International Journal of Education, Learning and Development
Vol. 13, No.2, pp.1-14, 2025
Print ISSN: 2054-6297(Print)
Online ISSN: 2054-6300 (Online)
Website: https://www.eajournals.org/
Publication of the European Centre for Research Training and Development-UK

Classroom Structure and Class Size on Physics Students' Academic Achievement in Calabar Education Zone of Cross River State, Nigeria

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doi: https://doi.org/10.37745/ijeld.2013/vol13n2114 Published February 14, 2025

Citation: Okokon E., Allahoki N.D., Eyo B.B., and Augustine O. (2025) Classroom Structure and Class Size on Physics Students' Academic Achievement in Calabar Education Zone of Cross River State, Nigeria, *International Journal of Education, Learning and Development*, Vol. 13, No.2, Pp.1-14

Abstract: *The purpose of this study was to determine the influence of classroom structure and class size on students' academic achievement in physics among secondary schools in Calabar Education Zone of Cross River State, Nigeria. Two research questions were raised from which two null hypotheses were formulated. Ex-post-facto design was adopted for the study. The population of the study consisted of 3,559 SS 2 physics students in Calabar Education Zone of Cross River State. The sample consisted of 500 physics students drawn from seven secondary schools using multipurpose sampling technique. Classroom structure and class size questionnaire (CSSQ) and physics achievement test (PAT) were the instruments used for the collection of data. Data analysis was carried out using independent t-test and one-way analysis of variance (ANOVA). All the hypotheses were tested at 0.05 level of significance. There was a significant difference in academic achievement in physics between students in small class size and large class size ($p = 0.000$, $p<.05$), hence class size significantly influences students' academic achievement in physics and there was significant difference in academic achievement in physics between students in terms of classroom seating arrangements (column- row, u-shape and amphitheater) ($p = 0.000$, $p<.05$), therefore classroom Structure (seating arrangements) significantly influence students' academic achievement in physics. The major implication in this study is that students' achievement in physics can be improved through improving the physical classroom structure and class size. Based on the findings, it was recommended, among others that, Government should inject more funds into school system for the construction of more school buildings.*

Keywords: Academic achievement, classroom structure, Class size

INTRODUCTION

Science education is instrumental to the development of any nation (Kola, 2013). It is reason behind the success in science and technology in the developed world. The launching of sputnik in 1957 by the Russians was only possible because of the position they placed physics education (Olayede, 2013). Physics is one of the subjects in science education. It involves the study of matter, energy and their interactions (Chiu & Lin, 2002). It plays a key role in the future progress of mankind. The interest and concerns of physics education form the basis of technology. Physics generates fundamental knowledge needed for the technological advancement which will in turn spearhead the economic engineering of the world (Zhaoyao, 2012). The concept learnt in physics contributes immensely to the technological infrastructure needed to make scientific advances and discoveries (Kola, 2013). Physics plays a major role in health education, economic development, energy and environment. The x-rays, radioisotope nuclear resource imaging, laser electron, microscope, synchrotron radiator among other advances in medicine depend on physics (Kola, 2013).

According to Anja (2000) class size and students' learning are two separate class variables which have significant relationship and are related in terms of the influence on each other in the social setting such as school where learning processes are organized systematically. Nwachuku (1994) asserted that rapid increase in school enrollment in Nigeria in recent time should be counter-balanced with improved facilities and to ensure effective teaching and learning of school subjects.

Attah (2002) opined that effective participation of students in classroom during instruction forms a vital part of effective learning. The author further stated that, a relatively small class size will allow more students opportunity to make inputs to the teaching/learning process as well as allowing teachers chance of distributing questions during lessons and interacting with students on one to one basis. Commenting on the teacher-students ratio, Botton, cited in Attah (2002) observed that when the class size was too large, some members would be unoccupied and if small the members would be occupied and properly attended to thus enhancing achievements.

Class size and academic performance has been a perplexing one for educators. Discussing factors affecting students' academic performance will require us to look the concept of poor performance. According to Aremu (2013), poor performance is a performance that is adjudged by the examinees and some significant as falling below an expected standard.

Classroom structure refers to the physical setting or arrangement of the classroom. In this study, amphitheater, column and U-shape arrangement is considered. Most classrooms in Nigerian schools are typically rectangular in shape, consisting of four walls made of block wall. A few secondary schools, however, still have half walls; some even made of mud over which a framework of wood or bamboo sticks rest; some classrooms are with few seats for learners.

Academic achievement entails students learning outcome over a given period of time. Academic performance by Scortt (2012) refers to how well students are attaining their tasks and studies. Also Okorie (2014) academic achievement is the ability to study and remember fact and being able to

communicate one's knowledge verbally or written on paper. Grades are one of the indicators of students' academic achievement.

Theoretical framework

The theoretical framework of this study is anchored on Need Achievement Theory**.** This theory was propounded by David McClelland in 1961. The theory posits that individual specific needs are acquired over time and are shaped by one's life experiences. This is a theory of human motivation that is based on human needs classifications. He stressed that there are certain needs that are learned and acquired socially as the individual interacts with his environment. In other words, David McClelland believed that many needs are acquired from culture, and some may be learned through training. He identified three aspects of need, namely, the need for achievement (nAch), need for affiliation (nAff), and the need for power (npow). He reasoned that a person's motivation and effectiveness in certain areas are influenced by these needs.

David McClelland (1961) pointed out that people with high need for achievement have the following characteristics:

i. They want to take personal responsibilities for solving problems. They prefer to work on a problem rather than leave the outcome to chance or to others.
ii. They tend to take moderate risk rather than high or low risk; set moderate, realistic and attainable achievement goals, and are inclined to take calculated risk.
iii. They desire regular and concrete feedback on their performance. Achievers need regular feedback in order to monitor the progress of their achievements. They prefer either to work alone or with other achievers.

David McClelland's need for achievement also postulated that the tendency to approach an achievement goal is a product of the need for achievement or the motive for success; the probability of success and incentive accorded success.
The implication of this theory is that teachers can encourage students to meet their growth needs by enhancing the attractiveness of learning situation. In the light of these, when the environment where the child is learning (in this study, classroom, laboratory, and location of school) is made attractive, effective learning is likely to take place.

Statement of the Problem
In developing countries like Nigeria, physics students in post primary schools are observed to have achieved poorly in the academic achievement. Records and statistics of entire results of both internal and examinations WACE and NECO from Ministry of education have shown that over decades of years now, students' academic achievement in physics in schools have been low compare to other subjects. Many studies had identified a wide range of factors that militate against students' academic achievement in physics and science in general.

Efforts have been put in by Federal Government, Ministry of Education (Federal, State and Local Government Area), parents and non–Government organizations, curriculum implementers (teachers) in their own efforts, have adopted several teaching methods which might have aided in their teaching and in order to improve upon school instruction. Some instructional materials have also been used in

the teaching process. Even with these efforts, the achievement in physics still remains low. Moreover, question may arise due to this low academic achievement. Government, teachers, parents may wonder what factors might have contributed to this low achievement in physics. Is it the class size and classroom structure (seating arrangement)**?** Based on this, the researcher sought to find out answers to the research questions.

Significance of the Study

This study may provide principals and teachers information on how to plan for conducive environment for optimal learning. This study may also aid teachers to introduce and structure (using amphitheater arrangement) their classroom before teaching. The findings will also provide ground for further research area

Purpose of the Study

Generally, the purpose of this study was to determine the influence of class structure and class size on students' academic achievement in physics. Specifically, this study was to determine influence of:

(i) Class size on students' achievement in physics
(ii) Classroom structure on students' achievement in physics

Research questions

On the basis of the specific purposes, the following research questions were raised

1. To what extent does class size (small and large) influence students' achievement in physics?
2. To what extent does classroom structure (seating arrangement) influence students' achievement in physics?

Statement of Hypotheses

On the basis of the research questions posed, the following null hypotheses were formulated to guide the study.

1. Class size does not significantly influence students' achievement in physics.
2. Classroom structure (column- row, u-shape and amphitheater) does not significantly influence students' achievement in physics.

LITERATURE REVIEW

Class Size and Students' Academic Achievement in Physics.

Class size refers to the number of students a teacher faces during a given course or teaching – learning situation. Class size is the average enrollment at the beginning and at the end of the course or learning processes. According to Murphy (1998) small class size contains 13-17 students while large class size contains 22-25 students. Dee and West's (2011) analysis of eighth-grade students in the nationally representative National Education Longitudinal Study, comparing scores of students who attended different size classes, observed that students in a small class size scored higher on a standardized mathematics test, than on an English test with students of a large class size.

Woessmann and West (2006) taking advantage of differences in average class size between the seventh and eighth grades within schools, examined class-size effects on achievement on international examinations in 11 countries around the world. They found educationally meaningful effects of smaller classes in two countries, but no effects in most other countries. They were able to rule out large class-

size effects in eight countries, and small effects in four countries. Konstantopoulos (2008) found that it was higher ability students who benefited most from small classes and small classes did not reduce the achievement gap.

Finn & Achilles, (1999) and naturalistic studies (Blatchford, Bassett, Goldstein, & Martin, 2003), noted that smaller classes have positive effects on students' academic achievement, if introduced immediately after school entry, that is, with younger children in school. Babatunde and Olanrewaju (2014) opined that, increase in class size leads to decrease in students' academic achievement. Similarly, overcrowding classroom makes it complicated for teachers to manage each individual's attention and also make use of various teaching and assessment methods (Morrow, 2007). Where a teacher is limited by space and is unable to provide individual attention and supervision, students who are unattended to tend to disturb the class and distract the attention of other students during lessons (Squires, 2002).

Bassey (2000) in his study of continuous assessment and students achievement in mathematics conducted in Akwa Ibom State reported that large class size in the Junior Secondary classes hampered effective continuous assessment. The researcher noted that at present, the larger number of students per class makes it difficult for teachers to teach and evaluate effectively. And such feedback as a motivating factor to both teachers and students is delayed and most often not available thus affecting students' achievement.

Stecher, Bohrnstedt, McRobbie, and Williams, (2001) investigated the class-size reduction (CSR) program that took place in California. The investigator performed a qualitative research study to discover if reduction in class sizes has positive impact on student achievement. Ninety-eight percent of eligible school districts participated in the CSR program. It began with the reduction of the number of students in kindergarten through third grade classes. Classes that normally had about 30 students were reduced to a maximum of 20 students. The students in these CSR programs were continually tested and their scores were compared to other classes that were not part of the CSR program. Students, who were in the classroom of 20 students, total scores continued to improve. Stecher, Bohrnstedt,

McsRobbie, and Williams, (2001) states that "Third grade students enrolled in reduced classes performed better on the Standard Achievement Test (SAT-9) than students in regular-size classrooms". The author argued that not only did students benefit academically from these reductions, but that the teachers were able to spend more time teaching students individually. They were able to devote more time to instructing small groups and to working with individual students on mathematics and language arts lessons than teachers whose classes were not reduced in size.

However, In 1985 Tennessee implemented a class size program, represented as the student/teacher achievement ratio (STAR) project. For four years, students from kindergarten through third grade were monitored and assessed in various subjects. They were assigned to three different groups, small (13-17 students), regular (22-25 students), and a regular classroom with aids. Both groups of students were assessed and observed continually based on their academic progress. The result had it that, class size of 13-17 students achieved more than that of large class size of 22-25.

Wenglinsky (1997) agrees that there is a positive relationship between per-pupil achievements, specifically in mathematics, due to class size reductions. Literature shows that reducing class sizes can have a positive effect on overall student achievement. Adeyela (2000) found that large class size is un-conducive for serious academic work. Afolabi (2002) found no significant relationship among the class size and students' learning outcomes. Costello (1992) argued that smaller class sizes lead to effective teaching and improved learning. This study looks at the reading achievement level of first grade students. A small class of 14-25 students and a large class of over 25 students were tested. Altogether, the population studied consisted of 88 first grade students at a Chicago public school. Costello (1992) opined that, in smaller size classes each child received more individual attention from the teacher and students paid more attention to their work. The author found that the curriculum took greater depth and discipline problems diminished. Both groups of participants were administered the Tests of Basic Skills (ITBS). A t- test (.05) of the independent sample was used based on their set of scores. Results showed that the random sample of students in the smaller class scored higher than those students in the larger class. According to Murphy (1998) these findings indicate that smaller class sizes do lead to "substantially faster gains in reading".

Zurawsky (2003) found that achievement in physics increased with smaller class sizes, especially for those of a minority. According to Costello (1992) if small class size does improve achievement, it should be considered no matter how costly it can be.

Classroom Structure and Students' Academic Achievement in Physics.

Researches show that classroom seating arrangement could affect students' behaviour (Bonus & Riordan, 1998; Kaya & Burgess, 2007; Wannarka & Ruhl, 2008; Anderson, 2009; Lei, 2010). It is believed that spatial arrangements in classrooms where students have enough space to move and work on their activities positively affect students' on-task behavior and social interaction (Kaya & Burgess, 2007). Baron (1992) believed that seating arrangements should be treated as a priority when thinking of a classroom with maximum on-task behaviour. Wannarka and Ruhl (2008) explained that deciding whether students' behaviour is on-task or not depends, to a great extent, on the nature of the activity and the desired communication pattern inside the class. They gave the example that if teachers want to guarantee on-task behavior during individual work, they should arrange their classroom furniture in rows and columns so as to minimize student-student interaction. Bonus and Riordan (1998), further highlighted this idea that the effectiveness of any seating arrangement depends on the activity done in class.

By examining the U-shape seating arrangement and its effect on students' interaction, Wengel (1992) found that this arrangement enabled teachers to have a more active and collaborative class where students were able to interact with the teacher as well as with each other. Wengel (1992) added that this could be considered evidence that the U-shape arrangement contributed to students' on-task behavior which in turn enhanced their learning. In this arrangement, students get the opportunity to share information and exchange ideas, thus, maximizing their learning space. Similarly, the cluster arrangement was reported to be suitable for self-instructional material and grouping of students according to their needs and interests (Papalia, 1994 as cited in Bonus & Riordan, 1998). Papalia (1994) added that the rows and columns setting best suits individual activities, testing and introducing new material to the students (cited in Bonus & Riordan, 1998). This, in fact, conforms to the idea that the

teacher is encouraged to use a seating arrangement where students can actually see each other if he/she aims at student-student interaction.

Wengel (1992) stated that there was no one seating arrangement that was better than the other. He has opined that choosing a seating arrangement should be based on the class needs, the interaction patterns aimed at and the teaching styles. In fact, results of both (Rosenfield, Lambert & Black, 1985) and Wengel (1992) conform to what classroom management books claim that when seated facing each other, students get a better chance to interact and adopt more on-task behaviors. In his study on the effect of classroom seating arrangement on a discussion-based classroom and how seating arrangement could affect the quality of students' learning,

Adams (2009) examined two different furniture arrangements: a regular rows-and-columns classroom and an auditorium amphitheater setting. Data were collected for over two weeks from two classes, through pre- and post-tests. Result of the study showed that in the first week, where students were seated in the rows and columns, interruptions in Class 1 originated from the back of the class while there were fewer interruptions in Class 2. Results also showed that some students could not hear each other or the teacher in the rows and columns setting during class discussions. As for the amphitheater seating arrangement, students in Class 1 asked for repetition less frequently. At the same time, students were more engaged in class discussions where students were able to remain on topic for a longer time. Students in Class 2, on the other hand, expressed, both verbally and non-verbally, that the amphitheater arrangement was not comfortable. Students' grades on the pre- and post- tests showed that the first class learned best in the rows and columns setting. Students in Class 1 got higher scores in the pre-test when having their class in the rows and columns settings while they got lower scores after having the class in the amphitheatre setting. Class 2 scored higher in the amphitheatre setting although students said they did not favor it while having their discussions. The results of the pre- and post- tests showed that students would learn better when seated in the amphitheater setting or arrangement. Class 1 reported that they preferred the amphitheatre seating arrangement saying that it was more effective to their learning. Class 2, however, favored the rows and columns setting (Adams, 2009). According to Adams' (2009) it seemed that the two seating arrangements he examined had minimal or no effect on the quality of students' learning. This could be attributed to the idea that both settings are actually very similar to each other. They were both rows and columns, where students were facing the teacher rather than their fellow students, except that the auditorium was, in a sense, more oval than the regular class.

Research Design

The study adopted "ex post facto" design. "Ex post facto" design is also called causal comparative study, a research design that does not permit the control of the independent variable by the investigator (Dehejia & Wahba, 2002).

METHODOLOGY

Area of the Study

This study was carried out in Calabar Education Zone of Cross River State, Nigeria.

Population of the Study
The total number of physics students in Calabar Education Zone is 3,559 and this formed the population of the study.

Sampling technique
A stratified sampling technique was used in the study to select seven (7) secondary schools from the eighty-nine (89) secondary schools in Calabar Education Zone (that is one secondary schools were selected from each local government area). Based on the school environment factors, which is the independent variable (class size and classroom structure), the population was stratified to obtain a fair representation on all the independent variables. A purposive sampling technique, otherwise called judgment sampling procedure (Onafowokan & Okpala, 1998) was used to select eight secondary schools, 80% of students' population from each selected school were sampled, making a total of 500 SS2 physics students to constitute the study sample.

Sample
The sample size comprised 500 SS2 physics students drawn from seven secondary schools in Calabar Education Zone. Three hundred and eighty eight (388) students were selected from public secondary schools while one hundred and twelve (112) students were selected from private secondary schools

Instrumentation
Two researcher-designed instruments were used in this study for data collection; Classroom structure and class size questionnaire (CSSQ) and Physics Achievement Test (PAT). Classroom structure and class size questionnaire (CSSQ) is a 7-item of four point likert-type scale. The responses include: Strongly Agreed (SA), Agreed (A), Disagreed (D) and Strongly Disagreed (DA).
one hour fifteen minutes.

Validity of the Instruments
In this study, face and content validity was established. The instruments were presented to two experts in Physics Education and two experts in Educational Measurement at Cross River University of Technology, Calabar, Calabar. The experts determined whether the items were internally consistent enough for use in the study

Reliability of the instrument
The Kuder-Richarson (K-R_{20}) method was used to test the reliability of PAT while Cronbach-coefficient Alpha method was used for testing the reliability of SEFQ. Based upon the formula $KR_{20} = \frac{K}{K-1}[1- \frac{\sum pq}{S^2}]$ and $\alpha = \frac{K}{K-1}[1 - \sum S^2_i / S^2_x]$, the calculated reliability coefficient for PAT is 0.71, Classroom structure and class size questionnaire (CSSQ) is 0.78

DATA ANALYSIS / DISCUSSION

Data collected were analysed using independent t-test descriptive statistics, and one way Analysis of variance, each hypothesis was tested at 0.05 level of significance. Results of the findings were presented in a and discussed

Hypothesis 1

The first hypothesis states that class size does not significantly influence students' academic achievement in physics.

To test the hypothesis, independent t-test was performed using SPSS version 22 computer programme. The results from the analysis is presented in Table 1. The result in Table 1, with p-value of 0.000 was found to be less than 0.05 level of significance (that is P<0.05) at 498 degree of freedom for the two-tailed test. With this result, the null hypothesis was rejected, meaning that class size (large and small) significantly influences students' academic achievement in physics. It indicates that students in small class size schools (mean=32.0982, SD= 9.62444) and large class size (mean=16.3608, SD=7.11723) do differ significantly in their academic achievement in physics.

Table 1

Result of Independent t-test Analysis of the Difference in Student's Academic Achievement in Physics between small Class Size and Large Class Size

Class size	N	$\bar{x}$	SD	t_{cal}	df	Sig(2-tailed)
Small class size	112	32.0982	9.62444	-18.939	498	0.000
Large class size	388	16.3608	7.11723			
Total	500					

* P < 0.05, df=498, p-value =0.000

Hypothesis 2

The second hypothesis states that classroom structure (seating arrangement) does not significantly influence students' academic achievement in physics. To test the hypothesis, One-way Analysis of Variance (ANOVA) was performed using SPSS version 22 computer programme. The results from the analysis are presented in Table 2. The result in Table 2 with p-value of .000 was found to be less than .05 level of significance (that is P<.05) at 497 degree of freedom. With this result, the null hypothesis was rejected, meaning that classroom structure (column-row, u-shape and amphitheater) significantly influence students' academic achievement in physics. The findings showed that students in column-row (mean= 8.5329, SD=5.18662), U-shape (mean=9.8133, SD= 6.87429) and amphitheater (mean=15.4551, SD=10.11721) arrangements differ significantly in the academic achievement in physics.

Table 2
Summary data of One-way Analysis of Variance (ANOVA) of significant difference among Column/Row, U-shape and Amphitheater Classroom Arrangement

	N	Mean	Std Deviation
Column row arrangement	167	8.5329	5.1866
U-shape	166	9.8133	6.8743
Amphitheater	167	15.4551	10.1172
Total	500		

Source of Variance	Sum of square	df	Mean Square	F	Sig
Between groups	4528.357	2	2246.179	38.466	.000
within groups	29254.193	497	58.862		
Total	33782.550	499			

* P<.05, df=497, P=.000

DISCUSSION OF FINDINGS

The findings of this study are discussed as follows:

Class Size and Students' Academic Achievement in Physics.
The findings from this study show that there was a significant difference in physics students' academic achievement between those in small and large classes. This finding implies that, students in small class size differ from students in large class size in terms of academic achievement.

This finding is supported by Dee and Wert's (2011). From his analysis, the report was that, students who attended small class size scored higher than those who attended large class size. This according to Attah (2000) may be because of the fact that small class size allows effective participation of the students in the classroom during learning. He stated that a small class size will give students opportunity to make input to the teaching/learning process as well as the interaction with other students on individual basis.

The finding of Knostantoponlis (2008) is in corroboration with this finding. He reported that smaller classes have a positive effect on students' academic achievement. This finding is also supported by Babatunde and Olanrewaju (2014) that increase in class size leads to decrease in students' academic achievement and also overcrowding in a classroom makes class management complicated to the teacher. The finding is also in corroboration with the research findings of the following authors Stecher, Bohrnest, McRobbie and Nilhams (2001). From their research report, students in third grade class who enrolled in a reduced classes had better achievement than students in regular size classroom. This according to Bohrnest (2001), may be as a result of the fact that teachers may have spent more time to teach the students individually.

Other studies that supported this finding are Costello (1992), Wenglinsky (1997); Murphy and Roseberg (1998); and Zurawsky (2003). They reported that physics achievement of student has increased with small size. Costello (1992) in his finding also reported that in smaller size classes, each child receive more individual attention from the teacher and each student paid more attention to his her work.

There is no contrary report obtained on this finding. This finding should be accepted because, class reduction or small class size, if adopted by schools will aid in increasing the academic achievement in physics.

Classroom Structure (Seating Arrangement) and Students' Academic Achievement in Physics.
This finding shows that there was a significant difference in physics students' academic achievement between column-row seating arrangement, U-shaped and amphitheater classroom seating arrangement. This implies that students' academic achievement in physics differs in terms of classroom seating arrangement.

This finding is supported by researches conducted by Bonuo and Riordan (1998), Kaya and Burgess (2007), Wannarka and Ruhi (2008), Anderson (2009) and Lei (2010). Their studies reported that spatial arrangement in classrooms students have enough space to move and work on their activities affect students' behavior.

Wengel (1992) was not in support of this finding. He reported that no one seating arrangement was better than the other. This is because students individual seating arrangement should be based on needs and the interaction pattern and teaching styles.

However, Adam (2009) found no significant difference in academic achievement between the three seating arrangements. This contrast might have been because of the task or nature of the activity and the desired communication pattern used by the teacher and students inside the class (Wannaka, and Ruhi (2008). The difference in the finding of the present work may also be because of the number of classes used by Wengel in his study. Whereas, he used a two classes (class 1 and class 2) while this study used one (1) class (SS 2). Another reason may be geographical location of the study which might have contributed to a difference in the result.

Implications of the Findings of the Study
Data obtained from this study highlights a number of points concerning the educational beliefs of the educational institution. Also teachers should receive adequate training on to how to be able to decide on the suitable seating arrangement and to where they should stand and react in each of these seating arrangements. Data obtained from this study also show that: students' academic achievement in physics differs in terms of class size, and this implies that teachers in various schools should adopt a proper class size ratio.

CONCLUSION

The data obtained in this study show that, class size and classroom structure significantly influence students' academic achievement in physics.

Recommendations

Based on the above findings and conclusions, the following recommendations are made:

1. Government officials, administrators, and educators should come together and implement class size reductions by erecting more classroom blocks in schools.
2. School proprietors, principals and teachers should ensure that appropriate classroom arrangement (amphitheater auditorium) is implemented in various schools before the commencement of lessons.

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