

CONSTRUCTION AND VALIDATION OF MATHEMATICS ACHIEVEMENT MOTIVATION SCALE (MAMS) FOR SENIOR SECONDARY SCHOOL STUDENTS IN NIGERIA

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Abstract

In consideration of the importance of Mathematics and the desire to alleviate the rate of failure in the subject, this study set out to construct, establish the validity and reliability of the Mathematics Achievement Motivation Scale (MAMS). A self-report instrument was designed for use among senior secondary school students in Nigeria using a survey design. The respondents were randomly selected among Senior Secondary School two (SS 2) from the six geo-political zones in Nigeria. The reliability of the instrument was measured using Cronbach's Alpha which was reported to be 0.89, the reasonable factorability of the entire items of MAMS provided adequate basis for empirical examination using Kaiser-Meyer-Olkin (KMO) and Bartlett's Test of Sphericity which also confirmed high validity. The KMO measure of sampling adequacy was 0.87, which was above the recommended value of .6 was also significant at $X(1219) = 5.807, P < 0.05$. The extracted factors of the eigenvalue after the ratios, contributed about 84.38% of factors required to explain the items. The communalities ranged between .651 and .859 in which each item showed the degree of common dimension of the items while the factors loading ranges between .666 and .877. The instrument correlated well with Mathematics Motivation Scale and Mathematics Achievement Test at 0.94 and 0.89 respectively connoting high criterion and predictive validities. The two hypotheses were tested at 0.05 level of significance and the implementation of the use of this instrument in Nigerian secondary schools will drastically reduce the rate of failure in Mathematics because it is both diagnostic and prognostic.

Keywords: Construction, Validation, Achievement Motivation.

Introduction

Learning involves a relatively durable change in behaviour especially in the classroom setting (Ilogu, 2005). Mathematics is a core subject that requires that all students at both primary and secondary must qualitatively learn. Though, there are many variables which often

influence these changes and these include learning environment, teachers' instructional methods, learning strategies, students' expectation of their own performance, expectation of parents, attitude towards learning, determination to succeed, achievement motivation among others. Among these variables, the motivational ability inherent in the individual is of paramount importance (Weiner, 1999). The achievement motivated students therefore seek achievement attainment of realistic but challenging goals and advancement in school subjects like Mathematics to enable them actualize their dreams in life.

Studies have shown that some people are highly motivated to succeed and expend considerable effort striving to excel. For instance, Kanu Nwankwo, a Nigerian footballer whose remarkable recovery from heart surgery was capped by being voted as African footballer of the year and the British Broadcasting Corporation's (BBC) African Footballer of the year (BBC Sport 1999) Jon Krakauer, an American whose laborious and grueling effort to reach the summit of Mount Everest in May 1996 despite the death of some other contestants, Sampson Davis, Rameck Hunt and George Jenkins also exemplified their desire to achieve and thereby strove to become doctors (Passer & Smith, 2004). Although, most students are keenly aware of society's emphasis on achievement, whether in academics, sports, music or other fields through personal effort and abilities to attain their goals, individuals differ in their achievement motivation. Those who are not as motivated to succeed do not work as hard to achieve. Weiten (2007) asserts that achievement motivation involves the need to excel, especially in competition with others. He also opined that people who are relatively high in need for achievement work harder and more persistently than others.

Studies such as Shah (1988), Pintrich, Smith, Garcia and McKeachie, (1991), Friedland, Mandel and Marcus (1996), and Stroud & Reynolds (2005) attempted to derive some instruments to measure achievement motivation. The need to measure achievement motivation in students cannot be overemphasized as this is a crucial exercise that needs adequate attention in order to enhance students' performance. A leadership-oriented teacher sets challenging goals, has high expectations of students, and displays confidence that students will assume responsibility and put forth extraordinary effort. The process of measurement involves cogent variables. These include among others the characteristics of achievement motivated students, locus of control, efficacy, attitude of teachers, parental expectation and the expectation of the students. Omoegun (1995) identified the home and family background as a major cause of maladaptive behaviours, while discussing adolescent crises, hence the relevance of parental expectation as part of the background variables measured in this research. Measuring achievement

motivation is relevant in many areas such as pre-assessing of abilities, monitoring learning process, diagnosing learning difficulties, supplying information to parents and selection of students for purposes like quiz, debate, sport, promotion, class type placement and awards, among others.

Many policies and programmes such as the National Policy on Education (NPE), emphasize the importance of Science, Technology, Engineering, and Mathematics Education (STEM) to the national development (Fafunwa, 2004). The 60:40 admission ratio is in favour of Science and Information Technology (Effiom, 2008), the Vision 20-20 of the Millennium Development Goals (MDGs), the Seven Point Agenda of the late President Musa Yar'Adua, and Education for All (EFA) were all borne out of the same concern (Danmole, 2011). Now the Sustainable Development Goals (SDGs) otherwise known as Global Goals and other contemporary policies are still in line with these aforementioned. Therefore, the students need to develop the need to achieve in preparation to answer the universal call.

Mass failure in Mathematics in Nigerian schools in the past thirteen years as seen in Table 1 has been a source of concern to both government and stakeholders in the educational sector nationwide (WAEC, 2017). This research focuses attention on the experiences of students in Mathematics as a result of serious challenges it generates to research in this part of the world. As a way of suggesting a possible solution to this national problem which, particularly, is challenging the proficiency of Mathematics teachers in the educational sector, this research is intended to investigate the assertion that virtually all Nigerian students do not know that it takes goal-setting to succeed, and that it takes motivation to achieve every set goal. This is probably because their level of achievement motivation has not been measured as their both formative and summative tests usually measure their cognitive strength only

Table 1: Percentage of Failure/Pass in Mathematics 2005 - 2017 across Nigeria

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
%Failed	63.94	65.94	63.09	65.48	61.31	55.88	58.88	53.15	66.91	74.01	60.43	69.30	61.19
%Passed	36.06	34.06	36.91	34.69	38.69	44.14	41.12	46.85	33.09	25.99	39.57	30.70	38.81

Source: WAEC Report 2017

In spite of the obvious importance of the measuring instrument of achievement motivation that is both diagnostic and prognostic for successful performance, the use of such measurement tools appear not to be inexistence in schools in Nigeria hence the need to construct and validate an instrument that can measure the achievement motivation of Senior Secondary Students

especially in Mathematics. The construction and validation of the instrument could assist in exploring some of the major reasons behind mass failure in Mathematics which in turn could assist in proffering a lasting solution to the problem through the early use of the measuring instrument.

The study was based on the following theoretical framework:

- Achievement Motivation Theory (McClelland, 1955)- McClelland's theory of achievement motivation states that a person's tendency to approach a task (effort) is a function of the strength of the achievement need, the strength of the need to avoid failure, the person's subjective belief about the possibility of success or failure, and value of the incentives associated with either success or failure.
- Theory of Motivation (Maslow, 1943)- Maslow (1943) stated that people are motivated to achieve certain needs. When one need is fulfilled, a person seeks to fulfill the next higher one, and so on
- Social Cognitive Theory (Bandura, 1997) The Social-cognitive theory of Albert Bandura (2001), states that behaviour, environment, and person/cognitive factors are important in understanding personality.
- Expectancy Value Theory (Fishbein, 1975)- Expectancy Value theory states that a person's behavior is determined by how much a goal is valued, and by the degree that the person expects to succeed.
- Realistic Mathematics Education Theory (Freudenthal, 1991)- Realistic Mathematics Education (RME) theory of Freudenthal states that Mathematics must be connected to reality and human activity

These theories representing major frameworks in achievement motivation have been developed over the decades. These theories also share a common social-cognitive heritage. Social-cognitive theories examine cognition and behaviour (e.g., attributions, expectancies, purposes, perceived needs, capacities, and vulnerabilities) that are contextually located and influenced. This does not imply that the place of achievement motivation instrument is explicit and central in each theory. However, when it comes to operationalizing the theories in achievement motivation research, there is often a clear relevance for the importance of Mathematics which cannot be over-emphasized and the environment in which the learner finds self. The drive that propels the student to achieve may centre on the value placed on mathematics by the students, the expectation of success is inevitable and all the aforementioned variables are embedded in the theories in one way or the other,

The study was guided by the following hypothesis:

- To what extent is the internal consistency in the scores of students in Mathematics Achievement Motivation Scale (MAMS) significant?
- What is the level of significant coefficients of concurrent validity when Mathematics Achievement Motivation Scale (MAMS) is correlated with Mathematics Motivation Scale (MMS)
- To what extent is the predictive validity of the Mathematics Achievement Motivation Scale (MAMS) on Mathematics Achievement Test (MAT) significant?

Method

The research design used in this study was an instrumentation design and it is subsumed in descriptive survey design. According to Kerlinger (1986), “survey design is the study of large and small population (universe) by selecting and studying samples chosen from the population to discover the relative incidence, distribution and interrelations of sociological and psychological variables”. This study covers all the six geo-political zones in Nigeria, hence it is appropriate because of the large population of senior secondary two students that are involved in this study.

The target population for this study comprised all the 1, 429, 435 Senior Secondary Two (SS II) students in public co- educational schools within the six Geo-Political zones of Nigeria

The sample for the main study comprised 1,219 SS II students drawn from all the six geo-political zones of Nigeria. Multistage sampling method was adopted for this study. First, simple random sampling was used to select three states from each zone. Thereafter, one Local Government Area (LGA) was randomly selected from each of the three states while a town was also randomly selected from each LGA. Finally, one co-educational school was randomly selected from a District or Educational zone of each town while stratified random sampling was employed in selecting Senior Secondary Two (SSII) students according to their gender and class type from each selected mixed school.

Three research instruments were used in this study for data collection:

- The Mathematics Achievement Motivation Scale (MAMS) which was constructed by the researcher used a Likert-Scale response format.
- The Mathematics Motivation Scale (MMS): was validated by Eric Zhi, Feng Liu and Chan Hung (1991). The scale was developed based on the theoretical framework of Social Cognitive Model of Motivation but was adapted for this study.

- The Mathematics Achievement Test (MAT) was constructed by the researcher based on over twenty year Mathematics teaching experience. The items were based on the first four domains of cognition; the content was selected based on the table of specification and also through item analysis.

Result

Table 2: Mean, Standard Deviation and Reliability of MAMS

Mean	Standard Deviation	Variance	No of Items	Cronbach Alpha
91.53	10.21	104.25	30	0.89

Table 2: shows the result of the statistical test of the reliability of Mathematics Achievement Motivation Scale (MAMS). It was found that the 30 items of the MAM scale has a Cronbach's alpha Reliability Coefficient of 0.89 which was an improvement on the pilot study where the first eighty-four item instrument had 0.79 at .05 level of significance. This high coefficient value indicates that each dimension of MAMS has sufficient internal consistency. Therefore, there is significant internal consistency of 0.89 in the scores of students in Mathematics.

Table 3: Correlation between MAMS and MMS

Variables	N	Mean	SD	r cal	r _c
MAMS	1219	91.53	10.33	0.94	0.062
MMS	1219	91.51	10.29		

* Significant, $p < 0.05$

Table 3 shows MAMS mean(x) score of 91.53 which is higher than that of the MMS mean(x) score of 91.51. The result of the Pearson product moment correlation coefficient shows that the calculated r-value of 0.94 is greater than the critical r-value of 0.062 at 0.05 significance level.. This means that scores of the participants in Mathematics Achievement Motivation (MAMS) significantly and sufficiently yielded high coefficient of concurrent validity with the scores in MMS. In addition, the MAMS which is the dependent variable while MMS, a validated instrument is the criterion correlate well at 0.94 implies that $R^2 = .88$, this also ascertain the higher validity of the MAMS. Therefore, there is significant coefficient of concurrent validity when Mathematics Achievement Motivation Scale (MAMS) was correlated with Mathematics Motivation Scale (MMS)

This was first computed before using SPSS to compute the means and standard deviations of both variables from the total scores. Hence, Pearson Product Moment Correlation statistic method was used to determine whether a relationship existed between the two variables. The result of the analysis of the first part data is presented in Tables 9 and 10

Table 4: Relationship between MAMS and MAT Scores

Variables	Mean	Std. Deviation	N	r-cal	r _c
MAMS Score	61.53	10.33	1219		
				0.89	0.062
MAT Score	58.46	12.21	1219		

* Significant, $p < 0.05$

Therefore, there is significant predictive validity of the MAMS on the MAT scores.

Table 5 Descriptive Statistics and Pearson Correlation Analysis

MAMS	MMS	MAT	
MAMS	1		
MMS	0.94**	1	
MAT	0.91**	0.89**	1

** . Correlation is significant at the 0.05 level.

Table 5 presents the result of the Pearson Product Moment correlation of the instruments. That the r-calculated values of 0.94, 0.89, and 0.91 were obtained at 0.05significance level. Also, it is observed that higher scores in achievement motivation led to increase in achievement in Mathematics. This implies that is the predictive validity of the Mathematics Achievement Motivation Scale (MAMS) on Mathematics Achievement Test (MAT) is very significant.

Discussion

The study was out to construct and validate a measuring instrument that can measure the achievement motivation of Nigerian secondary students in Mathematics. The following are the highlights of the findings of the research.

The scores of the participants in the Mathematics Achievement Motivation scale (MAMS) yielded significant internal coefficients with Cronbach Alpha 0.89 at 0.05 significant levels. DeVellis (1991) posited that an alpha below 0.60 is unacceptable; 0.60–0.65 undesirable, 0.65–0.70

minimally acceptable; 0.70–0.80, 0.81 – 0.90 very good and if much above, 0.90 excellent, It was discovered that having used six of the De Vellis (1991) guidelines among others, the instrument was found to be reliable and valid. The item discriminability which determines whether the students who have done well in particular items have also done well on the instrument as a whole was good as this was evident in this study. This MAMS measured the degree to which the test items are homogenous, that is, measuring the same things, talents or skill (Mathematics) as asserted by Ilogu (2005).

In factor analysis, dependent variables are manifest or observed variables linearly dependent on a set of latent unobserved independent variables (Ilogu, 2005). A measuring instrument can be reliable without being valid, but it cannot be valid unless it is first reliable (Ary, Jacobs & Sorensen 2010). The concurrent validity of Mathematics Achievement Motivation scale (MAMS) and Mathematics Motivation Scale (MMS) was significant. The scores of the participants in the MAMS yielded significant high coefficients of concurrent validity when compared with MMS. The correlation coefficient between the two instruments was 0.94 at 0.5 significant levels.

Validity, which is the development of sound evidence to demonstrate the test interpretation (of scores about the concept or construct that this MAMS has measured) matched the proposed use (AERA, APA, NCME, 1999). Therefore, the focus of validity emphasized *evidence* and *use* of this instrument rather than types (Thorndike, 1997). Validity is the degree to which all evidence point to the intended interpretation of test scores for the proposed purpose. Thus, a focus is on the consequences of using the scores from an instrument (Hubley & Zumbo, 1996; Messick, 1980). This is a generic term associated with a number of multivariate statistical methods that model sets of manifest or observed variables in terms of linear functions of latent unobserved variables (Mulaik, 1987).

The degree of correlation between the scores of the students in both MAMS and MAT confirmed the predictive validity of the MAMS instrument which implies that an instrument measuring the trait “achievement motivation” has shown to predict that high scorers work more independently, persist longer on problem-solving tasks, and do better in competitive situations than low scorers. This corroborated the assertion of Weiner (1992) that the achievement motivated students want and expect to succeed. When they fail, they redouble their efforts until they succeed. Not surprisingly, students who are high in achievement motivation tend to succeed at school tasks (Stipek, 1993). Attitude of students towards correction confirmed Fodor and Carver (2000) that achievement motivated people to handle negative feedback about task performance more effectively than others. Bank

and Finlapson (1980) found that successful students were found to have significantly higher motivation for achievement than the unsuccessful students. Johnson (1996); Broussard and Garrison (2004); Skaalvik and Skaalvik (2004); Skaalvik and Skaalvik (2006) and Sandra (2002) in their respective studies discovered significant relationship between achievement performance and motivation.

With respect to motivation, a behavioural theorist might focus on the degree to which students learn to do schoolwork to obtain desired outcomes (Bandura, 1986; Weielkiewicz, 1995; Sprintal (2006). Kushman, Sieber and Harold (2000) opined that high motivation and engagement in learning have consistently been linked to reduced dropout rates and increased levels of students' success. Also, high achieving individuals monitor their own learning and systematically evaluate their progress towards their goals more than low-achieving individuals (Zimmerman & Schunk, 2001). In 2007, Ilogu also asserted that teachers should emphasize achievement motivation for students in any learning situation because students with high achievement motivation perform better than those that are not really motivated to achieve.

The strong relationship between expectations and academic achievement has been well established both theoretically and empirically (Johnson, Livingston, Schwartz, and Slate, 2000; Marzano, 2003). Summarily, an instrument measuring the trait "achievement motivation" has shown to predict that high scorers work more independently, persist longer on problem-solving tasks, and do better in competitive situations than low scorers.

Recalling the purpose of the study therefore, namely to construct and validate an assessment instrument to enhance achievement scores in Mathematics has been made manifest. This should contribute to the effort being made through the Nigeria Policy on Education to attain its goal. The need for assessment instrument seems global as Garden (2003) in his "Development of TIMSS Performance Assessment Tasks", asserted the need to focus on educational policies, practices, and outcomes in order to enhance mathematics and science learning within and across systems of education by Beaton, Mullis, Martin, Gonzalez, Kelly, & Smith (1996). This has also been corroborated by this study.

Conclusion

In consideration of the forgoing, it is concluded that this Mathematics Achievement Motivation Scale (MAMS) is reliable and has both concurrent and predictive validity.

Recommendation

1. This instrument is recommended for use in all senior secondary schools for both diagnostic and prognostic purposes.
2. Orientation programs should be organized to motivate students to achieve at the beginning of each academic year
3. Every student should have expectation as regards Mathematics grades by determination which is major factor in achievement motivation

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