MUKHTAR ALHAJI LIMAN
MUHAMMAD BURHAN IBRAHIM
SHITTU, AHMED TAJUDEEN

Abstract

The use of Exploratory Factor Analysis (EFA) on researches based on certain theoretical frame-works in both social sciences and education cannot be over-emphasized, as such this study employed the Exploratory Factor Analysis (EFA) in an attempt to validates the mathematical values inculcation measurement model developed and used in the western cultural society by Professor Emeritus Alan J. Bishop, in order to see whether the model works among secondary schools' mathematics teachers in the north-eastern part of Nigeria with aim of finding whether or not the model also suit the north-eastern cultural community to which schools' mathematics teaching and learning is also paramount. The preliminary sample size for the study is (n=101) secondary schools' mathematics teachers' that are involved in the study. The instrument for the data collection was a 40-item Questionnaire with some of the items designed and adopted. The factor extraction method was a Principle Component Analysis (PCA) and only factors with eigenvalues >1 were extracted and three factor solution was realized. Twenty one items loaded on the three factors, with eleven items on the first factor (sociological mathematical values (SMV)), five items on the second factor (attitudinal mathematical values (AMV)) and lastly five items on third factor (ideological mathematical values (IMV)). The reliability of each factor was greater than 0.6 and the overall reliability of the three factor solution converges at 0.636. The total variance explained was 54.3% and Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) was found to be 0.850 which was greater than the required merging of 0.6. The purpose of this study is to validate mathematical values inculcation model with three main construct, which include: sociological mathematical values (SMV), attitudinal mathematical values (AMV) and ideological mathematical values (IMV) among mathematics teachers' in the north-eastern cultural society of Nigeria and at the same time acquaint secondary schools' mathematics teachers' the need for the inculcation of mathematical values in mathematics teaching and learning with sole objective of enhancing better understanding of mathematical concepts.

Keywords: Exploratory Factor Analysis, Validation , Mathematical Values, Inculcation Model, Secondary Schools, Mathematics Teachers , North-Eastern Region, Nigeria

INTRODUCTION

The role of values in mathematics teaching and learning cannot be over-emphasized in the sense that for a successful mathematics teaching and understanding of mathematical concepts, mathematical values inculcation in the course of mathematics teaching plays a vital role and should be imbibed by every mathematics teacher. The contemporary discipline of mathematics has been developed over millennia to incorporate a rich history and tradition that draws on the work of many societies and cultures (Lancaster,2010). The aspects of mathematics developed, the way mathematics was regarded, and the approaches to working mathematically have also varied across these societies and cultures, and changed over time (Lancaster,2010). In some societies and cultures knowledge of mathematics and its applications has been the province of an elite class of philosophers, priests or scribes, in others merchants and explorers, in yet others scientists and industrialist (Lancaster, 2010).

It can be deduced that, the conception of values in mathematics differ from one society to another and at time from one culture to another, as such there is an increasing demand for the mathematics teachers to know better the learners societal norms and values and their cultural

affiliations, this will enable them to inculcated the desirable and needed mathematics values based on the need and aspiration of society and culture where they came from. In many societies and indeed in contemporary Nigerian society, strong numeracy is expected of all adolescents, and a sound mathematical background is an essential requirement for many pathways of further study and it is a required as part of the compulsory years curriculum for senior secondary school students in the late adolescents years of schooling (Lancaster,2010). This poses challenges to mathematics teachers as to have tried to over-come through knowing the values they are teaching in mathematics classroom and the purposes to which mathematics is being a subject of study.

LITERATURE REVIEW

The research field of values in schools' mathematics teaching and learning has been conceptualized in explicit ways and developed since the late 1980s by Alan Bishop and stated that, there is need for the academic community to bring together considerations of mathematics teaching and values education if we are to teach mathematics successfully for democracy, and also argued that both considerations of education for democracy and of making school mathematics more relevant to the demands of everyday living involve the teaching and inculcation of values to students (Bishop,). In Bishop's views, "values in mathematics education are the deep affective qualities which education fosters through the school subject of mathematics. They appear to survive longer in people's memories than does conceptual and procedural knowledge, which unless it is regularly used tends to fade" (Bishop, 1999, p. 2).

(Bishop, 1988) in (Bishop, et'al, 2010), noted that, human beings everywhere and throughout time have used mathematics and mathematics typically can be observed as behaviors illustrating the following six "universal" activities (i.e. every cultural group does them): counting, measuring, locating, designing, explaining, and playing. These behaviors are reflective of the culture of the people demonstrating them and are inexorable influenced by what that cultural group values.

As a result of demands that students become more economically oriented and globally conscious, mathematics educators are being challenged about which values should be developed through mathematics education and the major concern is that, although values teaching and learning inevitably happen in all mathematics classrooms, they appear to be mostly implicit (Bishop,et'al,2010).

More-over, in the modern knowledge economy, societies are demanding greater mathematical and scientific literacy and expertise from their citizens than ever before and at the heart of such demands, there is need for greater engagement of students with school mathematics and science (Bishop,2008). The organization for economic co-operation and development (OECD) and the program for international students' assessment (PISA) put forward the definition of numeracy as:

> " *Mathematical literacy is an individual's capacity to identify and understand the*
> *role that mathematics plays in the world, to make well-founded judgments and to use*
> *and engage with mathematics in ways that meet the needs of that individual's life as*
> *a constructive, concerned and reflective citizen" (OECD, 2003).*

As a result of that, there is an ever increasing demand for mathematical values inculcation in a more explicit ways so that the learners of mathematics can realize and appreciate the beauty aspect of learning school mathematics as a subject of study and contribute meaningfully to the betterment and development of the societies to which they were belong. From above analysis, it has been established that, successful mathematics class should be one that, which mathematical values are portrayed in an explicit manner to the extent that the linkages between mathematical

concepts and its usefulness or application to the learners' immediate environment exhibited high degree of comprehensiveness.

(Bishop,1999) reiterated the earlier conception of mathematical values in (Bishop,1998, p. 3) regarding the different groups into which values in the mathematics classroom in the western world might be categorized and stated that, the three interrelated sources of values which permeate mathematics classrooms are: the general educational, mathematical, and specifically mathematics educational. Initial analyses from other studies of mathematical values, which reveal that there are three kinds of values which teachers intend to teach: the general educational, mathematical, and mathematics educational.

Currently, there is little knowledge about what values teachers are teaching in mathematics classes, and how mathematics teachers are aware of their own value positions (Bishop, 1998). In addition to how these affect the teaching of mathematics, and how their teaching thereby develops certain values in mathematics learning (Bishop,et'al,2010). Values are rarely considered in any discussions about mathematics teaching, and a casual question to teachers about the values they are teaching in mathematics class, often produces an answer to the effect that they don't believe they are teaching any values (Bishop,et'al,2010).

Therefore, values in mathematics education as discussed above, are conceptualized as the deep affective qualities which mathematics teachers promote and foster through the school subject of mathematics teaching and learning and the theoretical frame-work of this study is based on the six values cluster model developed by Professor Emeritus Alan J. Bishop 1988. It is important to note that, the emphasis in most of the researches conducted by the author were not primarily on which values might be, are, or, should be, emphasized in mathematics education, but rather on the development of mathematics as a subject of study throughout western history.

From the above we can deduce that for effective transmission of mathematical values in mathematics education classes, there is need for growing awareness about what kind of values mathematics teachers are fostering in mathematics teaching and learning and its relationship to the understanding of the contemporary mathematical issues outside the school setting. See below the conceptual model of mathematical values inculcation.
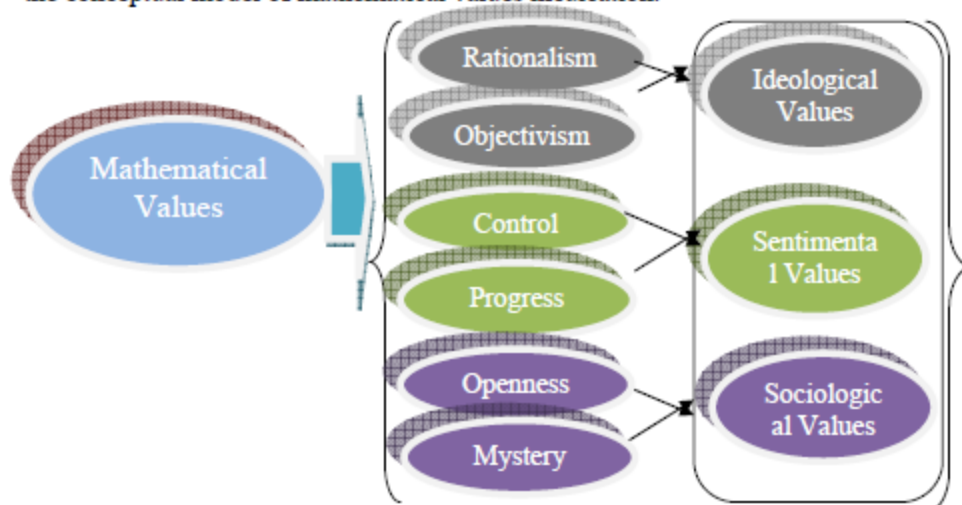
Figure 1

AIMS OF THE STUDY

The study's aims (1) to identify whether or not mathematics teachers inculcate mathematical values in mathematics teaching and learning processes; (2) to explore whether or not mathematics teachers are aware of the existing concept of mathematical values inculcation model in mathematics classroom. The findings will provide useful information for mathematics teachers' on the ways to improve mathematics teaching and learning processes through the understanding of mathematical values that could make the teaching of mathematical concepts real, free from any ambiguity and appreciable by the mathematics learners. It will also going to benefit curriculum planners/designers, text book writers on the ways that mathematics curriculum should explicitly dictate the components of mathematical values attached to each module, units and sub-units of mathematics syllabus for the easy conveyance by mathematics teachers'.

METHODOLOGY
INSTRUMENT

A self-administrated questionnaire survey containing 40-items on mathematical values inculcation based on the six cluster model of the three constructs of mathematical values was used to assess 150 secondary schools' mathematics teachers' in the north eastern region of Nigeria, out of which the preliminary sample size for this study was (n=101) of mathematics teachers' teaching in various secondary schools in the north-eastern region of Nigeria. The Statistical Package for Social Sciences (SPSS version 17.0) computer software was used for data analysis. The 40 item questionnaire, 80% of the item in the questionnaire were adopted with only 20% were constructed by the authors based on the six cluster model for mathematical values inculcation (Bishop,1998). As result of that, the exploratory factor analysis (EFA) was used to investigate the mathematical values inculcation model based on the three components of the model: sociological, attitudinal, and ideological mathematical values by the measure in order to provide preliminary evidence of reliability and validity. The results of the pilot study consistently indicated that the measure described, were relevant and culturally appropriate for this population.

POPULATION AND SAMPLE

The population of the study comprises all secondary schools mathematics teachers' from both junior and senior secondary schools in the north-eastern part of Nigeria. But due to the time constrain and limited number of days for my vacation was unable to cover the area under-study. Furthermore, purposeful Sampling technique was adopted this was because not all secondary schools teachers' teaches mathematics as a subject. One hundred and fifty questionnaires were distributed in thirty secondary schools, twenty senior secondary schools and ten junior secondary schools with the sub-region, out of which (101) which constituted 70% of the questionnaires were returned and as such the sample size was considered in this study as the preliminary sample size, as the collection of data is still ongoing. The data were collected by the researcher and with the assistance of some of the colleagues whom we were teaching together in secondary school before leaving to the University of Maiduguri, Nigeria. The researcher sought the permission of the principals of the secondary schools visited for the purpose of data collection for the study.

MEASUREMENT DEVELOPMENT

The respondents completed a personal survey questionnaire that included questions about the basic characteristics of the respondents' gender, age and academic qualification. The items were also designed to assess attitude and perception of secondary schools' mathematics teachers in relation to mathematical values inculcation in their mathematics teaching: Mathematical values inculcation among mathematics teachers in western culture were studied predominantly by Professor Emeritus   Alan J. Bishop from Monash University Australia for examples (Bishop,1988, 1999, 2001, and 2010). 80% of the mathematical values inculcation questionnaire items were adopted with only 20% of the items was constructed by the researchers and that necessitated the validation of the items. Forty items were rated using a multi-item method to increase the accuracy of measurement, and each item was based on a five-point Likert- scale ranging from (1) strongly disagree to (5) strongly agree.

THE PROCESS OF ANALYSIS AND FINDINGS

In an attempt to identify and validates the factor structure of the 40-item of mathematical values inculcation model Questionnaire which comprises, sociological, attitudinal and ideological mathematical values, Exploratory Factor Analysis (EFA) by principal component analysis (PCA) was used to detect the factor structure of the 40-item questionnaire using eigen-value >1 as the selection criterion. This method generated three factors as restricted and the result shows that, the Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) = 0.698, which indicates the strength level of the items, (Pallant,2007). But the anti-image revealed that ten out of the 40-item were found to have anti-images < 0.5, as result the items were removed and the data set was run for the second time, (Field, 2005). The results show that, the KMO shut-up to 0.837 and the rotated component matrix[a] shows the convergence of items into three different factor with factor loadings > 0.5, the total variance explained was 54.3% which shows adequate support for the population involved in the study,(Field, 2005). See table1 below: the rotated component matrix[a] table for the factor loadings against each construct.

TABLE:1 ROTATED COMPONENT MATRIX FOR MATHEMATICS TEACHERS

	Component		
	SOC (SMV)	ATT (AMV)	IDE (IMV)
Q37	.767		
Q40	.749		
Q35	.746		
Q34	.742		
Q2	-.740		
Q36	.724		
Q32	.722		
Q20	.598		
Q3	.558		
Q38	.536		
Q29	.536		
Q8		.781	
Q5		.629	
Q7		.627	
Q9		.563	
Q12		.543	
Q26			.687
Q23			.675
Q30			.653
Q24			.630
Q27			.581

In this survey, The Kaiser-Meyer-Oklin value was 0.850, exceeding the recommended value of 0.6 (Kaiser 1970, 1974) and Bartlett's Test of Sphericity (Bartlett 1954) reached statistical significance, supporting the factorability of the correlation matrix.

TABLE 2: RELIABILITY OF FACTORS

Factor	Reliability	Overall reliability
Sociological (SMV)	0.773	0.636
Attitudinal (AMV)	0.735	
Ideological (IMV)	0.644	

Table 2, above shows the reliability of the data collected for the study, the Cronbach's alphas of each factor were statistically strong; the factor one (Sociological) value was 0.773, factor two

(Attitudinal) value was 0.735 and factor three (Ideological) value was 0.644, (Pallant, 2007). These also supported the adequacy of the internal consistency of the overall Cronbach's alpha of the construct. Reliability from our sample showed a reasonable level of reliability (0.636).

TABLE 3: TOTAL VARIANCE EXPLAINED

Component	Initial Eagenvalues		
	Total	% of variance	Cumulative %
Sociological SMV)	6.625	31.548	31.548
Attitudinal (AMV)	3.084	14.687	46.234
Ideological (IMV)	1.685	8.023	54.257

Table 3, above shows the total variance explained by the three factors solution. In conducting the factor analysis the researchers followed (Bishop,1988) and (Bishop,1999) and from the Bishop's conceptualized model of mathematical values inculcation, three factors identified and explained 54.3% of the total variance. The extraction method used was principal component analysis (PCA) with varimax rotation. Principal component analysis is psychometrically sound and simpler to apply mathematically, and it avoids some of the potential problems of factor indeterminacy associated with factor analysis, (Stevens,1996).

RESULT AND DISCUSSION

The result shows that the attitude and perception of secondary school mathematics teachers in the north eastern region of Nigeria concurred with the analysis of the three constructs of mathematical values inculcation model by (Bishop, 1999) in the western cultural diversity. As such the study confirmed and validated the used of the six cluster model for the inculcation of mathematical values in sub-sahara Africa north-eastern region, Nigeria, which was the ultimate aim of this study.

Furthermore, the finding shows that there is need for advocating the inculcation of mathematical values inculcation in mathematics teaching and learning, this is because the result shows the existence of complete agreement or rather relationship between mathematics teachers' responses on mathematical values inculcation and its respective components of values, that is, the sociological (SMV), attitudinal (AMV) and ideological (IMV). Additionally, it is important for secondary school mathematics teachers to become aware that for a successful conveyance and understanding of mathematics concepts, there will be an enduring need for valuing mathematical concepts in mathematics classroom in such a way that the learners' could be able to appreciate the beauty aspect of learning mathematics as a school subject.

CONCLUSION

Conclusively, the finding of this study is another contribution to the existing body of empirical information about how inculcation of mathematical values is also conceived and perceived by the secondary mathematics teachers' in the north-eastern region of Nigeria, and the finding concurred with that of the western cultural societies. This shows that, there is still light at the end of the tunnel as mathematics teachers' and mathematics educators are striving to see the future of mathematics education and indeed the future of mathematics teaching and learning metamorphose from its traditional ways and techniques. More-over, mathematics curriculum planners and designers and mathematics text-book writers should strategies on the components of mathematical values attached to each module or chapter for easy identification and conveyance in mathematics classroom. Finally, refreshers courses, workshops, seminars, mathematics teachers' inter-schools collaboration and national and international mathematics pedagogical collaborative effort should be encouraged by the management of secondary schools' education. If this happens, the ultimate aim of mathematics learning will be realized.

LIMITATIONS AND RECOMMENDATION:

The study has its own shortcoming though, among this was that the finding cannot be generalized beyond the present setting of the study, the researchers therefore encourages more similar study in other geographical zone of the country in order to validate the usage of this model. Finally, there is a dare need of changing trend in the conceptualization of mathematics as a schools' subject both in terms of curriculum and the executors' of mathematics curriculum, it should be done with love and fashion. As part of the limitation of the study that it involved only secondary school mathematics teachers' from the north eastern region, Nigeria, in which that restricted the generalizability of the validation of mathematical values inculcation model on the other region or part of Nigeria, whereby differs in term of culture and values system from the region this study was conducted. Therefore, the outcome of the study can only be generalized to the attitude and perception of the north-eastern region mathematics teachers' on mathematical values inculcation in mathematics teaching and learning. We recommend that further analysis is needed on whether or not gender and academic qualification of mathematics teachers significantly affect the inculcation of mathematical values in mathematics classroom.

References

Bishop A.J. (1999). *Mathematics teaching and values education - an intersection in need   of research.* Zentralblatt für Didaktik der Mathematik, 31(1), 1-4

Bishop, A. J. (1988). *Mathematical Enculturation: A cultural perspective in Mathematics Education.* Dordrecht, Holland: Kluwer.

Clarkson, P.C. (1998). *Reflections on mathematics learning and teaching: Implications of cultural perspectives.* In A. Olivier & K. Newstead (Eds.).*Proceedings of the annual conference of the International Group for the Psychology for Mathematics Education* (Vol. 1, pp. 131-135). University of Stellenbosch, South Africa.

Field, A. (2005). Discovering Statistics Using SPSS, London Sage Publication.

FitzSimons, G.E., Seah, W.T., Bishop, A.J. & Clarkson, P.C. (2000). *What might be learned from researching values in mathematics eduication?* In T.Nakahara & M. Koyama (eds.), *Proceedings of the 24th conference of the International Group for the Psychology of Mathematics Education* (Vol. 1), (P.153) Hiroshima: Hiroshima University.

Seah, W.T. (1999). *The portrayal and relative emphasis of mathematics and mathematics educational values in Victoria and Singapore lower secondary school textbooks*: a preliminary study. Unpublished Master of Education thesis, Monash University, Melbourne, Australia.

Seah, W. T., & Bishop, A.J. (2001). *Teaching more than numeracy:* The socialisation experience of a migrant teacher. In J. Bobis, B. Perry, & M. Mitchelmore (Eds.), *Numeracy and beyond.* (pp. 442-450). Turramurra, NSW: Mathematics Education Research Group of Australasia Incorporated

Kline, R. (2000). Principles and practices of structural equation modeling. New York: The Guilford Press.

OECD (2003). *Assessment Framework – mathematics, reading, science and problem solving: knowledge and skills.* Paris: OECD.

Pallant, J. (2007). Survival Manual: A step by step Guide to Data Analysis Using SPSS for window, New York, Open University Press.

Stevens, J. (1996). Applied mulivariate statistics for the social sciences.