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DEVELOPMENT AND VALIDATION OF AN INSTRUMENT FOR ASSESSING JUNIOR SECONDARY SCHOOL MATHEMATICS CLASSROOM ENVIRONMENT IN ENUGU STATE OF NIGERIA

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ABSTRACT

The purpose of this study was to develop and validate an instrument for assessing junior secondary school Mathematics classroom environment as it affects teaching and learning of Mathematics in Enugu State. Instrumentation research design was adopted for the study. The sample of the study consisted of 1710 students drawn from the population of 43,540 Junior Secondary1, 2 and 3 students for 2010/2011 academic session in the 75 public junior secondary schools in Enugu State. The instrument used for data collection was the Mathematics Classroom Environment Assessment Scale (MCEAS) developed and validated by the researcher. The instrument covered nine dimensions as follows: Involvement, Affiliation, Teacher Support, Task- Orientation, Cooperation, Competition, Order and organization, Teacher Control and innovation. The instrument has two sections: students' actual and students' preferred forms. These items will enable students to provide information about the learning environment that is present in their classroom (the actual environment) as well as information about the learning environment that they would like to be present (preferred environment). Three research questions and two hypotheses guided the study. The statistical techniques used in analyzing the data were factor analysis, Cronbach's alpha and analysis of variance. A test of reliability showed that the instrument was reliable at 0.82 and 0. 97. This result made the researcher to recommend that the instrument MCEAS be used in junior secondary schools in Enugu State to ascertain effective Mathematics classroom learning environment. The findings showed that students preferred more favorable Mathematics classroom environment than was perceived as being actually present.

KEYWORDS: Development and Validation, Mathematics, Classroom and Environment.

INTRODUCTION

Mathematics plays a vital role in the development of science and technology. It is a basic requirement for day to day accomplishment of man's social economic and technological needs. Such importance justifies its inclusion as a compulsory subject in the primary and secondary school levels of education system. Researchers buttressed this point when they stated that mathematical competence is very vital for meaningful and productive life. Maliki, Mgban and Julie (2009), see Mathematics as a subject that affects all aspects of human life at different degrees. The social, economic, political, geographical, scientific and technological aspects of man are centered on numbers. The importance of Mathematics does not only lie in its contributions to scientific and technological development but also in its utility in day – to –day interaction at the market places, transportations, business of all sorts by both literate and illiterate

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members of the society. According to Obodo (2001), the language of Mathematics is a system of sounds, words and patterns used in communicating mathematical ideas by mathematician and other related professionals. It is also a system of signs and symbols used in conveying information. Obodo (2001a) described Mathematics as a language for computers in the new millennium development. Obodo stated that the advancement of technology is deeply rooted in Mathematics. Hence, Mathematics language plays a significant role in computer technology. Furthermore, Iyiola (2005) described Mathematics as the foundation of hard core science and technology and it is liable index of the potential for development. The importance of Mathematics cannot be over emphasized in the development and advancement of this country. Despite the important roles Mathematics plays in educational advancement, students still lack interest and achieve poorly in the subject. This is why the researcher deemed it necessary to develop and validate an instrument that will be used in monitoring all the activities in the Mathematics classroom environment.

In Nigeria, enough attention has not been focused on the effect of environment on teaching and learning in schools. Environment plays vital roles in academic achievement of students. Conducive classroom learning environment is needed for proper teaching and learning in schools. A classroom is a room in which teaching and learning activities can take place. The classroom attempts to provide a safe space where learning can take place uninterrupted by other distractions. It is a place where students in a particular grade meet at certain times under the supervision of a teacher who takes attendance and does other administrative businesses (Hannaflm and Oliver, 2000). Classroom learning environment is a space or a place where learners and teachers interact with one another and use a variety of tools and information resources in their pursuit of learning activities (Wilson, 1996). The nature of the classroom environment and psycho-social interaction can make a difference to how students learn and achieve their goals (Dorman, Adam and Ferguson, 2002). Due to the importance of learning environment in the school settings, instruments are developed outside Nigeria to assess learning environment. Classroom learning environment assessment according to Fraser (2006) were found to bear strong and consistent links with students 'achievement and attitudes. To the researcher, learning environment is an environment which should be managed so that students are encouraged to set personal goals, actively gather meaningful information, monitor and evaluate their own learning. However, there is paucity of research information on the incident of instrument for assessing junior secondary school Mathematics classroom learning environment in Enugu State. There is need to assess the appropriateness of the environment for Mathematics instruction since it influences the effectiveness of teachers and students in the classroom.

The main purpose of this study was to develop and validate an instrument for assessing junior secondary school Mathematics classroom learning environment as it affects teaching and learning of Mathematics in Enugu State. Specifically, this study sought to:

1. Develop an instrument for assessing junior secondary school Mathematics classroom learning environment in Enugu State of Nigeria.
2. Determine the construct validity of the instrument (MCEAS).
3. Determine the reliability of the instrument (MCEAS).
4. Determine the mean responses of students in different classes as measured by actual and preferred MCEAS J.S1, J.SII and J.SIII.

Research Questions

The following research questions guided the study.

1. What is the construct validity of the instrument MCEAS?
2. What is the reliability of the instrument MCESA?
3. What are the mean responses of students in different classrooms as measured by actual and preferred MCEAS?

Hypotheses

1. There is no significant difference in the mean perception scores of J.S1, J.S11 and J.S111 students' as measured in the actual MCEAS.
2. There is no significant difference in the mean perception scores of J.S1, J.S11

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and J.S111 students as measured in the preferred MCEAS.

Theoretical Framework

To provide the theoretical basis of this study, Jean Piaget's constructivist theory of cognitive development, Jerome Bruner's theory of learning and Vygotsky's social learning theory were considered. Piaget's constructivist theory was propounded early 1920. His learning theory in the classroom is based on the stages that children go through in order to learn. According to his constructivist theory in order to provide an ideal learning environment, children should be allowed to construct knowledge that is meaningful to them. He believed that a constructivist classroom must provide a variety of activities to challenge students to accept individual differences, increase their readiness to learn, discover new ideas and construct their own learning. Piaget's theory of development is based on four principles namely; the sensory motor stage, the pre-operational stage, the concrete operations stage and the formal operations stage.

Jerome Bruner, a social psychologist was born in October 1st, 1915. His theory of learning which was propounded in 1960 proposed three modes of representation; enactive representation, iconic representation and symbolic representation. Bruner emphasizes that the social nature of a child's environment plays a key role in teaching and learning in school. A major theme in the theoretical framework of Bruner is that learning is an active process in which learners construct new ideas or concepts based on their current/ past knowledge. He describes children as an active problem solver, ready to explore new subjects and ideas. Since children learn through their own personal experiences, conducive classroom environment is necessary for effective teaching and learning of Mathematics in schools. In order to support Piaget's and Bruner's theory in the classroom, the teacher must understand the different developmental stages that children go through. With this in mind, teachers need to prepare their classroom environment appropriately.

Lev Vygotsky, a social constructivist, was born in 1896. Vygotsky's social constructivism was propounded in 1962 and states that the learners are considered to be central in the learning process. Vygotsky believed that learning and development is a collaborative activity and that children are cognitively developed in the context of socialization and education. Since learners are considered to be central in the learning process, the classroom learning environment needs to be given optimum attention for proper teaching and learning in schools. Using these learning theories in the Mathematics classroom environment, teachers must remember that students in the same classroom have different learning abilities.

METHOD

RESEARCH DESIGN

The study employed an instrumentation research design. Instrumentation research design is aimed at the development of an instrument. Abonyi (2003) pointed out that a study which is purely geared towards the development and validation of an instrument in education is an instrumentation study. This is aimed at developing and certifying the efficacy of an instrument for measurement of a given behavior or construct. This study was conducted in Enugu State of Nigeria. A sample of 1710 students, 30 students each from 57 classes were drawn from the population of 43,540 J.S1, J.S11 and J.S111 students in the 75 public junior secondary schools in Enugu State by stratified random sampling without replacement. One quarter of the entire population of the schools were randomized into nineteen (19) schools. Stratified random sampling was used in drawing the three education Zones used for the study (Agbani, Enugu and Nsukka) by clips of paper method.

Instrumentation for Data Collection

The researcher developed the instrument Mathematics Classroom Environment Assessment Scale (MCEAS) which contained two sections: the students' actual forms and the students' preferred forms. The MCEAS was developed along the dimensions: Involvement, Affiliation, Teacher Support, Cooperation, Task-Orientation, Competition, Order and Organization, Teacher Control and Innovation. The instrument has nine scales. Each scale has six items. Four- point's response options were used for the study. Principles considered important in Mathematics classroom learning

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environment and are consistent with a more constructivist pedagogy were chosen as scales: such as involving students during classroom discussion, allowing students to participate fully during Mathematics instruction and also using other students centered activities while teaching. The researcher gathered and listed many attributes, skills and traits from literature which were thought to be necessary for competent, good and efficient for effective Mathematics classroom learning environment in schools. These are attributes that constitute the elements of effective Mathematics Classroom environment.

Validation of the Instrument

With the data collected from the trial test, the responses were subjected to factor analysis, a data reduction procedure using rotated principal component analysis method and varimax with Kaiser Normalization rotation method. The criterion the researcher adopted for accepting an item in terms of its factor loading is Meredith (1969), which states that item loaded from 0.35 and above are properly loaded. Any item which loads on more than one factor is nullified and discarded. Any item which fails to attain the factor loading standards which have been adopted is dropped. Such items are said to be factorially impure.

From the result of factor analysis of the items, for students' actual forms, twenty- one items were dropped. For the students' preferred forms, twenty – six items were discarded and rejected. Finally, out of the 100 items (students' actual and students' preferred) forms subjected for construct validity using factor analysis procedures, 29 items (students' actual forms) and 24 items (students' preferred forms) survived as valid items to be used in the study. The result of the Cronbach's alpha for the 29 items (students' actual forms), who survived after the construct validity, has the coefficient alpha of 0.82. For the students' preferred forms, the results of the 24 items have the coefficient alpha of 0.97. Finally, the result of the factor analysis was shown to be internally consistent as this was evidenced from the values of alpha reliability coefficients obtained for the items.

Method of Data Analysis

Research questions 1 and 2 were answered using factor analysis and Cronbach's alpha respectively while research question 3 was answered using mean and standard deviation. The null hypotheses were tested using analysis of variance (ANOVA). These statistical tools were used for the following reasons. (1) Factor analysis was used to ascertain the construct validity of the developed instrument (MCEAS). (2) Cronbach's alpha was used to determine the internal consistency of the developed instrument. (3) Mean and standard deviation were used to determine the magnitudes of the differences between the mean responses of students from different classes. (4) Analysis of variance (ANOVA) was used to determine the means of more than two groups.

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Table 1: The Nine Mathematics Classroom Environment Assessment Scale and their factor loadings (students' actual forms)

Scales	Items	Item Loadings
E. Involvement	1	.617
	3	.354
	5	.389
B. Affiliation	7	.590
	8	.537
	9	.494
	10	.430
	11	.640
C. Teacher Support	13	.609
	14	.907
	15	.883
	16	.776
	17	.800
D. Cooperation	22	.762
	24	.718
	25	.756
E. Task-Orientation	26	.763
	29	.858
F. Competition	31	.378
	32	.809
G. Order and Organization	36	.417
	37	.595
	40	.780
H. Teacher Control	41	.711
	44	.590
	44	.494
I. Innovation	47	.712
	48	.609
	50	.883

The summary of the result presented in table one above showed that out of 50 items of the instrument: students' actual forms, 29 items were factorially pure and are acceptable as suitable for use in the study. Items: 2,4,12,23,33,34,35,45 and 49 loaded less than 0.35 and are referred to be factorially impure (FI), while items: 6,18,19,20,21,27,28,30,38,39,43 and 46 were factor loaded up to 0.35 in more than one factor, which was referred to as factorially complex. These items were dropped.

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Table 2: Students' Preferred forms and its item loadings.

Scales	Items	Items loadings
A. Involvement	51	.776
	53	.398
	55	.811
B. Affiliation	57	.762
	58	.896
	59	.718
	60	.756
	61	.601
C. Teacher Support	63	.896
	64	.718
	72	.809
D. Cooperation	75	.354
E. Task- Orientation	76	.395
	78	.354
	79	.555
F. Competition	83	.537
G. order and Organization	86	.640
	87	.712
	88	.409
H. Teacher Control	92	.820
	94	.412
I. Innovation	97	.762
	98	.696
	100	.556

For students' preferred forms, items: 52,56,62,66,74,81,85,90,91,96 and 99 loaded less than 0.35 and are referred to as factorially impure (FI), while items: 54,65,67,68,69,70,71,73,77,80,82,84,89,93 and 95 were factor loaded up to 0.35 in more than one factor, which was referred to as factorially complex (FC).

Table 3 showed the result of the Cronbach's alpha test on the 53 items (students' actual and students' preferred forms).

Table 3: Students' actual forms and its Reliability Coefficient.

Scales	Items	Reliability Coefficient
A. Involvement	1, 3,5	.68
B. Affiliation	7,8,9,10,11	.77
C. Teacher Support	13, 14,15,16,17	.88
D Cooperation	22, 24, 25	.73
E. Task- Orientation	26, 29	.71
F. Competition	31, 32	.86
G. Order and Organization	36, 37, 40	.66
H. Teacher Control	41, 42, 44	.72
I. Innovation	47, 48, 50	.90

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Table 4: Students' Preferred Forms and its Reliability Coefficient

Scales	Items	Reliability Coefficient
A. Involvement	51, 53, 55	.73
B. Affiliation	57, 58, 59, 60, 61	.66
C. Teacher Support	63, 64, 72	.84
D. Cooperation	75	
E. Task- Orientation	76, 78, 79	.78
F. Competition	83	
G. Order and Organization	86, 87, 88	.67
H. Teacher Control	92, 94	.73
I. Innovation	97, 98, 100	.70

As would be recalled, the initial stage of the instrument development involved the construction of 100 items for students' actual and preferred forms. The 100 items were subjected to trial testing following from which only 53 items survived for students' actual and preferred forms. The above Tables 3 and 4 showed the reliability coefficient in the nine scales, one after the other.

Table 5: Mean and standard deviation of students' responses in different classes to MCEAS actual forms

Class	N	$\bar{X}$	SD
JSS1	540	2.94	.45
JSS2	540	3.01	.41
JSS3	540	2.91	.46
Total	1620	2.95	.44

The analysis of data in Table 5 showed the mean and standard deviation of the responses of students according to different classes. Their responses in different classrooms showed that JSS1 had a mean response of 2.94 with a standard deviation of .45; JSS11 had a mean response of 3.01 with a standard deviation of .41, while JSS111 had a mean response of 2.91 with standard deviation of .46 respectively. This implies that there are differences in the perception profiles of the students in different classes with regards to their Mathematics classroom environment. The analysis showed that students from different classrooms perceived their Mathematics classrooms differently.

Table 6: Mean and standard deviation of students' responses in different classes to MCEAS preferred forms.

Class	N	$\bar{X}$	SD
JSS1	540	3.27	.53
JSS2	540	3.30	.38
JSS3	540	3.21	.41
Total	1620	3.26	.45

The analysis of data in Table 6 showed the mean and standard deviation of the responses of students in different classes. Their responses showed that JSS1 students had a mean response of 3.27 and standard deviation of .53, JSS11 had a mean response of 3.30 and standard deviation of .38, while JSS111 students had a mean response of 3.21 and standard

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deviation of .41 respectively. Thus, there are differences in the perception profiles of the students in different classrooms. Even though students perceived their classrooms differently, the students preferred a conducive classroom environment for effective teaching and learning of Mathematics.

Hypotheses

In order to test hypotheses 1 and 2, analysis of variance (ANOVA) was used to measure the influence of class and Post Hoc test was used to determine the classes that contributed most to the significant difference. All the hypotheses were tested at 0.05 probability level.

Hypothesis one: There is no significant difference among the mean perception scores of JSS1, JSS2 and JSS3 students as measured in the actual MCEAS.

Table 7: An analysis of variance (ANOVA) showing the results of the responses of students in different classrooms as measured in the actual MCEAS.

	Sum of Square	Df	Mean Square	F	Sign
Between Groups	2.760	2	1.380	7.119	.001
Within Groups	299.682	1618	.194		
Total	302.442	1620			

Table 7 showed that the probability associated with the calculated value of F (7.119) for the mean perception scores of students' response to MCEAS was .001. Since the probability value of .001 was less than .05 level of significance, the null hypothesis was not accepted. Hence, there was significance difference among the mean perception scores of Mathematics classroom environment by JSS1, JSS2 and JSS3 students to MCEAS actual. A post Hoc test analysis was further carried out to determine the class that contributed most to the significant difference

Hypothesis Two: There is no significant difference between the mean perception scores of JSS1, JSS11 and JSS111 students as measured in the preferred MCEAS.

Table 8: Analysis of variance (ANOVA) showing the results of the responses of students in different classrooms as measured in the preferred MCEAS.

	Sum of Square	Df	Mean Square	F	Sign
Between Groups	2.293	2	1.146	5.594	.004
Within Groups	316.803	1618	.205		
Total	319.095	1620			

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Table 8 showed that the probability associated with calculated value of F (5.594) for the mean perception scores of the students' responses as measured in the preferred MCEAS is .004. Since the probability value of .004 is less than 0.05 level of significance, the null hypothesis is not accepted. Hence, there is significant difference among the mean perception scores of classroom learning environment by JSS1, JSS11 and JSS111 students to MCEAS preferred. A post hoc test analysis was further carried out to determine the class that contributed most to the significant difference. It was observed that the mean response of JSS3 students had the highest contributions to the significant difference (see the Post Hoc Test below). Multiple Comperisons

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(1) class	(J) class	Mean Difference(I-J)	Std Error	Sig	95% confidence Interval	
					Lower Bound	Upper Bound
JSS1	JSS2	-.06684	.02750	.040	-.1314	-.0023
	JSS3	-.03381	.02758	.438	-.0309	.0985
JSS2	JSS1	.06684	.02750	.040	.0023	.1314
	JSS3	.10066	.02715	.001	.0370	.1643
JSS3	JSS1	-.03381	.02758	.438	-.0985	.0309
	JSS2	-.10066	.02715	.001	-.1643	-.0370

. The mean difference is significant at the 0.05 level.

CONCLUSIONS

The findings of this study showed that the instrument: Mathematics Classroom Environment Assessment Scale (MCEAS) had 53 items for students' actual and preferred forms which survived the construct validation. These items are valid to be used in a Mathematics classroom. The instrument (MCEAS) exhibited adequate reliabilities in their various forms for use in a Mathematics classroom. There were significant differences in the Mathematics perception profiles of students in different classrooms with regard to the MCEAS. Students' preferred more favorable Mathematics classroom environment than was perceived as being actually present.

RECOMMENDATIONS

Based on the findings of the study, the following recommendations were made:

1. The instrument; Mathematics Classroom Environment Assessment Scale should be used in all the junior secondary schools in Nigeria.
2. If the goals of the instructional improvement will be achieved, the instrument should be used always by the monitoring themes to make sure that every classroom teacher does what is expected of him/her in the classroom for quality assurance.
3. Proprietors and stakeholders should provide conducive environment for teaching and learning of Mathematics in schools.

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4. Individual differences in terms of abilities and interests must be put into consideration when teaching Mathematics.
5. The teacher needs to use varieties of teaching methods and have cordial relationship with students while teaching Mathematics.

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