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Comparative Analysis of Effect of Assessment for Learning and Assessment of Learning on Learning Outcome in Mathematics

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Abstract: This study compares the impact of Assessment of Learning (AoL) and Assessment for Learning (AfL) on students' mathematics achievement. The quasi-experimental study, which was carried out in the Ekiti Central Local Government Area of Ekiti State, Nigeria, featured 140 seniors in secondary education out of the total population of 500 senior secondary school students, including 200 male and 300 female students from ten public secondary schools in the area. A multi-stage sampling procedure was employed; simple random sampling was also used to select four intact classes from these schools (two from each). One intact class was randomly assigned to the experimental group and the other to the control group. Well-structured items named Mathematics Achievement Test (MAT)was developed and used for data collection. The instrument's face validity was confirmed.The respondents were split into two groups: the experimental group received training in AfL practices, while the control group received training in AoL techniques. Math proficiency was assessed by pre-test and post-tests. Significant post-intervention gains were seen in the experimental group's scores, according to analysis with t-tests and ANCOVA; no significant gender differences were noted. The findings support previous research emphasizingAfL's beneficial effects at all educational levels and highlight how well it can improve mathematical understanding. These results emphasize the significance of using AfL techniques in instructionto enhance mathematics learning outcomes.

Keywords: Assessment of Learning (AoL), Assessment for Learning (AfL),Mathematics proficiency

Introduction

Mathematics is a fundamental subject in primary and secondary education due to its daily relevance. It is essential for everyone, regardless of their profession, as it deals with measurement, numbers, and quantities, forming the foundation for social transformations and practical problem-solving (Kehinde-Dada, 2020). Mathematics enables students to handle everyday tasks such as solving basic numerical problems, determining quantities, adding up purchases, and calculating distances.Mathematics is crucial for a well-rounded life and it is considered essential for the development of scientific and technological progress in any nation (Haruna &Daya, 2018). It is a major subject in upper basic education, where the curriculum is both pre-vocational and academic, making it one of the core subjects (Ugwuda&Ochuenwike, 2020). Despite its importance, many Nigerian students find mathematics so difficult and abstract. Research has shown that students' performance in mathematics has been consistently poor, particularly in senior secondary schools (Maliki, Ngnban&Ibu, 2017). In 2017, only 43% of candidates who took the senior school certificate examination obtained credit passes (NECO, 2017).

Despite concerted efforts by stakeholders to improve Mathematics education in Nigeria, performance in public examinations such as WAEC and NECO has remained suboptimal over the past decade. For instance, pass rates in WAEC Mathematics have fluctuated considerably, with only 65.71% of candidates attaining credit-level passes in 2020, declining to 54.11% in 2021 (Peace FM Online, 2021). Although there has been modest recovery in recent years, average success rates remain around 60%, indicating persistent gaps in foundational mathematical competencies (Geshub, 2024). Similarly, while NECO has reported relatively higher Mathematics credit rates (e.g., 78.23% in 2022 and 93.93% in 2024), the proportion of students passing both Mathematics and English simultaneously hovers around 60%, which is insufficient to guarantee broad academic progression or competitiveness (Guardian Nigeria, 2022; Capital Post, 2025).In-depth regional studies further reveal localized patterns of underperformance, with some secondary schools in Adamawa State recording WAEC Mathematics pass rates as low as 20–40% over a five-year period (Ibrahim et al., 2024). These findings highlight the need for targeted interventions to address the root causes of weak mathematical achievement among Nigerian students.

One area that has not been adequately explored in enhancing mathematics instruction is the use of assessment. Assessment is a critical tool in education for measuring learning outcomes and motivating learners. It plays a vital role in the school system, being used for appraisal, selection, and diagnosing student weaknesses (Harry, 1994; Ndlove, 1996). Assessment results are viewed as indicators of school success and are integral to teaching

and learning (Black & William, 1998). Summative assessments measure learning outcomes at the end of a specific period, but there is also a growing emphasis on assessment for learning, which aims to improve the quality of teaching and modify students' learning based on feedback (Rabinowitz, 2010).Assessment for learning is used by teachers and students to provide feedback that increases learning. It focuses on facilitating students' learning rather than merely evaluating or certifying competency (Assessment Reform Group, 2002). Effective feedback from teachers helps learners comprehend their progress and identify opportunities for development. Research shows the effectiveness of evaluation for learning in enhancing student performance and making them more self-regulating and autonomous learners (Earl, 2014; Willis, 2011; Van Der Vleuten *et al*., 2014).
The advantages of assessment for learning, according to Duckett (2005), include improving classroom instruction, fostering personalized learning, and increasing students' self- and peer-evaluation confidence. With this strategy, educators must provide students excellent feedback and help them apply it. For assessment for learning to be successfully implemented, teachers must receive the right training and assistance. Scholars have commended this methodology for its beneficial effects on student performance and its contribution to students' attainment of learning objectives (Earl, 2014; Willis, 2011).According to Wylie (2020), assessment of learning is concerned with assessing what has been learnt, whereas evaluation for learning aims to improve learning. This perspective is supported by researchers like Box (2019), Gotwals et al. (2015), and Moreno & Pineda (2020). Duckett (2005) noted a number ofadvantages of assessment for learning include improving classroom instruction, fostering personalized learning by giving students the freedom to take an active role in their education, and boosting students' self- and peer-evaluation confidence.(Jones, 2005) emphasized that "effective feedback provided by teachers to learners on their progress" is the main component of assessment for learning. The caliber of the input and how the pupils use it determine how effective this method is. Jones highlights that in order to provide students with constructive criticism and to provide high-quality feedback, teachers must have support and training.

Evaluation for learning has been commended by several researchers as a successful teaching strategy that raises student achievement (Earl, 2014; Willis, 2011; Van Der Vleuten, Schuwirth, Driessen, Govaerts, &Heeneman, 2014). While Willis (2011) notes that assessment for learning fosters students' development as more independent and self-reliant learners, Earl (2014) argues that assessment for learning can aid in the achievement of learning objectives. According to Willis, kids gain this advantage when learning objectives and evaluation standards are communicated to them giving them experience in self-assessment, and providing guidance through feedback.

Assessment for learning and assessment of learning are two distinct approaches to evaluating students' knowledge, skills, and progress in the educational process. There are differences between them which are:

Assessment for Learning (AfL) primary purpose is to support and enhance learning by providing feedback that helps students understand their strengths and areas for improvement. It occurs continuously during the learning process, allowing for real-time adjustments and interventions. It focuses on the learning process, student development, helps students set goals in order to understand the next steps in their learning journey. It provides detailed, constructive feedback aimed at helping students learn and improve. It is often formative, informs teaching and learning but is not necessarily used for grading.

Examples are quizzes, peer reviews, discussions, informal observations, and draft submissions.

Assessment of Learning (AoL) purpose is to measure and document what students have learned, often for the purpose of reporting to stakeholders such as educators, parents, and policymakers. It typically occurs at the end of a learning unit, course, or academic period, summarizing students' learning at a particular point in time. This focuses on the outcomes and results of the learning process. It evaluates students' performance against predefined standards or benchmarks. It provides summative feedback that often comes in the form of grades or scores. This type of assessment is more evaluative than formative.

Examples are final exams, standardized tests, end-of-term projects, and report cards.

Summary of Differences

AfL aims to improve ongoing learning, while AoL aims to evaluate and summarize what has been learned. AfL is continuous and formative, while AoL is periodic and summative. AfL is process-oriented, focusing on student development, while AoL is outcome-oriented, focusing on performance and achievement. AfL provides formative, constructive feedback, while AoL provides summative, evaluative feedback. Understanding the distinction between these two types of assessments helps educators design and implements effective strategies that not only measure student learning but also promote continuous improvement and development.

Furthermore, assessment for learning benefits teachers by requiring them to closely observe what students understand and do not understand, allowing them to adjust their teaching strategies accordingly. Sadler (1989) describes feedback as "information about how successful something is," which is crucial for improving tasks from a cognitive perspective (Wisniewski et al., 2020). Feedback also helps students develop self-evaluation skills and become aware of their thought processes (Moss & Brookhart, 2019). Hattie and Clarke (2018) emphasized feedback as an effective tool for enhancing learning, highlighting its critical role in assessment for learning (Ardington& Drury, 2017; Box, 2019; Cramp, 2011; Sadler, 1989).

Using assessment for learning in mathematics classrooms is essential for providing students with opportunities to review their knowledge, reflect, and improve their learning (Swan & Foster, 2018). Ajogbeje (2013) noted that teachers should inform students about their strengths and weaknesses in specific subject matter to improve learning. Feedback is crucial for enhancing student achievement, and teachers' feedback strategies play a significant role in this process. To develop more effective tools for mathematics teaching, new learning approaches need to be studied (Selçuk et al., 2014; Yalçınkaya&Özkan, 2012).The concept of functions is fundamental in mathematics, yet students often struggle with it (Teuscher&Reys, 2010). There is a need for more research on teaching this concept (Özgen&Alkan, 2014). Studies have shown that assessment for learning significantly improves students' learning in mathematics (Andersson & Palm, 2017; Cauley& McMillan, 2010; Chen et al., 2020) and positively impacts student motivation (Beesley et al., 2018; Faber et al., 2017). However, there is a lack of studies on high school mathematics education that combine education and evaluation (Er&Biber, 2020).

The aim of this research is to examine the impact of assessment for learning practices on students' performance in mathematics. Specifically, the study explored whether there would be differences in the mathematics achievement test scores between students in the experimental group (assessment for learning) and the control group (assessment of learning) before the intervention.

Research Hypotheses

Ho_1: There is no significant difference in the mean scores of the mathematics achievement test between students in the experimental group (assessment for learning) and the control group (assessment of learning) before the treatment.

Ho_2: There is no significant difference in the mean scores of the mathematics achievement test between students in the experimental group (assessment for learning) and the control group (assessment of learning) after the treatment.

Ho_3: There is no significant difference in the mean achievement scores between male and female students in the experimental group (team teaching) and the control group (conventional teaching).

Methods

A quasi-experimental research design was utilized in this study, conducted in the Ekiti Central Local Government Area of Ekiti State, Nigeria. This location was selected due to the limited amount of educational research previously conducted there. The study's population consisted of 500 senior secondary school students, including 200 male and

300 female students from ten public secondary schools in the area. Simple random sampling was also used to select four intact classes from these schools (two from each). One intact class was randomly assigned to the experimental group and the other to the control group.

The sample size was 140 students. A multi-stage sampling procedure was employed, using simple random sampling without replacement to select two secondary schools (one male and one female) from the ten in the Ekiti Central LGA.

The Mathematics Achievement Test (MAT), developed by the researchers, was used for data collection. The instrument's face validity was confirmed by three specialists—one in Mathematics Education and two in Measurement and Evaluation—from the College of Education at Bamidele Olumilua University of Education, Science and Technology Ikere Ekiti. Content validity was ensured through the construction of a test blueprint. The reliability of the MAT was estimated using the split-half method of correlation.A high correlation coefficient (0.92) between the scores on the two halves indicates strong split-half reliability. This suggests the different sections of the test are measuring the same construct consistently.

Results

To test this hypothesis, scores from the Mathematics Achievement Test for the experimental group (Assessment for Learning) and the control group (Assessment of Learning) were analyzed.

Ho_1: There is no significant difference in the mean scores of the mathematics achievement test between students in the experimental group (assessment for learning) and the control group (assessment of learning) before the treatment.

The results are presented in the table below:

Table 1: T-test Analysis of Achievement Mean Scores of Students in Experimental (Assessment for Learning) and Control (Assessment of Learning) Groups before Treatment.

Group	N	X	SD	df	t-cal	t-tab	Result
Assessment for learning	70	12.51	6.71	138	0.55	1.98	**
Assessment of learning	70	11.92	5.89				

P>0.05(Result Not significant at 0.05 level),=Not Significant**.

Table 1 illustrated the mean scores of the mathematics achievement test for students in both the experimental (Assessment for Learning) and control (Assessment of Learning) groups prior to the intervention (pre-test). A statistical comparison of the mean scores was conducted, yielding a t-value (t-cal) of 0.55 with a p-value greater than the 0.05 alpha level, indicating a lack of statistical significance at the 0.05 threshold. The mean difference in mathematics achievement scores between the two groups (12.51 for the experimental group and 11.92 for the control group) was 0.59. This result suggests that there is no significant difference in the pre-test mathematics achievement scores between the experimental (Assessment for Learning) and control (Assessment of Learning) groups. Consequently, the null hypothesis, which posited that there is no significant difference in the mathematics achievement mean scores of students in the experimental and control groups before treatment was not rejected. This indicates that the two groups were homogenous in terms of their mathematical achievement prior to the commencement of the treatments, ensuring a fair comparison for subsequent analyses.

Ho_2: There is no significant difference in the mean scores of the mathematics achievement test between students in the experimental group (assessment for learning) and the control group (assessment of learning) after the treatment.

Table 2: T-test analysis of mathematics achievement mean scores of students taught using Assessment for learning strategy and students taught using Assessment of learning strategy after the treatment.

Group	N	X	SD	df	t-cal	t-tab	Result
Assessment for learning Strategy	70	24.84	10.62	138	4.47	1.98	*
Assessment of learning Strategy	70	17.92	7.42				

P <0.05 (Result Significant at 0.05 level).* =Significant.

In Table 2, the posttest mathematics achievement mean scores of students taught using the Assessment for Learning strategy and those taught using the Assessment of Learning method were statistically compared. The analysis yielded a t-value (t-cal) of 4.47 with a p-value less than the 0.05 alpha level, indicating statistical significance at the 0.05 level. The mean difference in achievement scores between the two groups (24.84 for Assessment for Learning and 17.92 for Assessment of Learning) was 6.92. This result suggests a significant difference in the posttest mathematics achievement scores in favor of students taught using the Assessment for Learning strategy. Consequently, the null hypothesis, which stated that there is no significant difference in the achievement mean scores of students taught using the Assessment for Learning strategy and those taught using the Assessment of Learning strategy, was rejected. This finding indicates that the Assessment for Learning strategy is more effective compared to the Assessment of Learning strategy.

Ho3: There is no significant difference in the mean achievement scores between male and female students in the experimental group (team teaching) and the control group (conventional teaching).
To test this hypothesis, the mathematics achievement test scores of male and female students taught using the Assessment for Learning strategy and the Assessment of Learning strategy were computed and analyzed using Analysis of Covariance (ANCOVA) at a 0.05 level of significance. The results are presented in Table 3.

Table 3: ANCOVA showing Mathematics achievement scores of assessments for learning strategy and assessment of learning strategy byGender.

Source	Type III Sum of Squares	df	Mean Squares	F	Sig.	Partial Eta Squared
Corrected Model	2296.757	4	1653.276	233.231	.000	.946
pretest	1606.213	1	1606.213	231.267	2.68	.998
Achievement Sex	55.873	1	55.873	2.036	.108	.084
Group	312.563	1	312.563	163.682	.000	.976
Sex * Group	12.431	1	12.431	.302	.425	.008
Error	1687.334	115	25.316			
Corrected	1967.356	119				
Total	61243.322	**140**				

R Square =0.946,P>0.05 (Result Significant at 0.05level).

Table 3 shows that the calculated F-value (F-cal = 0.302) is less than the F-tab value (0.425), with a P-value greater than the 0.05 alpha level. This analysis indicates no significant difference in the mathematics achievement mean scores between male and female students taught using the Assessment for Learning strategy and the Assessment of Learning strategy. Consequently, the null hypothesis was not rejected. This implies that the mathematics achievement mean scores of male and female students are not significantly different when taught using either the Assessment for Learning or the Assessment of Learning strategies.

Conclusion

The results indicated that assessment for learning practices significantly improve students' mathematics achievement. Implementing these practices in mathematics lessons for senior secondary school students has led to notable improvements in achievement. These findings align with various studies in the literature (Andersson & Palm, 2017; Box, 2019; Cormier, 2020; Faber et al., 2017; Kline, 2013; Ozan &Kıncal, 2018), which have shown that assessment for learning practices positively impact learning across different grade levels (Loughland& Kilpatrick, 2015; Thoms, 2011; Wanner& Palmer, 2018). The benefits of assessment for learning are evident at all educational levels, from primary school to university, underscoring its importance in the learning process. Research hypothesis three examined the difference in mathematics achievement mean scores between male and female students taught using the assessment for learning strategy and the assessment of learning strategy. The findings showed no significant difference in academic achievement between male and female students in mathematics, whether in the experimental or control groups, both before and after the treatment. In other words, the achievement levels of male and female students exposed to the assessment for learning strategy did not significantly differ, with female students performing similarly to their male counterparts in both the assessment for learning and assessment of learning strategies. This implies that gender was not a significant predictor of students' achievement in mathematics. This finding is consistent with the results of Akpan, Usoro, Akpa, &Ekpo (2010), who reported no significant difference between the mean performance of male and female students in introductory technology when taught using assessment for learning and assessment of learning strategies.

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