – total analysis, intercorrelation analysis and factor analysis.

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At the end of all these processes, a 45-item finally emerged for the scale. The population of the study comprised all the Public and Private secondary school students in Northeast Nigeria. A sample of 960 students was obtained from 32 secondary schools from four of the six states of Northeast Nigeria using Multistage sampling techniques. Factor analysis confirmed the validity of the scale which includes the content and construct validity. The reliability of the scale was determined using Cronbach alpha with a high coefficient of 0.937. The instrument used for the study was the developed and validated scale titled "Mathematics Self-Concept and Attitude Scale (MSCAS)" designed in Likert's type. The students' response scores were analyzed and the hypotheses were tested at 0.05 level of significance. The result of the findings indicated that the instrument has valid psychometric properties; it is reliable, workable and is neither gender nor location biased. It was therefore recommended that the instrument be used for measuring secondary school students' mathematics Self-concept and attitude in Nigeria.

*Keywords: Development; self concept; attitude; scale; students and secondary schools.*

## 1. INTRODUCTION

The study of affective variables just like the cognitive variables has generated a lot of interest in schools in recent years. Because of their vital roles in general school process especially with regards to the teaching and learning of mathematics and many instruments for measuring them have been developed. Some of these affective variables include self-concept and attitude of students toward mathematics. For students to learn mathematics effectively, they have to develop positive self-concept and positive attitude such that they have positive feeling about themselves and about the subject and in fact other school subjects. Self-concept is very significant to psychologists and educationists because whatever an individual feels or thinks about himself/herself is very vital and it could be a strong determinant of his/her behaviour. Also, researchers in education have considered the word 'self' as an important psychological construct because it has been found to be both a cause and effect of academic achievement [1]. Mathematics self-concept, in the opinion of Reyes [2] is the perceptions of personal ability to learn and perform tasks in mathematics. Allport [3] defined attitude as ''a mental and a neutral state of readiness organized through experience exerting a directive or dynamic influence upon the individual's response to all objects and situations with which it is related.'' On the other hand, attitude towards mathematics have been defined by many people in different ways. Neale [4] defined attitude towards mathematics as *"an aggregated measure of a liking or disliking of mathematics, a tendency to engage in or avoid mathematical activities, a belief that one is good or bad at mathematics and a belief that mathematics is useful or is useless".*

The problem of poor performance of students in mathematics in secondary schools in Nigeria over the years has become persistent. This has become an issue of concern among stakeholders and researchers in the education sector. With the current trends in mathematics performance of secondary school students in the Nigeria, measuring their mathematics self-concept and attitude is necessary in order to know the effects of these affective variables and to help the children change their self concept and attitudes. This requires constant measurement using appropriate scale. For educators and teachers to measure the students' self-concept and attitude towards a subject like mathematics therefore, they have to employ the use of relevant scale(s). However, it is not enough to just state that teachers should help learners to have positive self-concept without knowing the right instrument to use and how to evaluate their students' self-concept in schools. There is therefore, a need to have a handy constructed and validated scale.

The construction and validation of measurement scales, the nucleus of Tests and Measurement, has become pivotal in identifying teachers and students who are not just theoretically good in mathematics but also have other personal attributes such as self-concept and attitude which are critical to their success on the general academic performance.

There are several researches carried out in the past on self-concept and attitude and scales were constructed in these regard such as Stakes [5]'s Six Factor Self-Concept Scale (SFSCS); Ezeilo (1988)'s Self-concept Scale; Chandradasa [6]'s Academic Self-concept Scale; modified Fennema-Sherman [7] Mathematics Attitude Scale (FSMAS) and Omirin [8] to mention but a few. Though a good number of those scales were extensively used,

they are however, done to measure the two variables separately. This study aims at developing a reliable and valid two–in–one scale that can measure both self-concept and attitude of students towards mathematics in Nigeria. This means, the two constructs when combined in a scale will reduce the challenges confronted by using two separate scales.

### Research Hypotheses

The following research hypotheses were generated and tested.

1. The scale will not be reliable.
2. The scale will not be valid.
3. There is no significant gender difference in the students' ratings on the scale.

## 2. METHODOLOGY

The instrument was the developed and validated using the internationally accepted procedures and principles for best practices [9-11]. The instrument was designed on a 4-point scale continuum with response options ranging from Strongly Agree (SA) to Strongly Disagree (SD).

The following procedure was followed in the development of scale:

- Defining the construct;
- Generating of items;
- Determining item response format to be adopted;
- Preliminary item development;
- Experts' judgment;
- Trial-testing of the resultant instrument;
- Administering the scale and subjecting the response scores to some analyses;
- Ascertaining the preliminary validity and reliability coefficients;
- Determining the standardization time;
- Determining the norms.

The Shevelson's model, attitude theories and Likerts summated rating scale were also considered in the development of the scale [12,13]. At the initial stage of the development, a total of 300 items were generated from literature, textbooks, teachers of mathematics and students. The items were carefully looked into through which the ambiguous or poorly stated ones were discarded and the similar ones merged leaving a total of 103 items. The 103 items were sorted out into categories of self-concept and attitude. These items were further subjected to experts' judgment by which 60 items (which comprised 30 on self-concept and 30 on attitude) were found to be worthy for measurement of self-concept and attitude. The items were then administered to a sample of 200 students from the population for trial - testing and the response scores were subjected various analyses. The items were subjected to different analyses including item–total correlation whose coefficients ranged from 0.12 to 0.58 which indicates homogeneity. Also, the items were subjected to factor analysis and the results of the correlation and factor analyses were used to sieve the items considered worthy for retained while the unworthy ones were deleted. Before adopting the factor analysis, Kaiser-Meyer-Olkin (KMO) and Bartlett's tests were done to establish the adequacy and suitability of the items. By the factor analysis which involved exploratory factor analysis (EFA) and confirmatory factor analysis (CFA and by the varimax-rotated component analysis it classified the instrument into subscales where items with eigenvalues greater than 1.0 were retained. In determining the number of items of factors, the varimax-rotated component and communalities for the subscales with item loadings from 0.30 to 0.75 were retained [14]. Thus, by these iterations, 45 items emerged which formed the final items of the scale.

### 2.1 Population and Sample

The population of the study consisted of all Senior Secondary School students in all the six states of Northeast Nigeria. Multistage sampling technique was used which includes stratified, purposive and simple random sampling techniques. A total sample of 960 Senior Secondary School students (SSSI–III) was randomly selected from 32 schools from four of the six states. In each of the sampled states, schools location, school type, school ownership, students' gender and age were considered.

### 2.2 Instrument

The instrument is made up of three sections with the first section on respondent's biodata while the other two sections (sections B and C) contains 45 items which comprises 23 items on students' mathematics self-concept and 22 on attitude towards mathematics respectively. The scale was titled 'Mathematics Self-Concept and Attitude Scale (MSCAS)'. The students were requested through the form of a survey to pick or

tick the best descriptor of their typical mathematics self-concept and attitude from the options for each item on the scale. The scale was designed in Likert's four-point type continuum of strongly agree (SA) to strongly disagreed (SD) which were rated 4, 3, 2 and 1 respectively. The data were analyzed using descriptive statistics for research questions and inferential statistics for hypotheses.

## 2.3 Administration of the Instrument

After the instrument was developed and validated, it was administered in each of the 32 sampled senior secondary schools in four of the six states in Northeast Nigeria with the help of some research assistants. The instrument was administered during normal class periods across the sampled schools. The respondents were given all the necessary guidelines and explanations to enable them respond appropriately to each of the sections of the instrument. Furthermore, after the instrument was administered, the copies were collected on the spot and those questionnaires that were returned empty or partially filled were discarded. Therefore, of the 960 students used, only 948 responded correctly and returned the questionnaire given to them.

## 2.4 Criteria for Item Retention

The following criteria were considered for item retention in the development process of the scale:

- Items that were considered significant on the correlation matrix.
- Those items that correlated from .30 to .75.
- Items with cut-off points within .39 and .63 depending on each subscale on the rotated-component matrix.
- Items that accounted for the reliability statistics also helped in establishing acceptable reliability coefficients of the subscale.

## 3. RESULTS

**Hypothesis One:** The Scale will not be reliable. After the items the scale was finally developed, the instrument was administered to the sample from the population. The students' response scores were subjected to Cronbach alpha (α) analysis and it yielded a high coefficient of 0.937. In order to further establish the stability of the scale, test–retest was carried out after an interval of two weeks and the response scores were analyzed using Pearson Product Moment Correlation Coefficient which also yielded a high coefficient of 0.914. Thus, indicating that the scale has high reliability. To further test the reliability of the scale, the calculation was per subscale.

Table 1 shows that the reliability coefficient of the final version of the scale is 0 .937 with a total number of 45 items indicating the high reliability of the scale.

**Table 1. Reliability statistics of the scale**

| Cronbach alpha coefficient | No. of items |
|---|---|
| .937 | 45 |

The analysis in Table 2 is the Cronbach alpha reliability coefficient of each subscale. The number of items per subscales is also indicated. All the subscales have high and moderate reliability coefficients with the exception of subscale 9 which is the "nature of mathematics" that has only .497 and is fairly okay. This further confirmed that the scale has a strong reliability.

**Table 2. Reliability per subscale**

| S/No. | Subscales | N | Reliability coefficients |
|---|---|---|---|
| 1 | Self-confidence | 10 | .871 |
| 2 | Value of mathematics | 6 | .801 |
| 3 | Mathematics Self-efficacy | 3 | .657 |
| 4 | Self-Adjustment | 4 | .632 |
| 5 | Interest in mathematics | 8 | .814 |
| 6 | Enjoyment of mathematics | 5 | .818 |
| 7 | Disposition to mathematics | 4 | .687 |
| 8 | Perception of the nature of Mathematics | 3 | .627 |
| 9 | Nature of mathematics | 2 | .497 |

**Hypothesis Two:** The Scale will not be valid.

## 3.1 Validity of the Scale

The process of the validity of the scale started with sorting and editing of the initially generated 300 items on self-concept and attitude and the experts' judgment mentioned earlier. However, in order to before embarking on other analysis, Kaiser-Meyer-Olkin (KMO) and Bartlett's tests

were first carried to establish the adequacy and suitability of the items respectively. The results of the KMO and Bartlett's tests were found to be appropriate and significant statistically significant at .000 levels.

Table 3, indicates that the Kaiser-Meyer Olkin(KMO test of sampling adequacy gave very high coefficients of .885 for the whole scale and .913 and .892 for self-concept and attitude aspects of the scale respectively. Also, the Bartlett's test was statistically significant at .000 levels.

After this, item–total correlation analysis was carried out and the coefficients ranged from low to medium values of 0.12 to 0.58 which indicates homogeneity of the items. Also, the validity of items was also established by calculating the interrelationships among items within the instrument. The intercorrelation matrix of the subscales was found to be statistically significant.

From Table 4, subscales 6 and 5, 1 and 2, 9 and 5 are highly correlated at 0.712, 0.737, and 0.795 respectively. This is also a proof of criterion and content validities and is in agreement with Holland (1959)'s opinion that the realistic and the investigative have to highly correlated. All the other subscales correlates significantly high.

The construct validity of the items was established by factor analysis through which the instrument was classified into nine subscales and items with eigenvalues greater than 1.0 were retained. The items that loaded from 0.30 to 0.75 were retained. Thus, by these iterations from the factor analysis, the construct validity of the scale was confirmed.

Table 5 is the extraction method with varimax-rotated component loadings of Kaiser Normalization. Initially, those items with factor loadings of 0.30 were retained for interpretation of the 45 items loaded for the 9 subscales which are four for self-concept and five for attitude towards mathematics. However, those items that loaded between .30 and .75 were retained. Though some degree of cross-loadings across other subscales occurred with some items of each of self-concept and attitude, items with higher loadings were retained and categorized as part of the scale. It should be known that the items retained were positive [14,16].

For the convergent validity of the scale, the response scores of the students on attitude items were correlated with the scores obtained using the popular Fennema-Sherman [7] modified Mathematics Attitude Scale (FSMAS) while the mathematics self-concept scores were correlated with the scores on Mathematics Self-Efficacy Scale (MSES) developed by Betz and [17] and they yielded high measures of 0.81 and 0.79 respectively.

**Hypothesis Three:** There is no significant difference between the ratings of male and female students on the scale.

Table 6 indicates that the $t = 1.230$, $df = 946$, $p = 0.219$; $p > 0.05$. By this analysis, it means that there is no significant gender difference in the ratings of the students on the scale. Thus, the scale is not sex biased.

## 4. DISCUSSION

From the results of this study, there are evidences that the scale is reliable as it yielded a high coefficient of 0.937 and also yielded Cronbach alpha coefficients of .871, .801, .657, .632, .814, .818, .687, .627 and .497 for each of the nine subscales. This finding is in agreement with the findings of Fennema-Sherman [7]; Marsh, Relich & Smith [18] and Yanica & Lu [19] where they found high reliability coefficients in their various scales. Also, it conforms to the statement of Kolawole [20] that a standardized test is said to have high reliability coefficient when it is within .80 and .90 and coefficients ranging from .50 to .70 are also considered reliable. Since the result of this finding are in consonant with this standardized test conditions, the scale therefore has a strong degree of internal consistency.

**Table 3. KMO and Bartlett's test of self-concept and attitude**

| | KMO 's measure of sampling adequacy | Bartlett's test of Sphericity | Significance |
|---|---|---|---|
| The whole scale | .885 | .000 | Sig. |
| Self-Concept | .913 | .000 | Sig. |
| Attitude | .892 | .000 | Sig. |

**Table 4. Intercorrelation matrix of the nine subscales**

| | B1 | B2 | B3 | B4 | B5 | B6 | B7 | B8 | B9 |
|---|---|---|---|---|---|---|---|---|---|
| B1: Self-confidence | 1.00 | | | | | | | | |
| B2: Value of math | .737** | 1.00 | | | | | | | |
| B3: Maths Self-efficacy | .464** | .485** | 1.00 | | | | | | |
| B4: Mathematics Self-Adjustment | .609** | .568** | .426** | 1.00 | | | | | |
| B5 Interest in Maths | .500** | .501** | .469** | .409** | 1.00 | | | | |
| B6: Enjoying Maths | .564** | .486** | .545** | .451** | .712** | 1.00 | | | |
| B7: Disposition to Maths | .436** | .395** | .415** | .380** | .562** | .540** | 1.00 | | |
| B8: Perception of the Nature of Maths | .364** | .409** | .365** | .289** | .527** | .536** | .474** | 1.00 | |
| B9: Nature of Maths | .348** | .340** | .290** | .202** | .795** | .538** | .447** | .399** | 1.00 |

*** Correlation is significant at the 0.01 level (2-tailed)*

**Table 5. Communalities and component - rotated matrix**

| Self-concept subscales | | | | | | Attitude subscales | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Items | Initial | Extractions per subscale | | | | Items | Initial | Extractions per Subscale | | | | |
| | | 1 | 2 | 3 | 4 | | | 1 | 2 | 3 | 4 | 5 |
| **B1** | 1.000 | .377 | .678 | .020 | .267 | **B24** | 1.000 | .129 | .659 | .450 | .076 | .030 |
| **B2** | 1.000 | .498 | .576 | .118 | .093 | **B25** | 1.000 | .134 | .307 | .718 | .116 | .001 |
| **B3** | 1.000 | .557 | .574 | .045 | -.009 | **B26** | 1.000 | .040 | .101 | .376 | .644 | -.030 |
| **B4** | 1.000 | .651 | .179 | .034 | .163 | **B27** | 1.000 | .243 | .163 | .730 | .246 | .026 |
| **B5** | 1.000 | .530 | .530 | .108 | .159 | **B28** | 1.000 | .092 | .629 | .232 | .230 | .081 |
| **B6** | 1.000 | .667 | .154 | .023 | .056 | **B29** | 1.000 | .417 | -.042 | .501 | .099 | .269 |
| **B7** | 1.000 | .053 | .657 | .417 | -.020 | **B30** | 1.000 | .635 | .004 | .330 | .180 | -.073 |
| **B8** | 1.000 | .724 | .152 | .070 | .273 | **B31** | 1.000 | .196 | .330 | .209 | .593 | .058 |
| **B9** | 1.000 | .116 | .571 | .208 | .262 | **B32** | 1.000 | .416 | .243 | .128 | .157 | .380 |
| **B10** | 1.000 | .667 | .153 | .144 | .154 | **B33** | 1.000 | .698 | .163 | .221 | -.003 | .167 |
| **B11** | 1.000 | .522 | .386 | .000 | .396 | **B34** | 1.000 | .420 | .422 | .169 | .372 | -.016 |
| **B12** | 1.000 | .516 | .117 | .113 | .558 | **B35** | 1.000 | .518 | .543 | .096 | .121 | -.032 |
| **B13** | 1.000 | .527 | .171 | .383 | .115 | **B36** | 1.000 | .515 | .415 | .096 | .004 | -.020 |
| **B14** | 1.000 | -.068 | .388 | .101 | .708 | **B37** | 1.000 | .664 | .142 | .119 | .332 | -.012 |
| **B15** | 1.000 | .651 | .153 | .189 | .108 | **B38** | 1.000 | .502 | .402 | .069 | .279 | .054 |
| **B16** | 1.000 | .412 | .385 | .190 | .105 | **B39** | 1.000 | .256 | .627 | .214 | .108 | .205 |
| **B17** | 1.000 | .197 | .434 | .226 | .370 | **B40** | 1.000 | .244 | .103 | -.014 | .732 | .180 |
| **B18** | 1.000 | .364 | .224 | .067 | .409 | **B41** | 1.000 | .480 | .431 | .126 | -.045 | .325 |
| **B19** | 1.000 | .196 | -.042 | .262 | .643 | **B42** | 1.000 | .182 | .699 | -.109 | .229 | .018 |
| **B20** | 1.000 | .171 | .112 | .742 | .230 | **B43** | 1.000 | .483 | .259 | -.023 | .238 | .192 |
| **B21** | 1.000 | .337 | .147 | .635 | .045 | **B44** | 1.000 | -.006 | .021 | .048 | -.138 | -.832 |
| **B22** | 1.000 | .603 | .118 | .304 | -.009 | **B45** | 1.000 | .119 | .442 | .276 | -.099 | .507 |
| **B23** | 1.000 | -.015 | .184 | .673 | .150 | | | | | | | |

**Table 6. Summary of t-test analysis of MSCAS scores of secondary school students based on gender**

| Gender | N | Mean | S.D | df | t | Sig. (2-tailed) |
|---|---|---|---|---|---|---|
| Male | 504 | 135.36 | 18.309 | | | |
| Female | 444 | 136.80 | 17.458 | 946 | 1.230 | 0.219 |

*P>0.05*

On the aspect of validity, the study revealed that the scale has content, construct and criterion-related validity. The convergent validity of the scale was established by correlating the students' mathematics attitude scores with the scores on the popular 47-item Fennema-Sherman [21] Mathematics Attitude Scale (FSMAT) and modified in 1997 while the mathematics self-concept scores were correlated with those obtained on a 53-item Betz and Hackett (1983) Mathematics Self-Efficacy Scale (MSES) and they yielded significant positive relationships($r = 0.83$, $p<0.05$ and $r = 0.79$, $p<0.05$ respectively). From the analysis of the

students' response to the scale based on gender, it was found that the scale is not sex biased. This implies that the issue of gender does not have influence on self-concept and attitude ratings. This is in line with findings of Obidigbo [22], Uguma & Akpama [23] and Olorungbemi [24]. Also, it is line with Patwardhan [25] who reported non existence of significant gender difference on the influence of mathematics on students' self-concept and attitude in Eritrea. However, the findings of Mboya [26] and Barbara [27] in Olorungbemi, 2008) found that there were significant gender differences in students' self-concept.

## 5. CONCLUSION AND RECOMMENDATIONS

Based on the Scale developed and the findings of this study, the following conclusions were drawn:

i. The scale is valid, reliable, workable and suitable for use;
ii. The scale is capable of determining students' self-concept and attitude to mathematics at the secondary school levels;
iii. There is significant correlation between self-concept and attitude;
iv. The scale is workable and suitable for use among large samples.

It is therefore recommended that the scale could be used by teachers for measuring or determining students' self-concept and attitudes towards mathematics at the secondary school levels in Nigeria. It could also be useful to researchers in education and educational psychologists who may wish investigate personality and other behavioural traits among secondary school students especially as it relates to school subjects. Furthermore, the scale will be useful for academic career guidance and counseling.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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