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Effect Of Activity-Based Teaching Strategy On Students' Academic Performance In Mathematics Concept

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ABSTRACT

Mathematics concepts cannot be well understood if students are not taught using an effective teaching method, and this can lead to poor academic performance. The teaching of mathematics in Nigeria has fewer hands-on activities that directly engage the students' ability to think and solve problems, such as the activity-based method. Hence, this study examined the effect of Activity-Based Teaching Strategy on Secondary School Students' Academic Performance in Mathematics in Ilorin South, Kwara State. Quasi-experimental research of non-equivalent control group design was employed for the study. This design was adopted to compare the performance of students who were taught Binary Numbers with an Activity-Based Teaching Strategy and those taught with the conventional method. The findings of the study showed that: (i) the experimental group in private school had a mean score of (= 15.00) while the counterpart in the control group had a mean score of (= 13.25); (ii) the experimental group in public school had the mean score of (= 12.00) while the counterpart in the control group had the mean score of (= 9.73); (iii) private school students performed better than public school students with the mean different of (= 3.00) after been taught mathematics concept with activity-based method; (iv) there was no significant difference in the performance of male and female students taught mathematics concept using activity-based method. [.561 > 0.05]; and (v) there was a significant difference between the academic performance of students taught mathematics concepts with activity-based methods based on school ownership (.000 <0.05). The study concluded that complex ideas in mathematics can be understood easily with the help of activity-based teaching.

ARTICLE INFO

1. INTRODUCTION

Teaching is an interactive process through which knowledge and skills are shared with students with the goal of improving understanding and ability to bring about desirable learning. Thus, the teacher initiates communication and interactions through proper instructional processes and methods. According to Ayeni (2017), *teaching* can be defined as a systematic process of transmitting knowledge, attitudes and skills in accordance with professional principles. Meanwhile, the main purpose of teaching at any level is to bring about a significant change in the learner. However, transferring knowledge requires teachers to use the appropriate method and pedagogy that best suits the learner and the objectives and desired outcomes. Thus, effective teaching methods are needed to stimulate learners' interest in order to form a base for achieving desired curriculum objectives in a school setting (Biwer et al., 2020; Munna & Kalam, 2021).

The Federal Republic of Nigeria (FRN, 2013), in the National Policy on Education, emphasized the adequate choice of teaching methods and strategies by teachers to solve educational problems and enhance students learning. This is because it has been observed that the reason for student's poor performance is a result of the teaching method applied by the teacher. Studies from Bello et al. (2016) confirmed that the negative attitude of learners at the basic education level towards certain subjects is a result of poor teaching techniques. Also, Ogide (2017) states that teachers in secondary schools mainly use the conventional or traditional method, which is a teacher-centered method, and the implication is that learners are passive and learning tends to be superficial.

Essentially, teacher-centered teaching methodologies are considered obsolete, a big burden with little impact on the learning development of the child; there is a need for emphasis on those teaching methods that will fully and actively involve students rather than being passive, ignorant and mere recipients of knowledge. The choice of a particular method of teaching by the teacher is determined by a number of factors, which include the content to be taught, the objectives that the teacher plans to achieve, the availability of teaching and learning resources and the ability and willingness of the teacher to improvise if convectional teaching aids are not available, evaluation and follow-up activities and individual learner differences (Ndirangu, 2017).

The methods used in teaching vary depending on the information or skills that are being taught, and the aptitude and enthusiasm of the student can also influence them. Various studies have been conducted concerning teaching methods; for example, Asikhia (2017) found that the qualification of teachers and students' environment factors do not influence students' poor performance, but teachers' methods of teaching influence poor academic performance, while Adunola (2016), also said that regular poor performance by majority students is fundamentally linked to the application of effective teaching methods by teachers to impact knowledge to learners.

Most of the traditional teaching methods are teacher-centered with no activity for the learners, making them passive and, therefore, obtaining knowledge from the teacher without building their engagement level with the subject matter. The approach is less practical, more theoretical and more memorizing (Tebabal & Kahssay, 2016). Student-centered approaches, which are more effective, are encouraged because they embrace the concept of discovery learning (Hoidn & Reusser, 2020).

Many teachers mainly use the conventional method. However, the method is said to be ineffective or obsolete as it does not promote active learning and the ability to foster a critical thinking holistic learning environment among learners and does not consider individual

differences existing in each class as their abilities vary considerably and thereby not meeting the different needs of the students (Green et al., 2020). It is believed that involving learners in the teaching and learning via activity-based methods will make teaching and learning more interesting, make the classroom environment lively, arouse the interest of the learners and sustain their interest and attention throughout the teaching and learning period (Jia et al., 2022). This is because activity-based learning is an instructional approach that emphasizes students' active learning through various activities to develop the three domains of learning (cognitive, affective, and psychomotor) equally (Priyono & Boedi, 2017). The realization of the importance of mathematics to man and society probably accounts for its inclusion in the school curriculum as a compulsory subject so as to enable individuals to face the challenges of life and enhance national development. Mathematics is a prerequisite subject for many fields of learning that contribute immensely to the technological growth of the nation (Vinnervik, 2022). This includes medicines, pharmacy, nursing, agriculture, forestry, biotechnology, nanotechnology, and many other areas (Ahmed & Abimbola, 2015). Also, Umameh (2021) was of the view that mathematics is the bedrock and an indispensable tool for the scientific, technological and economic advancement of any nation.

Mathematics is the foundation of science and technology, and the functional role of mathematics in science and technology is multifaceted and multifarious. Mathematics as a subject is indispensable in the development of any nation with respect to science and technology since mathematics itself is the language of science. Mathematics, as one of the core subjects in the secondary school curriculum in Nigeria, represents one of the modern curricular arrangements that focuses on enhancing students' reasoning and problem-solving skills (Ileuma & Jibou, 2021). Despite the fact that mathematics is one of the major and hinge of science subjects in Nigeria schools, it is quite unfortunate that the subject is being dreaded by many students today. So many factors are responsible for students' poor academic performance in mathematics, such as negative attitudes of students towards mathematics, poor instructional strategies, abstract nature of the subject, difficulty paying attention, lack of practice and poor learning environment in schools, among others (Oni & Isola, 2019).

Mathematics is one of the most poorly taught, widely hated, and abysmally understood subjects in Nigerian secondary schools (Ali et al., 2018). This is evident in the persistent poor performance of Nigerian secondary school students in external examinations such as the Senior School Certificate Examination (SSCE). Poor academic achievement in mathematics could be attributed to many factors, among which are the teachers' teaching methods. This means that mathematics concepts cannot be well understood if students are not taught with an effective teaching method. In the teaching of mathematics, strategies that involve critical thinking and the generation of innovative minds need to be employed.

A binary number is a number expressed in the base-2 numeral system or binary numeral system, a method of mathematical expression that uses only two symbols: typically "0" (zero) and "1" (one). The base-2 numeral system is a positional notation with a radius of 2. Each digit is referred to as a bit or binary digit. Because of its straightforward implementation in digital electronic circuitry using logic gates, the binary system is used by almost all modern computers and computer-based devices as a preferred system of use over various other human techniques of communication because of the simplicity of the language and the noise immunity in physical implementation. Counting in binary is similar to counting in any other number system, beginning with a single digit and counting proceeds through each symbol in increasing order. Before examining binary counting, it is useful to briefly discuss the more familiar decimal counting system as a frame of reference (Wrinkle, 2019).

The call for the Student-centered approach, which, according to the National Teachers Institute (2020), appealed to the needs and interests of the learner, thereby motivating continuous learning. The focus is on learners, encouraging participation and interaction throughout the lesson period, being gender-sensitive and collaborative, and encouraging critical thinking. The student-centered approach, therefore, is said to be the current thinking about teaching that is active and constructive, in which the teacher assumes the role of a guide by emphasizing the learner, guiding the learner, and promoting learner development. Saga (2021) asserts that if the existing teaching strategy is not yielding results, then other teaching strategies should be adopted. Given this, there is a need for a paradigm shift to using methods that are appropriate, relevant, and effective in teaching mathematics.

However, gender plays a significant role in students' academic achievement, especially in science subjects. The importance of studying students' performance as linked to gender differences is particularly related to behavioral differences and perceptions between boys and girls (Adigun, 2021). Voyer and Voyer (2014) equivocally state that differences between boys and girls proceed in a common design on test scores, regardless; girls have the edge on test scores irrespective of the subject matter. The implication is that society should not regard boys as better achievers than girls in matters involving much logical reasoning.

Furthermore, Voyer and Voyer (2014) educators have observed a trend where girls perform better than boys in science that needs logical thinking. In another study, Goni et al. (2015), while investigating the relationship between academic achievement and gender differences, established that an individual's environment, to a larger extent, affects student cognitive and non-cognitive behaviors in test scores. In a classroom environment, teachers may promote gender bias when a learning platform is created that favors the success of either boys or girls. The male gender performs excellently well in structural assignments, while the female gender excels in languages.

On the influence of school ownership (public and private) in the teaching and learning process. If certain types of schools have more resources or a better learning environment, students who attend these types of schools are more likely to perform better. Conversely, those students who attend schools with fewer resources for practical and disruptive environments tend to perform poorly, which could ultimately limit their prospects in life (Nwadi et al., 2020). In addition, as learning environments and gender play important roles not only in students' academic performance but also in their socialization in a broader sense, school ownership that is highly stratified along socio-economic lines could inadvertently undermine social cohesion. Socio-economic stratification and students' educational experiences differ depending on whether they attend publicly or privately managed schools (OECD, 2016).

Privately managed schools may have the authority to hire and compensate teachers and staff and thus can select better-prepared teachers and introduce incentives for performance. Privately managed schools may also have more discretion on curricula and instructional methods and so can adapt them to the interests and abilities of their students. The need to attract students means that privately managed schools must be more sensitive to parents' demands concerning curricula, teaching methods, facilities and discipline and more responsive to students' needs (Epple et al., 2015). It is on this premise that this study seeks to assess the effects of activity-based teaching strategies and conventional methods on Secondary school students' academic performance in Mathematics (Ozofor, 2018).

Mathematics is used either consciously or unconsciously in various aspects of life and is the basic tool for industrialization and national development. It is also recognized to play a

vital role in contemporary society, making it indispensable for the existence of any nation. The importance of Mathematics can be seen in its applications to science and technology, medicine, the economy, the environment, and public decision-making. The implication is that for effective functioning in society, all citizens need to study and understand science and mathematics. Analysis of students' achievement in Mathematics shows that the performance of Nigerian students is not encouraging (Oribhabor, 2020). According to the Naija News (2019), 43.30% of candidates who attended the 2018 West African Examination Council (WAEC) in Nigeria obtained credits and above in Mathematics; this shows the abysmal performance in the state. WAEC Chief Examiner for the private candidates (2018) further observed that candidates were weak in areas such as Mensuration, Translation of word problems to form equations, Sequence and Series, Inequality, Histogram, Circle Geometry, Matrices, and Construction. This has always led to poor academic achievement and has been a great thing of worry to all educational stakeholders, such as parents, teachers, educational psychologists, counselors, government, and society at large. This is because mathematics is, today, part of the basic requirements for entrance into tertiary institutions. This consistent poor performance by students in mathematics calls for serious national action to remedy the situation. Poor academic achievement in mathematics could be attributed to many factors, among which are the teachers' teaching methods (Daka et al., 2021).

This means that mathematics concepts cannot be well understood if students are not taught with an effective teaching method. The teaching of mathematics in Nigeria is mainly theoretical, with the talk and chalk method, with fewer hands-on activities and fewer methods that directly engage the student in building the capacity to think and solve problems independently (Adigun, 2021). With the advent of the concept of discovery learning, there is a need to adopt supplier student-centered methods to enhance active learning widely. The student-centered approach in mathematics will help promote interest, analytical research, critical thinking, and enjoyment among students, as it is more effective since it does not centralize the flow of knowledge from the teacher to the student. Therefore, for better student performance, there is a need to adopt an activity-based, student-centered approach instead of depending on the conventional approach (Kang & Keinonen, 2018). This study, therefore, seeks to find out whether activity-based and problem-solving methods might have a positive impact over the conventional method on students' performance in Mathematics.

2. METHODOLOGY

A quasi-experimental design of a non-randomized control group design was used to compare the performance of students who were exposed to the Activity-based strategy for learning mathematics concepts and those exposed to the conventional method. Students' performance test on a Mathematics concept was administered to both the control and experimental groups. The experimental group was subjected to a treatment using an activity-based teaching technique, while the control group was taught using the conventional teaching method. The research design layout is shown in Table 1.

Tabel 1. Research Design Layout

Groups	Treatment	Test
Experimental Group	Activity-Based Test	O1
Control Group	Conventional Classroom	O2

X   O1

-    O2

Where,

O1 represents the Experimental Group,

O2 represents the Control Group,

X represents the treatment for the Experimental Group,

- represent the conventional method for the Control Group.

The independent variable in this study was the Conventional and Activity-based teaching method. The moderating variables were gender and school ownership of students while the dependent variable was the academic performance of both the experimental and control group.

2.1. Population, Sample and Sampling Techniques

The population of this study was all private and public secondary schools in Kwara state, Nigeria. The target population for this study was students from a selected private and public Junior secondary school in Ilorin South, Ilorin, Kwara State, Nigeria. Specifically, Junior secondary students were purposively selected as samples for this study. The class was divided into two groups: the experimental group and the control group. An intact class of 22 students constituted the experimental group in private schools, while 20 students were also sampled for the control group. Twenty-seven students constituted the experimental group in public schools, while 30 students were also sampled for the control group.

2.2. Research Instrument

Two research instruments were developed and used by the researchers to gather relevant data in this study. The instruments include (i) Activity-based Teaching Strategy (ATS) and (ii) Student Performance Test in Mathematics (SPTM). Activity-based Teaching Strategy (ATS is an instructional approach that emphasizes students' active learning through various activities to develop the three domains of learning (cognitive, affective, and psychomotor). This experiential learning focused on learning by doing; students physically and mentally explore binary numbers as a mathematics concept by doing various activities. The activity-based method is a method of teaching that enables students to be involved in reading, writing, discussion, practical activities, analysis, and evaluation of the topic under discussion. Student Performance Test in Mathematics (SPTP): A list of 20-question objective tests developed by the researcher and with its items selected from the binary number system, which are in the Junior Secondary School Mathematics curriculum and the lesson plan, will be used as an instructional tool for the study.

2.3. Procedure for Data Collection

The researcher collected an introduction letter from the Department of Educational Technology, which was taken to the target secondary schools. The researcher visited the

selected schools to get official permission to use the schools and students for the study. Data was collected with the help of research assistants.

The experimental group was taught a mathematics concept using the activity-based teaching method, specifically a mathematics activity game based on the binary numbers system. The treatment lasted for one week, after which the researcher also taught the experimental group. The control group was simultaneously given the SPTP with the help of the research assistants, and they were taught the conventional method for one week, after which the post-test was also administered to them. The SPTM was administered to both groups. The experimental group was taught selected mathematics concepts using the conventional teaching method and later exposed to ABL for one week. In contrast, the control groups were simultaneously taught the same concepts with the conventional teaching method.

2.4. Data Analysis Techniques

The analysis and interpretation of data obtained from the test items were carried out using descriptive and inferential statistics. Percentage, Mean and standard deviation were used to answer the five (5) research questions. Independent t-test was used to test hypotheses 1 and 2. All hypotheses were tested at 0.05 level of significance.

3. RESULTS AND DISCUSSION

This chapter presents the analysis and results obtained from the data gathered based on research questions and hypotheses formulated in this study. The data presented provide a summary of the major characteristics of the respondents who were involved in the study. The respondents were comprised of different genders, males and females. In this study, 49 (49.5%) were male, while 50(50.5%) were female. The respondents were also distributed based on school type. 42(42.4%) of the respondents were from private schools while 57(57.6%) of the respondents were from public school. Furthermore, the respondents in the experimental group were 49(49.5%), while those in the control group were 50(50.5%), respectively. Demographic data collected were analyzed using frequency counts and percentages while they were further presented using graphs and charts. The two hypotheses generated were tested at a 0.05 level of significance. The results from the analysis of data are presented as follows:

Tabel 2. Distribution Of The Participants Based On Gender

Gender	Frequency	Percentage
Male	49	49.5
Female	50	50.5
Total	99	100

Table 2 shows the total number of pupils that participated in this study to be 99. Out of these 99 Students, 49(49.5%) were male while 50(50.5%) were female. The result from table 1 shows that male pupils participated more than females pupils in the study. Figure 1 further presnts the distribution in pie chart.
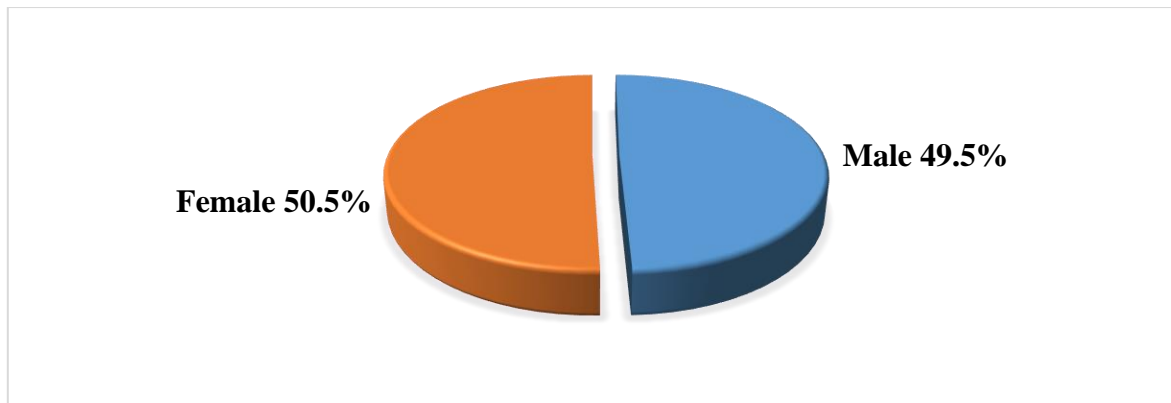
Figure 1. Distributin of the participants Based on Gender

Tabel 3. Distribution of the Paticipants Based on School Ownership

School Type	Frequency	Percentage	Cumulative
Private	42	42.4	42.4
Public	57	57.6	100.0
Total	99	100.0	

Table 3 shows the participants' distribution based on school ownership. The table shows that 42 (42.4%) of the participants are from private schools, while 57(57.6%) of the respondents are from public schools. The distribution shows that public school students participated more than private school students in the study. Figure 2 further presents the distribution in a pie chart.
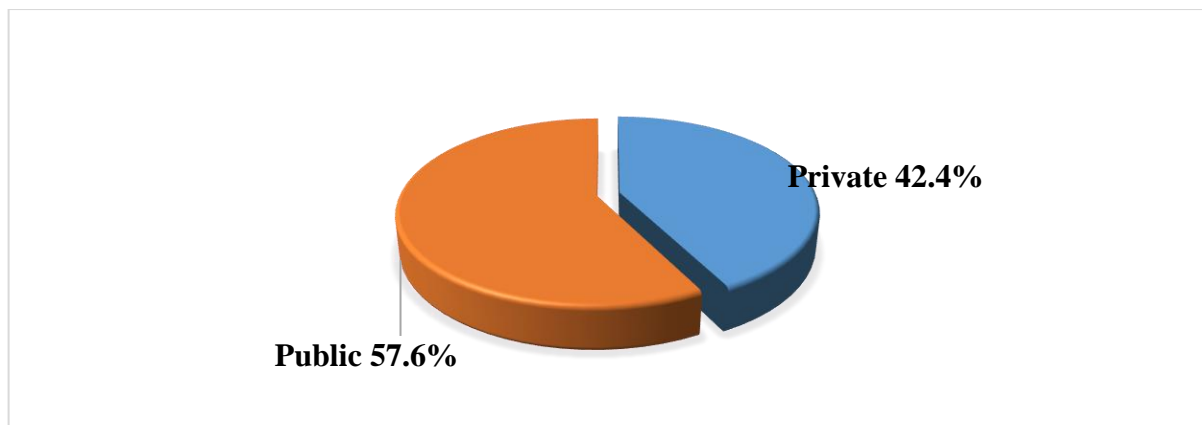

Figure 1. Distribution of the Paticipants Based on School Ownership

Tabel 4. Distribution of Paticipants Based on Treatment Groups

Group	Frequency	Percentage
Activity-based Learning Strategy (ALS)	49	49.5
Conventional Method (CM)	50	50.5
Total	99	100.0

Table 4 shows the number and percentage of the participants in each of the two groups (Activity-based Learning Strategy and Conventional Method groups) that were used for this study. Table 3 shows that 49(49.5%) of the participants were in the ALS group, while 50(50.5%) were in the conventional method group. Figure 3 further presents the distribution in a pie chart.
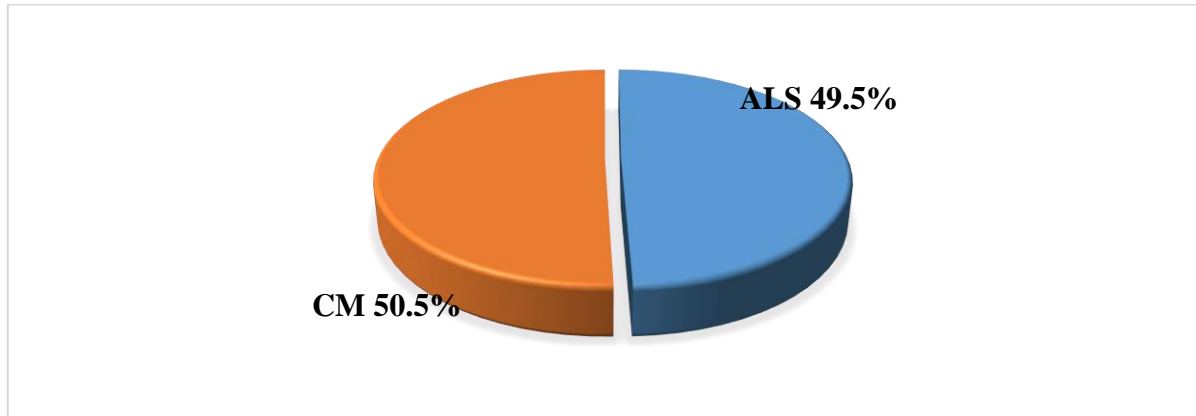

Figure 2. Distribution of Paticipants Based on Treatment Groups

Research Question One: what is the academic performance of junior secondary school students taught mathematics concept using activity-based method and those taught with conventional method in private school.

Tabel 5. Percentage, Mean and Standard Deviation Showing the Academic Performance of Junior Secondary School Students Taught Using Activity-based Method and those Taught with Conventional Method in Private School

Group	N	Percentage(%)	Mean	Std. D
Activity-Based Strategy (Experimental Group)	22	55.46	15.00	2.91
Conventional Method (Control Group)	20	44.54	13.25	2.51

Table 5 shows the percentage, mean and standard deviation of the students in both experimental and control groups in private schools. The experimental group had a mean score of (= 15.00), while the control group had a mean score of (= 13.25). Based on the mean score of each group, it can be inferred that the experimental group in private school performed better than their counterparts in the control group. The difference between the academic performance of students in both groups is (= 1.75). That is, the mean score of students taught with activity-based strategy is higher than that of those taught with conventional method. Using percentages to establish the performance of both groups, students taught with the activity-based strategy had 55.46%, while those taught with the conventional method had 44.54.

Research Question Two: What is the academic performance of junior secondary school students taught mathematics concepts using activity-based methods and those taught with conventional methods in public schools?

Tabel 6. Percentage, Mean And Standard Deviation Showing The Academic Performance Of Junior Secondary School Students Taught Using Activity-Based Method And Those Taught With Conventional Method In Public School

Group	N	Percentage(%)	Mean	Std. Deviation
Activity-Based Strategy (Experimental Group)	27	52.60	12.00	2.51
Conventional Method (Control Group)	30	47.40	9.73	2.49

Table 6 shows the percentage, mean and standard deviation of the students in both experimental and control groups in public schools. The experimental group had a mean score of (= 12.00), while the control group had a mean score of (= 9.73). Based on the mean score of each group, it can be inferred that the experimental group in public schools performed better than their counterparts in the control group. The difference between the academic performance of students in both groups is (= 2.27). That is, the mean score of students taught with activity-based strategy is higher than that of those taught with conventional method. Using percentages to establish the performance of both groups, students taught with the activity-based strategy had 52.60%, while those taught with the conventional method had 47.40.

Research Question Three: what is the difference between the academic performance of junior secondary school students taught mathematics concept with activity-based method in both private and public school.

Tabel 7. Percentage, Mean and Standard Deviation Showing the Difference between the Academic Performance of Junior Secondary School Students Taught with Activity-based Method in Both Private and Public School

Group	N	Percentage(%)	Mean	Std. Deviation
Activity-Based Strategy (Experimental in Private)	22	50.46	15.00	2.91
Activity-Based Strategy (Experimental in Public)	27	49.54	12.00	2.51

Table 7, shows the difference between academic performance of junior secondary school students taught mathematics concept with activity-based method in both private and public school. Experimental group in private school with the mean score of ($\bar{x}$ = 15.00) while experimental group in public school with the mean score of ($\bar{x}$ = 12.00). Using percentage score to establish the difference in the performance of both students, students taught with activity-based strategy in private school had 50.46% while those taught with activity-based strategy in public school had 49.54. Based on the difference in the score of the students, it can be inferred that private school students performed better than public school students. The different between the academic performance of students in both schools is ($\bar{x}$ = 3.00). That is, the mean score of private school students is higher than that of those students in public school even though they were both exposed to active-based teaching strategy.

Research Questions on the academic performance of junior secondary school students taught mathematics concepts using activity-based methods and those taught binary number

systems with conventional methods in private schools revealed that students taught with activity-based strategies performed better than their counterparts taught with the conventional method with a percentage difference of 10.92%. This result is in agreement with Wiggins (2017), who reported that interaction between the teacher and students during the teaching and learning process of mathematics encourages the students to search for knowledge rather than the teacher monopolizing the transmission of information to learners. This shows that there was a significant relationship between the activity-based method and students' academic performance in mathematics.

Research question two examined the academic performance of junior secondary school students taught mathematics concepts using activity-based methods and those taught with conventional methods in public schools. Results reveal that students taught with an activity-based strategy performed better than their counterparts taught with the conventional method, with a percentage difference of 5.20%. This result agrees with Daluba (2013), who argued that for the better performance of students, the use of an activity-stimulating and student-centered approach would be necessary instead of depending on the conventional approach.

The research question answered the difference between the academic performance of junior secondary school students taught the binary number system with the activity-based method in both private and public schools. Based on the difference in the scores of the students, it can be inferred that private school students performed better than public school students. The difference between the academic performance of students in both schools is ($\overline{x}$ = 3.00). That is, the mean score of private school students is higher than that of those students in public schools, even though they were both exposed to active-based teaching strategies. The finding of this study is in agreement with the finding of Mokiwa and Agbenyeku (2019), who found a significant difference in the academic performance between the experimental groups exposed to the activity-based teaching strategy when compared to the control group exposed to the traditional lecture method in both public and private schools.

Hypothesis one tested the significant difference between the academic performance of junior secondary school students taught mathematics concepts using activity-based methods based on gender. Findings show that there was no significant difference between the academic performance of junior secondary school students taught mathematics concepts using activity-based methods based on gender. Also, the values of the mean scores do not reveal any appreciable difference. This finding agrees with Stanley's (2017) findings that understanding and retention are products of meaningful learning when teaching is effective and meaningful to students, whether male or female. Thus, meaningful learning is the product of the student's involvement in the act of learning, such as seen in the Activity-Based Instructional Strategy. Also, this finding agrees with that of Ajayi (2017), who observed that the instructional strategy used does not discriminate between males and females.

Finally, hypothesis two tested the significant difference between the academic performance of students taught mathematics concepts with activity-based methods based on school type. As revealed, there was no significant difference between the academic performance of students taught mathematics concepts and activity-based methods based on school type. The mean score of private school students is higher than that of public school students. That is, private school students performed better than public school students after being taught the concept of mathematics using an activity-based method. This is supported by the conclusion of Mokiwa and Agbenyeku (2019), who opined that the reason for this may

be that activities in Mathematics classes in private schools provide opportunities to work with tangible materials and increase the motivation and interest of the students. Additionally, it may be considered that the presentation and content of the activities made it easier to learn the subject and relate it to daily life.

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