CONFIRMATORY FACTOR ANALYSIS: THE VALIDATION OF MATHEMATICAL VALUES INCULCATION PATH MEASUREMENT MODEL AMONG SECONDARY SCHOOLS' MATHEMATICS TEACHERS IN THE NORTH- EASTERN REGION NIGERIA

MUKHTAR ALHAJI LIMAN
MOHAMMAD SAHARI NORDIN
SHITTU, AHMED TAJUDEEN
International Islamic University Malaysia

Abstract
The use of Confirmatory Factor Analysis (CFA) on researches based on certain theoretical frame-work in both social sciences and education cannot be over-emphasized, as such this study employed the confirmatory factor analysis in an attempt to validates the mathematical values inculcation path measurement model among secondary schools' mathematics teachers in the north-eastern part of Nigeria with aim of finding whether or not the data fit the model for the purpose of inference generalization. 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 Questionnaire with some of the items designed and adopted. Amos graphic a statistical tool for structural equation modeling was used in finding the fit adequacy of the mathematical values path measurement model which shows the following fit-indices: NormX^2 = 1.993, CFI = 0.903 and RMSEA = 0.099 all of which indicated the goodness of fit of the model except for RMSEA which lies within the range of mediocre. The purpose of this study is to acquaint secondary schools' mathematics teachers to the need of inculcation of mathematical values in mathematics teaching and learning with sole objective of enhancing better understanding of mathematical concepts. The study is guided by the following research question and hypothesis: Is there any significant correlation between mathematics teaching and learning and its components of values inculcation? The understanding of mathematics teaching and learning is not significantly correlated to the inculcation of the mathematics conceptual values.
Keywords*:* Confirmatory Factor Analysis, Validation , Mathematical Values , Inculcation Path , Secondary Schools Mathematics , Teachers , North- Eastern Region Nigeria

1. Introduction

The need to make the teaching and learning of mathematic values laden cannot be over-emphasized, because successful teaching of mathematics and understanding of it concepts, require inculcation of appropriate values in the entire process of imparting the subject to the students. 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 notion of values in mathematics differ from one society to another and at times 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 inculcate 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 Australian 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 part of the compulsory years curriculum for senior secondary school students in the late adolescents years of schooling (Lancaster,2010). Similarly, Nigeria educational system place a high premium to acquisition of mathematic so much so that all students are required to learn

the subject and pass it before they can proceed for tertiary education. Despite the importance attached to this subject there is fewer study conducted to empirically understand the inculcation of mathematical value by the implementer of mathematic curriculum. More over, the study aim at understand if the teacher know the values they are teaching in mathematics classrooms and the purposes to which mathematics is being a subject of study.

2. 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).

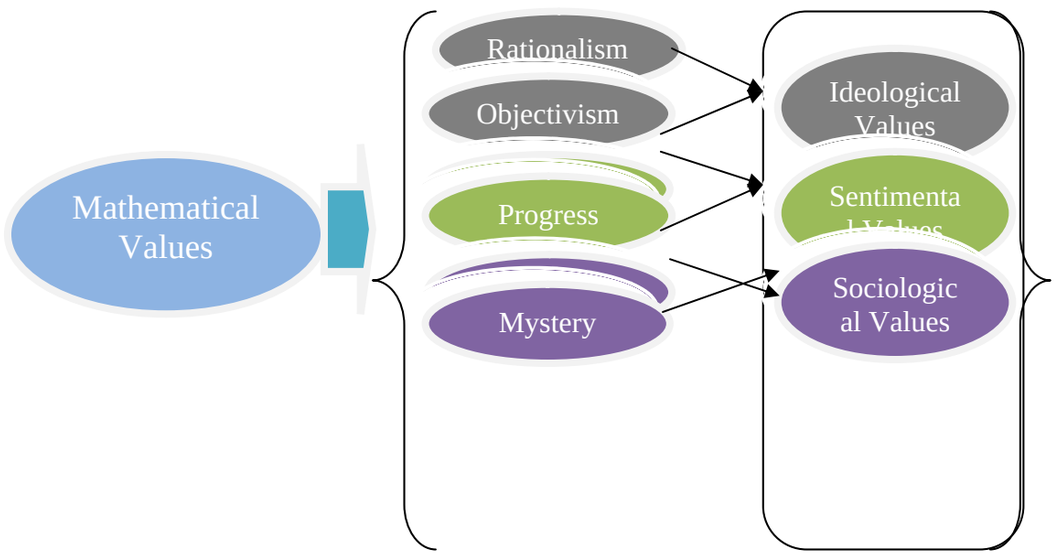
As a result of that, there is an ever increasing demand for mathematical values inculcation in a more explicit ways so that the learners of mathematics can realize and appreciate the beauty aspect of learning school mathematics as a subject of study and contribute meaningfully to the betterment and development 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.



3. AIMS OF THE STUDY

This study 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 for the better understanding of mathematical concepts to their application in the real world; 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.

4. METHODOLOGY

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 200 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 18) 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 author 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 mathematics concepts described were relevant and culturally appropriate for this population.

5. THE PROCESS OF ANALYSIS AND FINDINGS:

In an attempt to identify and validates the factor structure of the 40-item of mathematical values Questionnaire EFA by principal component analysis (PCA) was used to detect the factor structure of the 40 questionnaire items, 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, but the anti-image revealed that ten out of the 40-items were found to have anti-images < 0.5, as result the items were removed and the data set was run for the second time. 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 for the data was 45.8% which was much low than the required ≥ 0.6 and this was as a result of the said preliminary small sample size of the data. See the table1 below: the rotated component matrix[a] table.

TABLE:1 ROTATED COMPONENT MATRIX FOR MATHEMATICS TEACHERS

	Component		
	SOC	ATT	IDE
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.

6. MEASUREMENT MODEL

Results of the three-factor solution are presented in Table 1. Confirmatory factor analysis (CFA) was then used to test the three-factor solution. The root mean square error of approximation (RMSEA=0.099) lies within the range of mediocre while the (CMIN/DF=1.993) and (CFI=0.903) indicated the goodness of fit of the model which provide full support for three-factor solution. See the the table below is the result of the factor loading, average variance extracted, and composite reliability of the items used in the current study.

HYPOTHESIZED MATHEMATICAL VALUES INCULCATION MODEL

Normed chi square 1.993
CFI .903
RMSEA .099
P .000

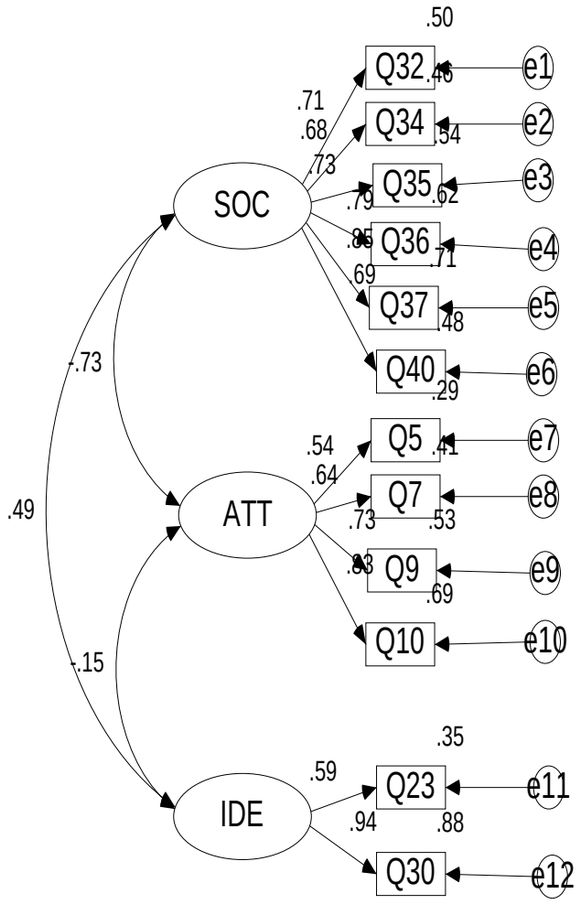


Table 2: Factor loading, Average variance extracted, and composite reliability

ITEMS	FACTOR LOADING	AVE	COMPOSITE RELIABILITY
SOC 32	0.71		
SOC 34	0.68		
SOC 35	0.73		
SOC 36	0.79		
SOC 37	0.85		
SOC 40	0.69	**0.6**	**0.93**
ATT 5	0.54		
ATT 7	0.64		
ATT 9	0.73		
ATT 10	0.83	**0.5**	**0.86**
IDE 23	0.59		
IDE 30	0.94	**0.6**	**0.83**

Prior to model estimation, the researcher checks for the normality of the item so as to know whether the items were normally distributed. All the items used in the study were found to be normally distributed with the standard value of skewness and kurtosis were less than 2.5 based on Kline (2000) recommendation. The mean score and the standard deviation of the items were also analyzed, see the table 3 below

Table 3: Mean, Standard Deviation and Normal Distribution of the selected variables of the study

Item	Mean	Std. Deviation	Skewness	Kurtosis
SOC 32	2.5446	1.36766	.395	-1.103
SOC 34	2.7525	1.60254	.281	-1.540
SOC 35	2.8713	1.03599	.208	-.419
SOC 36	2.9406	1.42001	.085	-1.276
SOC 37	2.9901	1.46625	.056	-1.384
SOC 40	3.0000	1.36382	-.072	-1.232
ATT 5	3.0990	1.26099	.054	-1.066
ATT 7	3.2079	1.16032	-.104	-.860
ATT 9	3.7228	1.09653	-.587	-.449
ATT 10	3.8020	.99015	-.788	.436
IDE 23	4.0099	.91099	-.587	-.492
IDE 30	4.0990	.90006	-1.038	. 963

7. Discussion and Conclusion

The confirmatory factor analysis (CFA) involve the validation of mathematical values inculcation path measurement model among secondary schools' mathematics teachers in the north- eastern region Nigeria, the findings confirmed that the six cluster model of mathematical values inculcation (MMVI) is an important factor in predicting how secondary schools' mathematics teachers' inculcate mathematical values in their mathematics teaching. This finding is consistent with previous finding of other study (Bishop, 1988; Bishop,1998; Seah & Bishop, 2001; Lancaster, 2010). The result demonstrated that despite societal and cultural differences between the western and the sub-Sahara Africa, particularly north-eastern part of Nigeria. The mathematical values inculcation model, still stand to be significantly a good predicting model on the attitude and perception of mathematics teachers' on the mathematical values to be inculcated in mathematics classrooms. This showed the usefulness and validity of the model in the prediction on how mathematics teachers' in the region imbibed the inculcation of mathematical values in their teaching. The important information from this study was that the mathematics teachers' in the region were aware of the existence of these mathematical values but with limited understand of the distinction between them. This made the situation in terms of which mathematical values and for teaching which mathematical concept is most appropriate and what stage in the teaching and learning process. With this result, the mathematics curriculum planners/designers, text-book writers, mathematics teachers' are encourage to provide system changes mathematics curriculum in such a way that the curriculum should contained in each units of mathematics modules value-laden activities. This will enable mathematics learners to have seen the essence of schools' mathematics. Furthermore, user friendly mathematics text-books with a clear spelling of the mathematical values component should be provided to guide the proceeding of mathematics teaching and learning for each mathematical concept. This will increase mathematics teachers' ability in knowing which mathematical values could be used in aiding the learning of a particular mathematical concept and at the same time aiding mathematics teachers' to gain confidence in their teaching. It is also important to note that human-being can only be encourage to change to a new way of doing thing if the new method is found to be easier than what they are used to. This could be an explanation to why inculcation of mathematical values is paramount to the understanding of mathematics teaching and learning.

Similarly inculcation of mathematical values through the six cluster model: objectivism/rationalism, control/progress and openness/mystery were system processes whereby

if it is well adopted mathematics teachers' can effectively transmit mathematical ideas and ideals to mathematics learners. The process demonstrated to be a strong determinant of how mathematics could be learned as well as development of students' interest to mathematics, as compared to learning of social sciences and humanities subject. The finding equally support the finding from previous study of Bishop and Seah (2000); Clarkson, (1998); Bishop (1999); FitzSimons, Seah, Bishop, & Clarkson, (2000). The main aim of this study is to validate the mathematical values inculcation model in the north-eastern region of Nigeria and the finding from this study showed that, the data collected for the study fitted the model of the study, this result is congruent with what was earlier obtained in the western world (Bishop,1999).

8. 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. 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 that teaching and learning of mathematics metamorphose from its traditional ways and techniques. Nevertheless, 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 it implementation by the mathematic educators.

References

Bishop A.J. (1999). *Mathematics teaching and values education - an intersection in need of research.* Zentralblatt fur 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.

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.