Classroom environment variables and mathematics achievement of junior secondary school students in Cross River State, Nigeria

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The study was designed to investigate the influence of classroom environment variables on mathematics achievement of junior secondary schools students in Cross River State, Nigeria. It was a survey research involving 1200 Junior Secondary 2 (JS2) students from 48 secondary schools in Cross River State. A valid and reliable achievement test and questionnaire were used for data collection, while multiple regression analysis technique was used to analyse the data. The research findings indicated that: there is a significant individual and combined prediction effect of the classroom environment variables on students' mathematics achievement; twenty-seven (27) out of the thirty-six (36) paths in the hypothesised recursive model are significant at .05 probability level. Based on the findings, it was concluded that classroom environment variables significantly influence students' mathematics achievement in secondary school. It was recommended among others that teachers and school counsellors should educate the students on the need to establish a good relationship with teachers and themselves in the classroom in order to improve their performance. Also, classrooms should be furnished and equipped to enhance effective teaching and learning.

Keywords: classroom, environment, mathematics, achievement

Introduction

Education in any country is a tool for national development. Investment in it therefore, is considered relevant both to individual nations and to individuals and their families. For individuals to function effectively in the society they must be educated. Education is seen by many people as the key to future success and mathematics as a major tool to turn this key in order to unlock the door to development (Meremikwu, 2008; Ayodele, 2004). Thus, the place of mathematics in education and development is central. This is because scientific and technological developments of the centuries have depended to a larger extent on mathematical development. Nigeria is regarded as an under-developed nation because of its backwardness in scientific achievements as well as in technological developments (Meremikwu, 2008).

The role of mathematics in the field of science and technology is enormous and cannot easily be over-looked. It is essentially a dynamic science which serves as the underlying knowledge for science and technology. Because of the importance of mathematics, the Federal Government of Nigeria made it a compulsory subject at the primary and secondary levels of education and a basic requirement for admission into all levels of education. A strong background in mathematics is therefore critical for many jobs and career opportunities in today's increasingly technological society.

The Federal Government of Nigeria in its National Policy on Education (Federal Government of Nigeria, 2004) set out some specific objectives to be achieved in the school system. To achieve this, a conducive classroom learning environment, apart from the background of the learner, should be nurtured and utilised by erudite teachers by invigorating the respective organs of cognitive, affective and psychomotor domains. For a teacher with a good knowledge of the subject matter in a good conducive learning environment, with students having a good background, it is expected that the intellectual achievement of every child would be above average. Within the classroom learning environment variables which have significant influence on students' academic achievement include time teacher spends in the classroom; physical layout of classroom; classroom climate; teacher's motivation of students; instructional material utilisation; classroom management skills; teacher-student classroom interaction; student-student classroom interaction and many more (Igiri, 2006; Mgbechi, 2006). Udonwa (2001) and Rasser (1993) are of the opinion that teacher classroom management skills influence academic performance. Essien (2004) found that teacher motivation of students influence students' performance. Battistich, Schaps and Wilson (2004) and Akpan (2002) see student-student interaction as one of the variables that influence students' performance. Jones (2004); Nnaka and Anaekwe (2000) in their studies found that teacher-student interaction do not influence performance. Barkley (1998); Stallings and Kaskowitz (1994) and Frazer (1994) are of the opinion that the physical layout of classroom, time teacher spent in classroom and classroom climate respectively influence students' performance.

Educational researches have also been carried out using static or stable variables such as intelligence, teachers' and students' characteristics such as age, sex and socio-economic status (Halpern, 1992). Others use variables that are part of the teaching – learning process such as classroom environment variables, instructional materials, instructional method (Meremikwu, 2008).

However, these studies only examined the influence and/or a combination of some of the classroom environment variables that is, teacher-student classroom interaction, student-student classroom interaction, learning facilities, physical layout of classroom, classroom climate, and classroom management skills just to mention a few on students' academic performance. Most of these studies thus use statistical techniques like t-test, Analysis of Variance ANOVA and correlation for data analysis. For instance, Ukashia (2010) used ANOVA to study the influence of classroom learning environment variables like class size, teacher-pupil relationship, peer group influence, learning facilities, teachers' leadership style and pupils' attitude towards the school. Also, Mgbechi (2006) used ANOVA and independent t-test statistical techniques to study the influence of classroom interaction variables like teacher-student interaction, student gender, teachers' interaction pattern, teacher gender and subject matter on interaction patterns.

Some of these studies did not provide empirical evidence of the influence of the classroom environment variables and the dependent variable (students' performance) especially when the classroom variables are taken together or combined. It is in order to fill this gap that provoked this study to ascertain the interaction of classroom environment variables (Time Teacher Spends in the Classroom TSI; Physical Layout of Classroom PLC; Classroom Climate CC; Teacher's Motivation of Students TMS; Instructional Material Utilisation IMU; classroom management skills CMS; Teacher-Student Classroom Interaction TSI; Student-Student Classroom Interaction SSI) and their effects on students'

mathematics performance. This has made it imperative to study classroom environment variables and students' mathematics achievement in schools in Cross River State in order to make appropriate suggestions and recommendations based on the finding of the study. It is hoped that from this, inputs could be made to improve students' mathematics achievement.

Purpose of the study

The main purpose of this study is to determine the relationship between classroom environment variables and students' mathematics achievement. Specifically, the study was designed to: (a) examine the extent to which the following classroom environment variables (Time utilised by teacher; Physical layout of classroom; Classroom climate; Teacher's motivation of students; Instructional material utilisation; Classroom management skills; Teacher-student classroom interaction and Student-student classroom interaction) do individually and collectively predict students' mathematics achievement; and (b) examine the significant pathways in the path model through which the classroom environment variables determine students' mathematics achievement.

Hypotheses:

The following hypotheses were tested in the study:

1. There are no significant individual and combined prediction effects of the variables of the classroom environment variables (Time utilized by teacher; Physical layout of classroom; Classroom climate; Teacher's motivation of students; Instructional material utilisation; Classroom management skills; Teacher-student classroom interaction and Student-student classroom interaction) on students' mathematics achievement.
2. There are no significant pathways in the path model through which the classroom environment variables predict students' mathematics achievement.

Methodology

The design adopted for this study was survey research. Multi-stage sampling techniques were adopted for this study. The techniques include stratified random sampling and simple random sampling. The basic criterion for stratification was on the basis of educational zones and government areas. The state Ministry of Education has already stratified the state into three educational zones and the study was carried out in these three zones. A simple random sampling technique was used to select four Local Government Areas LGAs per zone, four schools per LGA and 25 students per school. The calculation of the sample size was based on the (Yamane, 1967: 886) formula: $N/(1+N(e^2))$ which gave a minimum sample size of 399.98 plus 200% of the minimum sample size resulting in 1200 students. The sample for the study consisted of 1200 Junior Secondary 2 (JS2) students randomly drawn from a total population of 18 573 (JS2) students in the study area.

Two research instruments were used for data collection, these were: a 48-item four point Likert-type questionnaire and a 40-item Mathematics Achievement Test (MAT). To achieve the validity of instruments, the items of the questionnaire were face validated by two experts in test and measurement, while a specification table was constructed for the content validity of the test and item analysis was done to show the item difficulty and discrimination. The reliability coefficient estimate of the

questionnaire using Cronbach Alpha after a pilot test (since the derived scores were continuous) ranged from 0.54 for Instructional Materials Utilisation (IMU) to 0.75 for Classroom Climate (CC). While the reliability estimate of the Mathematics Achievement Test using the K-R 20 method (since the derived scores were dichotomous) was 0.51. A reliability coefficient of 0.50 is good enough for any instrument to be suitable for use (Nenty, 1985).

Results

Hypothesis one

Table 1 is in two parts; the upper part shows the combined effect of the eight classroom environment variables (teacher-student classroom interaction, classroom management skills, teacher motivation of students, physical layout of classroom, time utilised by teacher, instructional material utilisation, student-student classroom interaction and classroom climate) in predicting students' mathematics achievement, which yielded a coefficient of determination (R^2) of .368. The result shows that the eight classroom environment variables could account for up to 36.8% of students' mathematics achievement. The mean scores of the variables of the study ranged from 17.53 to 24.87 and their standard deviations ranged from 2.71 to 4.25. The low values of the standard deviations show the homogeneity of the response opinions of the respondents. The result shows a multiple R of .606, coefficient of determination R^2 of .368, adjusted R^2 of .363 and an F-ratio of 83.536 with 8;1149 degrees of freedom. It also produced an equation shown below:

MAT = 16.110 + .053TSI + .187CMS + .495TMS + .396PLC +.243IMU + .184TSC + .067SSI + 094CC

Table 1: Summary of multiple regression analysis of the individual and combined effects of the eight classroom environment variables to the prediction of students' mathematics achievement

Multiple R		=	.606		
Multiple R – square (R^2)		=	.368		
Adjusted multiple R-square		=	.363		
Standard error of estimate		=	3.175		
Source of Variation	sum of square	df	mean square		F- ratio
Regression	6738.862	8	842.358		83.536*
Residual	11586.223	1149	10.084		
Total	18325.085	1157			
Variable	Unstandardised regression weight (b)	Standard error of regression weight	Beta weight (β)	t-value	sig t
TSI	.053	.031	.040	1.711	.087NS
CMS	.187	.036	.127	5.155	.000**
TMS	.495	.026	.309	18.939	.000**
PLC	.396	.023	.225	17.014	.000**
IMU	.243	.040	.101	6.119	.000**
TUT	.184	.025	.106	7.348	.000**
SSI	.067	.027	.059	2.475	.013**
CC	.094	.036	.079	2.573	.010**

*Significant at .05 level (for F-ratio); ** P < .05; NS =Not significant at .05 levels.

MAT=16.110+ .053TSI+ .187CMS + .495TMS + .396PLC+ .243IMU+ .184TSC + .067SSI + 094CC

Looking at the individual contributions of the predictor variables, it is observed from the result that the standardised regression coefficients (β-weights) range from .040 to .309. The unstandardised coefficients range from .053 to .495. The errors of the estimates range from .023 to .040, while the t-ratios ranges from 7.348 to 18.939. However, the β-weights show the strength of each predictor variable (Table 1). The analysis of these strengths shows that classroom management skills (β-weight of .127), teacher motivation of students (β-weight of .309), physical layout of classroom (β-weight of .225), instructional materials utilisation (β -weight of .101), time utilised by teacher (β -weight of .106), student-student classroom interaction (β-weight of .059) and classroom climate (β-weight of .079) are significant predictors of students' mathematics achievement. Only teacher-student classroom interaction (β-weight of .040) is not a significant predictor of students' mathematics achievement.

The prediction equation with these eight predictor variables is also shown. From this equation, it could be observed that the variables predict students' mathematics achievement positively. Therefore, the null hypothesis which states that "there is no significant individual and combined prediction effect of the variables of the classroom environment variables on students' mathematics achievement" is rejected.

Hypothesis Two

To determine the path coefficients in the hypothesised model, the zero-order correlations and beta weights (β) for each path were generated using the enter method of the multiple regression analysis technique. The result shows that the least path coefficient is p_{76} (β = -.217) while the strongest path is p_{93} (β = .309). The result also reveals that 27 out of the 36 paths in the hypothesised recursive model are significant at .05 probability level. Therefore, the null hypothesis is rejected for 27 paths out of 36 possible pathways this is because the paths whose β-weight or coefficients are significant at .05 probability level (β-weights greater than .05) were retained, while the others were trimmed to produce the more parsimonious (over-identified) model.

Summary of findings

From the results of data analyses, the following can be deduced:

i. There is a significant individual and combined prediction effect of the classroom environment variables on students' mathematics achievement.
ii. Twenty-seven (27) out of the thirty-six (36) paths in the hypothesised recursive model are significant at .05 probability level.

Discussion

The result of the testing of hypothesis one, which is the individual and combined contributions made by the variables in predicting students' mathematics achievement, has this to say. For the individual contributions, the t-value associated with each of the eight variables of the study reveals that seven (classroom management skills, teacher motivation of students, physical layout of classroom, instructional materials utilisation, time teacher spends in classroom, student-student classroom interaction and classroom climate) out of the eight variables were significant at .05 level. This

means that only these seven variables contributed significantly to the prediction of students' mathematics achievement at .05 level.

A closer look at these contributions shows that teacher motivation of student made the most significant contribution (t = 18.939) followed by physical layout of classroom (t = 17.014), time teacher spent in classroom (t = 7.348), instructional materials utilisation (t = 6.119), teacher classroom management skills (t = 5.155), classroom climate (t = 2.573) and finally student-student classroom interaction (t = 2.475|) to the prediction of students' mathematics achievement.

The result that teacher classroom management skills (t = 5.155, p< .05) was a significant predictor of students' mathematics achievement is in support of the findings of Udonwa (2001), Rasser (1993). The result that teacher motivation of students is a significant predictor of students' mathematics achievement (t = 18.939, p< .05) is consistent with Essien (2004), who studied teachers' variables and secondary school students' academic performance in social studies Cross River State with a sample of 1000 students and teachers and found that there is a significant relationship between teachers' motivation and students' performance. The physical layout of the classroom as a significant predictor of students' mathematics achievement (t= 17.014, p<.05) is consistent with Barkley (1998) who is of the view that closed classroom architecture (i.e. four walls and a door) is more conducive for learning than an open classroom design since this presents considerably less auditory and visual distractions that impair the concentration of students.

The result that the time a teacher spends in the classroom is a significant predictor of students' mathematics achievement (t = 7.348, p<.05) is consistent with the findings of Stallings et al. (1994) who found that effective time use in the classroom could raise students' achievement. In the study teachers and students were observed and students were tested for learning gains in some subjects taught.

The findings of the study show that student-student classroom interaction is a significant predictor of students' academic achievements (t = 2.475, p<.05). For student-student interaction, this finding is consistent with the studies of Akpan (2002), Battistich et al. (2004) among others who all agree that there is a significant relationship between student-student classroom interaction and students' academic achievement.

The findings show that classroom climate is a significant predictor of students' mathematic achievement (t= 2.573, p<.05). This agrees with Frazer (1994) who examined the results of 40 past studies that showed collectively, that classroom climate and classroom environment factors are positively linked to valued students' achievement and affective outcome. The results also show that teacher-student interaction (t = 1.711) is not a significant predictor of students' mathematics achievement which is contrary to the earlier findings of Jones (2004), Nnaka and Anaekwe (2000).

The result of findings of the combined effects of the eight classroom environment variables on students' mathematics achievement as shown in the upper part of Table 1 showed a significant effect. That is, the eight classroom environment variables (teacher-student classroom interaction, classroom management skills, teacher motivation of students, physical layout of classroom, time spent in classroom factor, instructional material utilisation, student-student classroom interaction and classroom climate) when taken collectively are effective predictors of students' mathematics achievement among the respondents in the study.

Conclusion

The results of the study show that classroom environment variables have a relationship with students' mathematics achievement in junior secondary schools. This suggests the importance of classroom environment as a major component of variations in the teaching-learning behaviour. Also, this is an indication that the classroom environment created by the teacher has a positive effect on students' achievement in mathematics.

Recommendations

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

i. As the teacher related classroom environment variables appear to be significant predictors of students' mathematics achievement. Teachers and school counsellors need to educate students on the value of establishing a good relationship with teachers and one another in order to improve their performance.
ii. Mathematics teachers can enhance students' performance in mathematics. Therefore, they should endeavour to provide a classroom environment conducive to learning.

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