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EFFECTS OF GROUP AND INDIVIDUAL LABORATORY ACTIVITIES ON ACADEMIC PERFORMANCE IN MATHEMATICS AMONG SECONDARY SCHOOL STUDENTS IN BAUCHI, BAUCHI STATE NIGERIA

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Abstarct
Improving students' academic performance in Geometry of plane shapes, Geometric Ratio and Mensuration in Mathematics remain a major concern in secondary schools in Nigeria, particularly in Bauchi State, where persistent challenges has been reported. In response to this challenge, learner-centered instructional strategies such as laboratory activities have been increasingly advocated in mathematics teaching. This study investigated the effects of group and individual laboratory activities on secondary school students' academic performance in Mathematics. The study was carried out in Bauchi Metropolis Bauchi State, Nigeria. Two research questions and two null hypotheses guided the study. A quasi-experimental design (pretest-posttest non randomized, non-equivalent control group) was used. The sample size of the study comprised of one hundred and eighty-three (183) SS2 Mathematics students drawn from the population of study. In composing the sample size, the researchers used purposive sampling technique to select two schools where Four intact class were used for this study. The instrument for data collection in this study was a Mathematics Performance Test (MPT). The MPT was validated and a reliability of 0.89 was established, using Pearson Product Moment Correlation Statistics at 0.05 alpha level of significant which indicates a good reliability. Data was collected from the field work and the research questions were analyzed using mean, standard deviation and t-test was used to test the hypotheses at 0.05 level of significance. The results revealed that students taught Mathematics using group laboratory activity performed better than those taught using individual laboratory activity. Male students had higher mean performance score than the female. In line with the findings of the study, recommendations made, which include among others that Mathematics teachers should use group laboratory activity in teaching Mathematics practical, Government should build more infrastructure such as laboratories and further research should explore long term effects of combined group and individual activities on effective outcomes like attitude and motivation.

Keywords: Mathematics, Performances, Teaching Methods, Laboratory Activities, Gender

Introduction

The significance of Mathematics to science and technology and everyday life cannot be over emphasized in fact, Mathematics serves as a foundation to the development of science and technology. Science and technology are the primary vehicles through which humanity progresses, this is so because the development of new technology has been vital for both human survival and human progress (Akanmu & Bala, 2022). Mathematics can be defined as the science of numbers, space and the language of science and technology; it is an essential requirement in every field of intellectual endeavor and human development to cope with the challenges of life. Thanheiser and Mamolo (2024) defined Mathematics as an abstract body of knowledge/ideas, the organization of that into systems and structures, and a set of methods for reaching conclusions.

Performance can be referred to as the degree to which a student, teacher or institution has achieved their short or long-term educational goals. Students' performance is generally measured by the outcome of external examinations such as the National Examination Council (NECO), West African Senior School Certificate Examination (WASSCE). The WAEC Chief Examiner's Report (2021, 2022 and 2023) stated that most students have inadequate knowledge of Geometry of plane shapes, Geometric Ratio and Mensuration in Mathematics. This may be attributed to the poor teaching method such as lecture and demonstration used in Mathematics laboratory because they do not give room for active learning but only help intellectual passivity and weariness of the learners. To this effect, the WAEC Chief Examiner suggested that teachers should endeavor to pay attention to diagrams related topics especially geometry. Teaching methods such as lecture and demonstrations used by some secondary school teachers without involving students have been found to contribute to poor Performance in Mathematics Particularly, Geometry of plane shapes, Geometric Ratio and Mensuration in Mathematics. The persistent use of conventional method makes students passive rather than active learners. It does not promote insightful learning and long term retention of any abstract concepts in Mathematics and emphasizes learning through the teacher's guidance at all times. In response to this challenge, learner-centered instructional strategies such as laboratory activities have been increasingly advocated in mathematics teaching.

Laboratory activities involve hands on investigations that equip students with essential practical skills in science, encompassing a range of key competencies. It also provides students the opportunities of becoming more knowledgeable with science practical skills, which includes observation, identification, classifying, hypothesizing, predicting, measuring and experimenting. These activities enable students to conduct detailed observations, recognize and categorize phenomena, formulate informed hypotheses, make educated predictions, accurately measure variables, and design and execute experiments (Ugwu, Ngwu, Eze, & Ezea, 2020). A laboratory is a specialized facility where scientific research and experimentation are conducted to explore and understand natural phenomena through hands-on investigation. According to Ali (2018) a laboratory is a designated space for conducting scientific research, varying in scope and setup, from advanced facilities to basic, makeshift areas, and can be situated in diverse locations, such as a dedicated room, outdoor areas, or even temporary settings. Mathematics laboratory is a place where students can learn and explore various mathematical concepts and verify

different mathematical facts and theories using varieties of activities and material. These activities can be either collaborative group work or individualized experimentation (Bajon, 2015).

Human beings can be organized as a group in order to reach a general purpose in modern life and thus they can be successful in realizing any purpose in business life, sport and military fields. Group laboratory activities involve collaborative, where a small team of students works together to achieve a shared objective and finalize instructional task in the course of conducting practical laboratory lessons (Donald Ikenna Unamma, 2024). A group laboratory activity is a mode of interaction that exists in the laboratory, where learners work together in groups to accomplish a certain goal. In group activities, cooperative type of interaction is used in which the learners help one another in an academic activity, in small groups formed in laboratories to accomplish a task. The method helps the learner to gain more self-confidence and develop their communication, problem- solving and critical thinking abilities and students actively participate in the learning processes (Gillies, 2006). Students in group interact with one another, share ideas, and seek additional information and decisions about their findings (Kolawale, 2008). It could also help students to acquire practical skills, spirit of socialization, leadership and conflict resolution skills that are basic to productive working teams. Therefore, group laboratory activity is a teaching and learning method in which students of different levels of learning ability are grouped, to work cooperatively in small teams, to carry out laboratory practical works in which each member of a team is expected to contribute to the success of the group without reservation.

Individual laboratory activities entail students working independently to investigate an instruction during practical lessons, with the option to seek guidance from peers, classmates, or instructors when needed. Individual laboratory work involves only a student and the materials during the process of practical work in the laboratory. Individual laboratory work is unlike the group laboratory work which deals with the students working cooperatively with one another. Individualized instruction tailors teaching to meet the unique abilities, interests, and learning pace of each student, utilizing personalized content, materials, and media to foster self-directed growth.

Another variable of interest is Gender. Gender refers to the social, cultural and psychological attributes, roles, behaviors and expectations that a society considers appropriate for men and women. The concept of gender is the expectations held about the characteristics, attitudes and likely behavior of both men and women (masculinity and femininity) in the society (Ezeh, 2013). There is a general belief among Nigerians that boys are superior to girls in Mathematician, Science, intelligence and reasoning. Several researchers had led to a series of divergent views on the influence of gender on students' performance and interest in Mathematics. Usman (2018) submitted that males continue to outperform females on measures of Mathematical performances especially on more difficult concepts. Gunderson, Ramirez, Levine and Beilock (2012) were of the opinion that females have more negative attitude toward Mathematics than male thus, affects their achievement in Mathematical concept. Ajai and Imoko (2015) in a study on gender differences in Mathematics achievement and retention scores, the study found that female students outperformed their male counterpart. Hence, there is no doubt that

gender and academic performance in Mathematics exist with different views and findings, and produced inconclusive results, it is believed that bridging gender gap is one major way of achieving egalitarianism and enhancing human development. Since the findings about gender are inconclusive, the researchers are interested in investigating the effect of group and individual laboratory activities on students' performance in Mathematics.

Statement of problem

In Nigeria, students' poor performance in Mathematics, particularly Geometry of plane shapes, Geometric Ratio and Mensuration in Mathematics has not been encouraging. So many factors can be attributed to students' poor performance in Mathematics which include teachers' use of poor teaching methods, lack of adequate laboratory facilities, poor organization of laboratory activities, lack of commitment to laboratory work by both teachers and students, partial or total absence of Mathematics laboratory, lack of qualified Mathematics teachers and mode of laboratory activities that are used by teachers in Mathematics laboratories. The problem of this study stated in question form is: would the use of group and individual laboratory activity improve students' performance in Mathematics?

While, much has been done on the effect of practical method of teaching on students' academic performance of senior secondary schools in different subjects and in various localities like Ugwu, Ngwu, Eze, and Ezea, (2020) who conducted a research on Effects of group and individual laboratory activities on students' achievement in biology among secondary school students in Nsukka Local Government Area of Enugu State. In view of the above mentioned problems, this study was carried out to determine the Effects of Group and Individual Laboratory Activities on Academic Performance in Mathematics among Secondary School Students in Bauchi metropolis, Bauchi State.

Research Questions

The study raised and answered the following research questions:

1. What is the effects of group and individual laboratory activities on students' mean performance scores in Mathematics?
2. What is the influence of gender on the academic performance of students in Mathematics when they are taught using group and individual laboratory activities?

Research Hypotheses

The following hypotheses were tested in this research at 0.05 alpha level of significance.

$H0_1$ There is no significant difference in the mean performance scores of students taught Mathematics using group laboratory activities and those taught using individual laboratory activities.

$H0_2$ There is no significant difference in the mean gain scores of male and female students in Mathematics when taught using group and individual Laboratory activities.

Methodology

The study adopted a quasi-experimental research design. It used a pre-test, post-test, non-randomized, non-equivalent control group involving a 2×2 factorial matrix. Two levels of independent Variable, and two levels of gender (male and female) were investigated on students' performance in Mathematics.

The population for the study comprised all the senior secondary school students in Bauchi, Bauchi State, Nigeria. The target population for the study was all senior secondary school students in Senior Secondary School II (SSS II) in Bauchi, Bauchi State, Nigeria. The choice of SSS II students is based on the fact that a

Geometry of plane shapes, Geometric Ratio and Mensuration in Mathematics is an SSS II topic of Mathematics scheme in the Mathematics Curriculum (NERDC, 2011). Four intact classes of 183 students (102 Males and 81 females) were involved in the study from two purposively selected senior secondary schools in Bauchi, Bauchi State, Nigeria. The schools were purposively selected because of the availability of functioning Mathematics laboratory and also being co-educational. The instruments for the study is the Mathematics Performance Test (MPT), which was used for collecting data. MPT is divided into two sections (section A & section B). Section A is to obtain the bio-data of the respondents which include: Gender, class and test number. Section B of the instrument consisted of twenty (20) multiple questions on Geometry of plane shapes, Geometric Ratio and Mensuration in Mathematics. The instrument was designed by the researcher in line with the Mathematics curriculum. MPT were validated by four experts in Mathematics Education. One expert from the department of science education, University of Ilorin, one expert from the department of science education, Federal University of Kashere, one expert in examination development department, in West African Examination Council (WAEC) and one experienced Mathematics teacher (of at least ten years of working experience) in Bauchi, Bauchi State, Nigeria. The validated MPT was tested for reliability using Pearson Product Moment Correlation (PPMC), which yielded 0.89 at 0.05 alpha level of significance, indicating that the MPT is reliable with good construct validity.

The lesson was taught by research assistants using the lesson plan provided by the researchers. The experiment lasted for two weeks, after which the classroom teacher administered the (BAT) again to the students as the post-test. Both pre-test and post-test scores were collected, marked and scored. The data was recorded and collated for analysis. The collected data was analyzed using mean and standard deviation in answering the research questions, while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05% level of Significance.

The researcher conducted training for the research assistants and all the groups (experimental and control) were given pretest before the treatment so as to ascertain the initial knowledge of the students before the experiment. The lesson was taught by research assistants using the lesson plan provided by the researchers. The experiment lasted for three weeks, after which the classroom teacher administered the (MPT) again to the students as the post-test. Both pre-test and post-test scores were collected, marked and scored. The data was recorded and collated for analysis. The collected data was analyzed using mean and standard deviation in answering the research questions, while t-test and Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05% level of Significance. Specifically, hypotheses 1 and 2 was tested using t-test and hypothesis 3 was tested using ANCOVA.

Results

Research Question One: What is the effects of group and individual laboratory activities on students' mean performance scores in Mathematics?

The performance of experimental and control groups of Mathematics students who were given Mathematics problems is compared in Table 1. The pretest mean scores for the experimental and control groups were 40.62 and 45.50, respectively, but the post-test mean scores for the experimental and control groups were 68.10 and 59.48, respectively. In addition, the mean gain scores for the experimental and

control groups were 27.48 and 13.98, respectively. The mean gain scores of the experimental and control groups differed by 13.50, with the experimental group having a higher mean gain score.

Table 1

Expressions of the Mean Gain Scores of Students in the Experimental and Control Groups

Groups	N	Pretest		Posttest		$\bar{X}$Mean Gain Score
		$\bar{X}$	SD	$\bar{X}$	SD	
Experimental	99	40.62	19.53	68.10	16.59	27.48
Control	84	45.50	10.88	59.48	13.04	13.98

Research Hypothesis One: There is no significant difference in the mean performance scores of students taught Mathematics using group laboratory activities and those taught using individual laboratory activities.

The results of the data analysis for research hypothesis 1, which was tested using a *t*-test, are shown in Table 2. According to the results of the analysis in, the t-value ($t_{(71)}$ = 2.19, p<0.05) was significant at the 0.05 alpha level. This implies that there was a significant difference in performance between the experimental and control groups, with the experimental group outperforming the control group. As a result, hypothesis 1 was rejected, meaning that using group Laboratory activities enhanced students' performance in Mathematics more than individual Laboratory activities.

Table 2: The t-test Analysis of the Significant Differences in the Performance between the Experimental and Control Groups

Groups	N	Mean	SD	*df*	*t*	Sig. (2-tailed)
Experimental	99	68.10	16.59			
				71	2.19	0.032
Control	84	59.48	13.04			

p< 0.05

Research Question Two: What is the influence of gender on the academic performance of students in Mathematics?

Table 3 demonstrates the results of male and female students in the experimental group who were taught Mathematics. Male and female students had significantly different mean scores of 69.94 and 56.42, respectively. This indicates that the male students benefited more from the use of group and individual Laboratory activities in Mathematics, as they had a higher mean score than the female students, with a mean score difference of 13.52 in their favor.

Table 3 : Mean Scores and Standard Deviations of Male and Female Students' Performance in Mathematics Taught Using group and individual laboratory activities.

Gender	N	Mean	Std. Deviation	Mean Gain Score
Male	102	69.94	9.84	
				13.52
Female	81	56.42	19.62	

Research Hypothesis Two: There is no significant difference in the mean performance scores of students taught Mathematics using group laboratory activities and those taught using individual laboratory activities.

The results of the data analysis for research hypothesis 2, which was examined using the *t*-test, are shown in Table 4. The t-value ($t_{(27)}$ = 2.99, p<0.05) was statistically significant at the 0.05 alpha level, as indicated in Table 4. This finding demonstrates that male and female students who were taught Mathematics using group and individual Laboratory activities performed significantly differently, with male students outperforming female students, and it answers research question 2. As a result, hypothesis 2 was rejected, implying that Laboratory activities assist male students' more than female students.

Table 4: t-test Analysis of Significant Differences in Male and Female Students' Performance in the Experimental Group

Gender	N	M	SD	*df*	*t*	Sig. (2tailed)
Male	102	69.94	9.84			
				27	2.99	0.006
Female	81	56.42	19.62			

$p < 0.05$

Summary of Findings

The following are the findings of the study

1 Students taught Mathematics using group laboratory activities performed better than those taught using individual laboratory activities.
2 The male students had a higher mean performance score than the female students when taught Mathematics using group and individual laboratory activities.

Discussion

The result from this finding revealed that students taught Mathematics using group laboratory activities performed better than those taught using individual laboratory activities. This is because, the students working in groups were required to construct knowledge by cooperating with their colleagues and sharing ideas to construct knowledge, which made them to perform better than their colleagues who were taught using Individual laboratory activities. When students work in groups they construct knowledge, analyze and discuss their findings among themselves while those working individually have to construct knowledge by themselves. This finding agreed with some researchers such as of Olutola, Daramola and Bamidele, (2016), Ezra and Agah (2019), Ugwu, Ngwu, Eze, and Ezea, (2020), Abidoye and Omotayo (2023), Kambaila, Kasali, and Kayamba, (2019), Ihejiamazu, Obi and Neji, (2020), Ntawuhiganayo and Nsanganwimana, (2022) who found out that, students who work cooperatively in a group laboratory activities perform better than those who worked individually. Therefore, group laboratory activities were superior to individual laboratory activities in enhancing achievement of students in Mathematics.

Result of the study on the influence of gender on the mean performance scores of the students in Mathematics showed that male students performed better than female students in both group and individual laboratory activities. This could be because of the different socialization processes of male and female in which the males are expected to explore their environment while the females are to conform or maintain their existing environment. The

result of this study supports the findings of Ezra and Agah (2019) and Ugwu, Ngwu, Eze, and Ezea, (2020) who found out in their respective studies that male students perform better than their female counterpart in science subjects. The findings of this study also contradict that of Olutola, Daramola and Bamidele, (2016) and Abidoye and Omotayo (2023) who found out that, there is no significant effect of gender on students' academic performance in Biology. Therefore, the male students performed better than the female students probably because of their outstanding eagerness to learn towards science related subjects.

Conclusion

From the results obtained in the study on the effects of group and individual laboratory activities on students' performance in Mathematics, it was found out that, students taught Mathematics using group laboratory activity performed better than those taught Mathematics using individual laboratory activity and male students performed better than their female student in Mathematics performance test.

Recommendation

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

1. Mathematics teachers should be trained on how best to involve students in group laboratory activities during Mathematics practical in order to improve students' performance in Mathematics. This could be achieved through seminars and workshops for Mathematics teachers in secondary schools
2. In view of the fact that group laboratory activity was more effective in improving student's performance in Mathematics practical than individual laboratory activity, the Ministries of Education should ensure that textbook authors should include group laboratory activity in the instructional methods for secondary school biology practical.
3. Further research should explore long term effects of combined group and individual activities on effective outcomes like attitude and motivation.

Implication of the research findings

he findings of this study have implications for education particularly in teaching Mathematics in secondary schools. The implications of this study are based on development of more active instructional approach for teaching Mathematics. The study revealed that group laboratory activity was more effective in improving students' performance in Mathematics than individual laboratory activity. This result implies that the current instructional method used in teaching might have been partly responsible for student's poor performance in Mathematics. The findings of this study equally have implication for Mathematics teachers because it showed that Mathematics teachers may have been using methods that are not favorable to students' understanding of the subject. Therefore, they need to move from using teacher centred to student-centred teaching methods.

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