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School variables and mathematics performance among students in Akwa Ibom State

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Abstract

This study examined the extent to which school variables (school location, school type and school proprietorship) relatively and collectively contribute to students' performance in Mathematics. The hypothesis formulated to guide the study proposed that the independent and interactive effects of the selected school variables on JS 3 students' performance in Mathematics are not statistically significant. This ex post facto research employed stratified cum simple random sampling technique in selecting a total of 853 students from 20 secondary schools in Akwa Ibom State. The study made use of a researcher developed and standardized instrument: a 40 item Mathematics Achievement Test (MAT). The effect by school variables on students' performance in Mathematics was analysed using a 2-way factorial ANOVA. The result showed that school proprietorship was the only school variable that exerted a significant effect on students' performance in Mathematics. School type and school location did not have any effect on Mathematics performance even after being subjected to an interactive analysis. The researcher therefore recommended, among other things, that teaching and learning situations and conditions should be improved in public and rural schools to enable students in these schools compete favourably with their counterparts in private and urban schools.

Keywords: Mathematics achievement; School location; School type; School proprietorship; Academic performance; School variables

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1. Introduction

The Nigerian National Policy on Education as stated in the policy guidelines (Federal Republic of Nigeria, 2004) aims at producing literate and numerate citizens who can think logically and scientifically for themselves. In order to give the students a sound scientific background, Mathematics is made a compulsory subject in our schools due to its foundational role in the study of basic sciences. Science subjects like physics, chemistry and biology are the building blocks for most scientific and technologically based courses including engineering, medicine, computer science etc. A careful look at these science subjects reveal that their basic principles hinge heavily on mathematics. In view of this, students' proficiency in mathematics is believed to enhance their performance in these subject areas. In spite of the importance attached to mathematics and the relevance of mathematics in the admission of students into tertiary institutions, a reasonable percentage of students in Nigerian secondary schools still underachieve in mathematics.

1.1. Purpose of the study

This study was designed to determine the independent and interactive effect(s) of school variables namely: school location, school type and school proprietorship on Junior Secondary 3 students' performance in Mathematics.

1.2. Research question

For the purpose of this study to be achieved, the research question raised to provide a guide was: What are the independent and interactive effects of school variables (school location, school type and school proprietorship) on JS 3 students' performance in Mathematics?

1.3. Research hypothesis

H_0: The independent and interactive effects of school variables (school location, school type and school proprietorship) on JS 3 students' performance in Mathematics are not statistically significant.

2. Review of related studies

A careful examination of some related empirical studies on the variables that may impact mathematics achievement have indicted various cognitive, affective, and environmental variables. For instance, Wilson et al. (2002) in their study assessed the relations among school environment variables and students' achievement. Their results showed clearly the relationships between school attributes and constructivist teaching. Although the authors did not claim such relations to be causal attributions, they posited that a great deal of the variance in constructivist teaching is explained by the school attributes included in their study. They showed that schools that emphasize parental and community involvement and that have teaching staff that model and expect responsible behaviour and mutual respect were more likely to also have staff who use

constructivist teaching methods. Another outstanding submission by these authors is the finding that school environment and partnerships affect student achievement indirectly through constructivist teaching, especially in the case of mathematics.

A further important finding reported by this study is the direct pathway from school environment to student achievement. The authors reported that staff expectations regarding responsible behaviour and mutual respect were related to higher achievement scores. Thus, these elements of the learning environment directly influenced student outcomes as well as the nature of the teaching. In sum, the findings from this study show that school environment variables impact strongly on students' achievement. Furthermore, the analytic techniques used in this study helped to illuminate the structural relationships among school characteristics at multiple levels (i.e., the teaching methods, the school environment, and partnerships in the community) and student learning. Thus, Wilson et al. (2002) recommended that future studies be directed still at a comparative analysis of schools that attempt to develop the characteristics of their current research interest and those that do not. This is considered an invitation for further studies on the impact of school variables on the performance of students with the aim of furthering current understanding of the dynamic relationships among school attributes and student achievement.

Konstantopoulos (2006), using three National probability samples of high school seniors in Columbia (NLS:72, HSB:82, and NELS:92) examined trends of school effects on students' achievement. The researcher employed Hierarchical linear models in the investigation. The findings revealed that the substantial proportion of the variation in student achievement lies within schools, not between schools. This finding suggests that certain school-specific variables have significant impact on student achievement.

Konstantopoulos (2006) also examined between-school variations in students' achievement and found a widening continuum over time. This finding, according to the researcher indicated that schools became more diverse and more segregated in the 1990s than in the 1970s. Furthermore, the researcher opined that such school characteristics as school [location], school socioeconomic status, and such student-population-variables as students' daily attendance, students' in-college preparatory classes, and high school graduates college enrolment are important predictors of average student achievement. The researcher explained that the observed school predictors explained consistently more than 50% of the variation in average student achievement across surveys. The researcher also reported considerable teacher heterogeneity in achievement within schools, which suggests important teacher effects on student achievement.

Noteworthy from the study was that the impact of teacher heterogeneity on student achievement was larger than that of school heterogeneity, which may indicate that teacher effects have a relatively larger impact on mathematics and science students' achievement than do school effects. This, notwithstanding, the study by Konstantopoulos (2006) gives further impetus to the need for the impact of school variables on students' achievement in mathematics to be examined in the 2000s.

Kim et al. (2011) in their study attempted to compare the structural relationships between students' achievement in mathematics and the contextual variables among three high achieving countries (Korea, Finland and Singapore). The authors utilised multilevel models in their analyses of TIMSS 2011 data to discover the contextual variables that underpin differences in students' performance in mathematics across

their population. They reported both similarities and differences with regard to predictors at student and school level in student performance in mathematics. Analysing the trends that appeared in both Grades 4 and 8, among the student background, student characteristics, and school background, the authors found that there were some similarities between the two grades. They however report no similarities in school policy variables for the three countries. Generally, the authors report that school background showed the same pattern for Grade 4 and Grade 8 in all three countries. Economic Background positively affected achievement for both grades in Korea and Singapore, and so did School Emphasis on Academic Success in Singapore and Finland. Among the school policy variables, Mathematics Instructional Activities had a negative influence on Grade 4 only in Finland, while it had a positive influence on Grade 8 only in Korea. In contrast, Homework had a negative influence on Grade 4 only in Korea, while it had a positive influence on Grade 8 only in Finland. Thus, this study by Kim et al. (2011) shows the influence of educational contextual characteristics of high performance in their study population. This indicates that school variables may have significant impact on students' performance in mathematics generally.

Ilie and Lietz (2010), while at Jacobs University, Bremen, undertook an investigation into the effects of school quality on students' achievement in 21 European Countries, using the Heyneman-Loxley effect. The Heyneman-Loxley effect (1982, 1983) refers to an effect moderating the degree to which school quality affects student achievement. This moderating effect was found to relate to a country's economic productivity. More specifically, the effect is one in which school quality has a greater impact on student achievement in countries that are less developed economically than in countries that are more highly developed. Thus, the authors undertook a re-examination of this effect using hierarchical linear modelling (HLM) analyses of data for 21 European countries that participated in the Trends in International Mathematics and Science Study (TIMSS) in 2003. Two models were analysed. The first was a three-level model that includes each country's economic status at the highest level, school resources at the middle level, and students' respective family backgrounds at the lowest level. The second was a two-level model that includes school and student context variables only and examines these separately for each country. Based on their analyses, the authors opined that their analyses provide little, if any, support for the existence of the Heyneman-Loxley effect, which maintains that school quality is of greater importance and family context is of lower importance in low-income countries than in high-income countries. The authors further maintained that their analyses do however emphasize the consistent and continuing importance of the home environment for student achievement across countries. While this study highlights the possibility of Heyneman-Loxley effect being absent in some contexts, it however suggests that beyond school quality, there may be other school variables that impact on student achievement.

In another study, Catsambis and Beveridge (2001) examined the influences of neighbourhood and schools on the family life and mathematics performance of eighth grade students in public schools in the United States. Data from the National Educational Longitudinal Study (NELS:88) combined with the U.S. census data were utilised in the study. The authors proposed and evinced, based on the outcome of their study, that disadvantages at the neighbourhood and school level may place students at risk through a twofold process. They posited that first, neighbourhood and school characteristics may influence students and their achievement in mathematics. Neighbourhoods characterized by concentrated disadvantage and schools

characterized by high levels of student poverty and student absenteeism are associated with lower levels of mathematics achievement, net of individual-level background controls. And that second, neighbourhoods may also affect students' mathematics achievement indirectly by influencing parents' ability to help children succeed in school.

The authors (Catsambis and Beveridge, 2001) reported that the net of individual-level background controls, neighbourhood characteristics were associated with five out of their seven indicators of parental involvement, while neighbourhood disadvantage tended to mediate the impact of social class background for all parental involvement indicators. Moreover, they reported that neighbourhood characteristics also tended to mediate the impact of some parental involvement indicators on students' mathematics achievement. The authors thus submitted that parents may be able to overcome neighbourhood disadvantages to some degree by frequently communicating with their children, closely monitoring their activities, and providing extra learning opportunities for them. Though the current study does not intend to show the mediatory effects of intervening variables on the influence of school variables on students' achievement, this study by Catsambis and Beveridge (2001) shows the significance of school variables on students' achievement in general.

Grootenboer and Hemmings (2007), in their study of mathematics performance examined how mathematically affective factors and such background characteristics as gender, ethnicity, and socioeconomic status may contribute to the mathematics performance of a sample of children aged 8 to 13. The researchers obtained data by surveying the children and drawing on performance ratings from their teachers. From a correlational analysis of their data, the researchers reported that the relationships between the respective dispositional and background variables with mathematics performance were significant and in the direction as predicted.

The researchers (Grootenboer and Hemmings, 2007) further found from a logistic regression of their results that a combination of these variables appropriately classified students who were either below-average or above-average performers in mathematics. The researchers acknowledged a few limitations in their study. One of interest was the report that despite the fact that differences in mathematical performance were evident between Pakeha and Maori/Pacific Islander students, the study could not explore these differences in any meaningful way. A concentrated focus on the school experience for the latter group of students is warranted to ascertain how dispositions towards mathematics are being formed and whether or not certain dispositions can be changed. This highlights the need for a careful examination of the influence of school variables in mathematics achievement.

Singh and Imam (2013) also investigated the effects of personal and institutional variables on the performance of secondary school students. Their study, conducted in India, examined among other things, the effects of school type, school climate, and medium of instruction on students' performance in an important school subject, mathematics. The researchers used a convenience sample of 1944 students, 975 males and 969 female from thirty six schools of South-East Bihar (India) for study. Their instruments for data collection included the Mathematics Attitude Scale, Mathematics Achievement Test and School Climate Scale. They utilised t-test, F-test, Duncan's Mean Test and correlation techniques for statistical analysis of their data. The results obtained revealed that there was a significant difference between mathematics achievement of

boys and girls. A further analysis of their result showed that the males hold more positive attitude towards mathematics and the school climate than female students. Moreover the researchers found that students of central government schools and private managed schools had higher mathematics achievement in comparison to minority managed schools and state government schools. Furthermore, this study showed a positive correlation of attitude towards mathematics and school climate with mathematics achievement. Although this study by Singh and Imam (2013) broadly considered school variables interacting with other cognitive variables to influence students' achievement in mathematics, it gives further basis to specifically examine the impact of school variables on the academic achievement of students.

In a study conducted locally, Meremikwu and Enukoha (2010) examined, *inter alia*, the effects of school variables on students' mathematics achievement in both public and private schools in Cross River State, Nigeria. The study utilised a quasi-experimental design and a sample of 600 students selected using multi-stage random method. The authors selected school type and school location as their main variables. The experimental group was subjected to the treatment, which was teaching with instructional aids. A 20–item multiple-choice Mathematics Achievement Test (MAT), designed by the researchers, with a split–half reliability index of 0.67 was the instrument used to gather data. The MAT was used as pre-test and post-test for both the experimental and the control groups. Data collected from the study were subjected to the Analysis of Covariance (ANCOVA) with the pre-test scores as the covariate. The results of the study showed that pupils' Mathematics achievement was significantly dependent on the treatment, school type and school location but not on pupil gender. Also, all the interactions of the treatment, gender, school type, and school location were statistically significant in explaining pupils' Mathematics achievement. In the urban areas, the authors report that pupils in the experimental group in private schools achieved significantly higher than their counterparts in the public schools. However, in the rural areas, the difference between the mean Mathematics achievement of the pupils in private and public schools was not statistically significant. This study by Meremikwu and Enukoha (2010) furthers an understanding of how school variables may play a role in students' achievement in mathematics.

3. Methodology

3.1. Location

The study covered Akwa Ibom State in the Federal Republic of Nigeria. Akwa Ibom State is one of the 36 states in Nigeria. This state is located in the South-south geopolitical zone of Nigeria and it lies between latitudes 4o32' and 5o33' North; and longitudes 7o25' and 8o25' East of the Greenwich meridian, with a total area of 8412.00 square kilometres.

3.2. Design

This research is part of a larger work which adopted the causal comparative design because in the course of conducting this research, the researcher had no direct control over the changes in the variables under study,

therefore, the inferences from the dependent variables made are only based on the natural variations in the independent variables as they affect or effect the dependent variables.

3.3. Population

The population of this study was made up of all the JS 3 students from both public and private secondary schools in Akwa Ibom Sate. There were 438 secondary schools in Akwa Ibom State; this comprised 240 public schools and 198 private schools with an approximate JS 3 student population of 29,000 as at the school year this study was conducted.

3.4. Sample

A total of 20 schools were sampled, from which 50 students were randomly selected to make up a study sample of 1000 respondents. Out of the 1000 students, complete and correct data were obtained from 853 respondents of which, 407 were males and 446 were females representing a percentage of 47.7% and 52.3% respectively.

3.5. Instrument

The main instrument employed by the researcher to gather relevant information for this study was the Mathematics Achievement Test (MAT). To ascertain the respondents' academic performance in Mathematics, a 50- item test for mathematics was constructed and used. The researcher developed the instrument in accordance with the JS 3 Mathematics syllabus. Considering the cognitive level of the students, items included in the instrument were based on knowledge, comprehension and application levels of Blooms taxonomy of educational objectives. The test items were vetted and reviewed for face validity by Measurement and Evaluation experts and Secondary school teachers who are currently teaching Mathematics in the study region.

The Mathematics Achievement Test (MAT) was pre-tested using 100 JS 3 students in four secondary schools within the study area. To make the final fifty (50)-item instrument, items with negative discrimination indices were discarded while those with low discrimination indices between 0.2 and 0.45 were restructured. The reliability coefficient for the mathematics achievement test was 0.87 this was ascertained through the split-half method. The researcher with the assistance of Mathematics teacher in the sampled schools administered the instruments. These teachers were enlisted by the researcher as research assistance for the proper collection and collation of the relevant data from the respondents. Each instrument was administered within a day in each school so, data collection in each school lasted two days.

4. Presentation and discussion of results

Table 1. Group means and standard deviation of students' scores in Mathematics Achievement Test

Factor	Group	n	%	$\bar{x}$
School Location	1(Urban)	409	47.95	45.43
	2(Rural)	444	52.05	34.18
School type	1(All Boys)	60	7.03	32.46
	2(All Girls)	121	14.18	35.37
	3(Coedu)	672	78.8	40.97
School Proprietorship	1(Public)	505	59.20	29.13
	2(Private)	348	40.80	54.72

n=853 in all cases

The result in Table 1 showed that 409 (47.95%) from school situated in urban areas scored a mean value of 45.43 to be superior to their 444 (52.05%) rural counterparts with the mean score of 34.18 on the MAT. An inspection of the scores earned by the three groups classified on the basis of gender showed only slight disparity in scores of the 672 (78.8%) students from coeducational institutions had a mean score of 35.37 while the 121 (14.18%) from all girls' schools recorded a mean score of 35.37 and the 60 students from the all boys' school had the lowest - 32.46 as their average score on the MAT. The variable tagged school proprietorship showed a reasonable disparity in the margin of the scores earned by the 348 (40.8%) students from private schools (54.72) while their peers from public schools had 29.13 as their average score on the MAT.

To establish the level of significance of the observed mean scores, and by extension verify the only hypothesis that guided the study, 2-way ANOVA technique was employed and the result is presented in Table 2. The statistical results show that, only school proprietorship with an F-ratio of 16.325 has a significant influence on students' performance in Mathematics, this is further buttressed by the conspicuous disparity in the mean score of students in private schools and those students in public schools. Students from private schools had an average score of 54.72 while their peers in public schools had a low mean score of 29.13. The researcher therefore rejects the null hypothesis with regards to school proprietorship, but retains the same null hypothesis for school location and school type. The result explained above implies that students in private schools perform better in Mathematics than their peers in government owned schools.

For the two-way interaction effects the null hypothesis of no significant interactive influence of the school variables on students' performance in Mathematics is upheld as none of the 2-way interactions yielded any statistically significant result.

Table 2. Results of factorial ANOVA of influence of school location, school type and school proprietorship on students' performance in Mathematics

Source of Variation	Sum of squares	*df*	Mean Squares	F
Main effects	148309.29	10	14830.929	51.994
Location	392.859	1	392.859	1.377
School type	1098.430	2	549.215	1.925
School Proprietorship	4656.531	1	4656.531	16.325*
2-way interactions				
SL by ST	331.893	2	165.946	0.582
SL by SP	25.621	1	25.621	0.090
SP by ST	461.001	2	230.500	0.808
SP by ST by SL	86.456	1	86.456	0.303
Error	240173.39	842	285.242	
Total	1724318.0	853		

**p 0.05; critical F $_{(1.842)}$ = 3.86; critical t=1.96*

On investigating the influence of school variables on students' performance using a 3 way factorial ANOVA, school proprietorship earned an F – ratio of 16.325 to top the significance table at 0.05. The influence of school proprietorship had already been confirmed by an earlier analysis which showed its direct effect on performance in mathematics with a correlation coefficient of 0.589 and a beta weight of 0.535. This result has also been confirmed by previous research works. For instance, Wilson et al. (2002) found from their study, an indirect association between school attributes and mathematics achievement. The researchers found that schools which emphasize parental and community involvement and whose teaching staff model responsible behaviour and mutual respect were more likely to also have staff who employed constructivist teaching methods, which indirectly impacted positively on mathematics achievement among their students. The school attributes of mutual respect among teachers and students and parent and community involvement are characteristic of privately owned schools in the current study location and is rare in government/public schools. Thus the finding of Wilson et al. (2002) supports the finding of this study, that school proprietorship has a significant effect on students' achievement in mathematics. A study that may seem to argue against the findings of this work is the study by Ilie and Lietz (2010), which suggested that the Heyneman-Loxley effect does not operate in every context as illustrated by their study of 21 European Countries. However, it must be noted that beyond socioeconomic statuses moderating students' achievement, other explanatory variables, as suggested by this study, which may be encapsulated in such wider factors as school proprietorship may still hold sway. Thus this study makes a significant input to the current debate on the impact of school variables on, especially, mathematics achievement; showing that school proprietorship should not be ignored.

Result displayed on Table 2 shows that school location does not influence students' performance in Mathematics. It is generally expected that students in schools located in urban regions will out-perform students from rural schools. Against such popular belief and expectation, the current study found no significant effect of school location on students' achievement in mathematics. This is similar to the results obtained by Kim et al. (2011). These authors found from their study that no significant variation in student achievement existed across the three Countries they investigated, based on specific school variables, whereas generally, there existed some variations based on educational contexts. From the current study, it would be noted that although there was no main effect by school location, further analysis involving the interplay of school type (See Table 2) showed that the mean score of urban students was higher than that of rural students. But when the variable of school type was entered into the analysis, it was observed that students in rural schools performed better than those in urban schools. This result is further supported by the study by Catsambis and Bveridge (2001), who found that neighbourhood and school level variables may interact to impinge students' academic achievement. Also, the report by Grootenboer and Hemmings (2007) gives further support to the findings of the current study. These authors reported, based on their findings, that such background characteristic as socioeconomic status, which is inherently geographical may independently or in combination with other mathematically affective variables impact on the mathematics achievement of students.

Generally, the findings of this study is supported by the reports of Konstantopoulos (2006), Singh and Imam (2013), and Meremikwu and Enukoha (2010) whose separate empirical findings posited that beyond teacher-specific variables, school-specific variables and school-environmental variables all have significant effects on students' achievement in mathematics. Thus, the findings of the current study are a significant addition to current literacy on the impact of school variables on students' achievement in mathematics.

5. Conclusion and recommendations

The researcher concludes from the findings of this study that such school variables as school type and school location are potent factors that may either impede or enhance students' achievement in mathematics in the study region. Thus it is recommended that public/government school administrators borrow a leaf from the constructivist approach to teaching common in private schools and which is suggested by the findings of this study to have a positive influence on mathematics achievement. Moreover, the researcher recommends that rural schools should be given special attention, with a view to improving the educational resources available for the teaching and learning of mathematics. Government and non-governmental organisations may lend a hand in this respect and thus raise the socioeconomic status of these rural schools; which this study suggests may indirectly impact on achievement in mathematics. It is further recommended that researchers and education stakeholders pay close attention to the influence on school variables on students' academic achievement. If this is done, such variables may be controlled in order for desired outcomes to be actualised in keeping with the policy thrust of the Nigerian National policy on Education.

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