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Effect of Mobile Learning Apps & Instructional Strategy on Mathematics Achievement among Secondary School Students in Enugu State

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Abstract **Original Research Articles**

Persistent underachievement in mathematics among Nigerian secondary school students, as reflected in fluctuating WASSCE results, has raised concerns about the effectiveness of traditional instructional methods and the role of technology in learning. This study investigated the effect of mobile learning applications and instructional strategies on mathematics achievement among secondary school students in Enugu State. Guided by the Constructivist Learning Theory and the Technology Acceptance Model, the study adopted a quasi-experimental design involving 300 students sampled from three public secondary schools, out of which 230 valid responses were analyzed. Data were collected using a structured questionnaire and pre-test/post-test assessments, with constructs measured on a 5-point Likert scale. Descriptive statistics, t-tests, and ANOVA were employed in data analysis. Findings revealed that students exposed to mobile learning apps (Udemy and Khan Academy apps) combined with learner-centered instructional strategies recorded significantly higher achievement gains (mean gain = +31.4) compared to those taught using conventional methods (mean gain = +14.6). Results further showed minimal gender disparities and consistent improvement across academic tracks, underscoring the universal benefit of mobile learning integration. The study concludes that the combined use of mobile learning apps and innovative instructional strategies substantially improves mathematics achievement and provides a viable solution to declining performance trends. It recommends curriculum integration of mobile learning, teacher professional development in technology use, provision of ICT infrastructure, and parental support for sustained learning beyond the classroom. Despite limitations in scope, sample size, and duration, the study provides empirical evidence for policymakers, educators, and stakeholders on the transformative potential of mobile-assisted learning in mathematics education.

Keywords: Mobile Learning, Instruction, Mathematics Achievement, Secondary Schools.

INTRODUCTION

Mathematics is a foundational subject for every learner, in the curriculum of secondary education worldwide, thereby serving as a gateway to careers in science, technology, engineering, and mathematics (STEM). According to Thanheiser (2023) in the study of Mathematical Behavior, mathematics holds a crucial place in disciplines such as science and technology, and it is essential for research and innovation across engineering, computer science, healthcare, and finance. As a subject rich in depth and challenge, mathematics captures the curiosity of learners of all ages, backgrounds, and abilities (Thanheiser, 2023).

Mathematics, as a subject in Nigerian secondary schools is compulsory at that level because of its importance in national development, innovation, and problem-solving (Melhuish et al., 2022). However, despite its significance, reports from examination bodies such as the West African Examinations Council (WAEC) have consistently presented students' poor performance in core mathematics, across several years.

A major instance was observed by Martin (2022) when WASSCE results from 2017 to 2019 which revealed fluctuating performance levels in Mathematics scores were considered: 57.3% in 2017, 61.67% in 2018, and 34.45% in 2019, thereby indicating a 4.37% increase from 2017 – 2018, before drastically plummeting down with a decrease of over 27%

(Martin, 2022). Although there was an improvement in 2018, the sharp decline in 2019 underscores the unpredictability of students' performance trends. Similarly, in the 2021 May/June WASSCE, the percentage of students who passed core mathematics at credit level (A1–C6) was relatively lower than the scores in 2018 (WAEC, 2021).

On a global scale, mobile learning (m-learning) has gradually emerged as one of the important instructional innovation. Mobile apps like Khan Academy, Duolingo, Quizlet, Google Classroom, Babbel, Coursera, Udemy, Brilliant, Headspace, Mimo, Skillshare, Limosity, and an endless list of others provide flexible, interactive, and personalized learning experiences, especially for students in developing parts of the world where access to quality resources is limited (Kaur, 2024; Kirby and Oblinger, 2020; Mishra et al., 2019). Meta-analyses between the year 2010 and 2020 all suggest that mobile learning has significantly enhanced students' performance, especially in math-related subjects with learning apps like Zearn Math, the Math Learning Centre, MathSpace, Elephant Learning, Doodle Math, Moose Math, and Rocket Math (Mann, 2022).

Statement of the Problem

Major factors influencing mathematics achievement is engagement, and confidence, the teaching method, the attitude of the math teacher, and the attitude of the student towards mathematics (Ayebale et al., 2020). Ayebale et al. (2020) in developing the Mathematics and Technology Attitudes Scale (MTAS), identified five critical constructs: behavioral engagement, confidence with technology, mathematics confidence (Melhuish et al., 2022), affective engagement, and mathematics with technology. They opined that these factors show that mathematics students' success may depend not only on their cognitive ability but also on their interaction with technology and their emotional disposition towards mathematics (Nivens & Otten, 2024).

While research has shown that mobile learning applications can positively impact academic achievement, and effective instructional strategies are crucial for enhancing students' understanding, there is limited empirical evidence on the combined influence of mobile learning apps and instructional strategies in the Nigerian context, especially within Enugu State. Without addressing these gaps, students may continue to underperform in mathematics, thereby limiting their opportunities in STEM-related fields. This study therefore seeks to investigate the effect of mobile learning apps and instructional strategy on mathematics achievement among secondary school students in Enugu State.

Purpose of the Study

1. To determine the effect of mobile learning applications on secondary school students' mathematics achievement in Enugu State.
2. To examine the moderating role of instructional strategies in the relationship between mobile learning apps and mathematics achievement.
3. To analyze demographic variations (gender and academic track) in mathematics achievement when mobile learning apps are applied.

Research Questions

1. To what extent do mobile learning applications influence secondary school students' achievement in mathematics in Enugu State?
2. How do instructional strategies moderate the effect of mobile learning apps on mathematics achievement among secondary school students?
3. Are there significant differences in mathematics achievement gains across gender and academic tracks (science, arts, business, technical) when mobile learning apps are integrated with instructional strategies?

Hypothesis

H_{01}: Mobile learning applications have no significant effect on students' mathematics achievement in Enugu State.

H_{02}: Instructional strategies do not significantly moderate the effect of mobile learning apps on students' mathematics achievement.

H_{03}: There is no significant difference in mathematics achievement gains across gender and academic tracks when mobile learning apps are used.

LITERATURE REVIEW

Mathematics Achievement

According to Shear (2020) Defined as students' ability to acquire, retain, and apply mathematical knowledge, skills, and problem-solving strategies. Previous studies emphasize that achievement is influenced by instructional strategies, student engagement, and technological integration. Mathematics achievement can be evaluated at both the individual and collective levels, making it a multidimensional concept (Zumbo & Forer, 2021). On the individual level, it reflects the specific mathematical knowledge and skills a learner has acquired (Shear, 2020). At the collective level, it captures the overall learning outcomes of a class, school, district, state, or even a nation, and often serves as a measure of the quality of educational opportunities provided. In educational research and policy discussions, mathematics achievement is commonly assessed through standardized examinations or other formal assessment tools (Shear, 2020).

It is well established that mathematics serves as the bedrock of science and technology, not just in Nigeria, but throughout the world (Pandey, 2024). Its applications are vast and indispensable, as no field within science or technology can fully function without mathematical principles (Okereke, 2022). Nevertheless, despite the adoption of modern teaching and learning strategies, students' performance in mathematics continues to lag behind. The 2025 Programme for International Student Assessment (PISA) revealed that Malaysia ranked 52nd among 76 participating countries (Papanastasiou, 2020).

According to Pandey (2024), mathematical achievement refers to the level of proficiency students demonstrate in mathematics, reflecting their acquired knowledge, comprehension, skills, and techniques at a given stage of learning. It is commonly measured through scores obtained in mathematics achievement tests (Pandey, 2024). Success in mathematics at the secondary educational level is considered one of the most critical academic accomplishments in a student's educational journey (Okereke, 2022).

Numerous studies have explored the contributing factors influencing mathematics performance, one of which is the positive correlation between mathematics achievement and students' attitudes toward the subject (Papanastasiou, 2020). Kiray, Gok, and Bozkir (2025) examined the relationship between mathematics achievement, reading ability, problem-solving skills, and the impact of both cognitive and affective variables. Employing data mining techniques in their study, they concluded that success in science and mathematics is not solely determined by course-specific variables; instead, reading proficiency and problem-solving skills emerge as the most significant factors (Kiray, Gok, and Bozkir, 2025).

Other researchers have also investigated mathematics achievement extensively, in various parts of the world. In Malaysia, several studies have focused on the determinants of students' performance in this field. Notable contributions include the works of Veloo, Ali, and Krishnasamy (2024), Davadas and Lay (2021), and Zakaria, Chin, and Daud (2020). Collectively, past research has identified multiple predictors of students' achievement in mathematics and related disciplines, such as students' attitudes, learner-centered pedagogy, and classroom learning environments.

Mobile Learning (M-Learning)

Mobile learning refers to the ability to access or deliver educational materials through portable digital devices such as smartphones, tablets, and personal digital assistants (PDAs). In the context, educational content means digital resources that can be retrieved from any personal electronic device. According to Pimmer et al. (2022), mobile learning (M-learning) occurs when the designed learning experience takes place beyond the traditional classroom, within real-world settings. It offers flexible, technology-driven education, combining Information and Communication Technologies (ICT) to make learning possible anytime and anywhere (Mehdipour & Zerehkafi, 2023). Through mobile devices learners can retrieve resources from the internet, share information among their peers, collaborate, or even create new content, both inside and outside the classroom.

Mobile learning demonstrates its value as a learning platform, based on the works of Islam et al. (2020) in several ways:

1. It broadens learning opportunities for individuals (especially students) who may otherwise be excluded. It forms new learning communities, and reaches larger audiences beyond conventional classrooms settings (Eluemuno, et al., 2025).
2. Owing to the affordability and portability of nowadays mobile devices, learning in schools have become more flexible and tailored to individual student needs (Aina, 2025).
3. Some features like text enlargement, speech-to-text, text-to-speech, and location-based tools have now enabled students with physical or learning challenges and disabilities to improve their educational experiences (Agbo et al., 2025).
4. Mobile learning devices allow for faster, reliable, and more cost-effective communication between teachers and students thereby enabling them to exchange information, conduct evaluations and or assessments, and also receive immediate progress updates (Aina, 2025).
5. Since mobile devices are always carried by users (in this case students), learning can occur in various formal and non-formal environments which goes on to extend education beyond traditional boundaries which currently exist (Agbo, et al., 2023).
6. Students can now use mobile tools to access supplementary resources and materials that can reinforce classroom concepts like active, cooperative and or blended learning (Eluemuno, et al., 2025).
7. By using mobile technologies for tasks like note-taking or reviewing lessons, classroom time can instead be devoted to discussions, collaboration, and higher-order skill development (Chapman, 2025).
8. Mobile applications enrich experiences by aligning learning with real-life environments, such as museum audio guides that provide explanations of artworks during visits (Clooney, 2021).
9. With cloud-based storage and applications, young learners and students can access updated learning materials and progress data from multiple devices whether or not there are hardware limitations, provided they have internet access (Chapman, 2025).
10. In times of pandemics like the COVID-19 health crisis, mobile devices can help sustain learning when traditional systems break down (Chapman, 2025).

Instructional Strategies in Mathematics

Instructional strategies include teacher-centered and learner-centered approaches. The effectiveness of these strategies depends on their ability to engage learners actively, promote critical thinking, and adapt to individual learning needs (Nabayra & Sagge, 2022).

Because of the abstract nature of mathematics, reliance on complex ideas and the demand for accuracy, it often poses significant challenges for learners (Grimes & Stevens, 2019). Unlike other subjects that involve concrete materials, mathematics is built on theoretical principles and requires distinct ways of thinking and problem-solving, which many students find difficult to grasp. When learners struggle to understand concepts around equations, standard deviation, measurement, graphical representation, estimates and statistics, analytical thinking, geometry, etc, they may experience discouragement and feel as though they are falling behind (Mathunya, 2023).

Regardless of these challenges that comes with learning mathematical concepts, applying simple strategies can make mathematical learning more approachable. For instance, incorporating visual aids can greatly assist in clarifying abstract concepts (Nabayra & Sagge, 2022). The use of graphs, diagrams, and illustrations can transform complex ideas into forms that are easier to interpret and connect with (Mathunya, 2023).

Students' Attitudes toward Mathematics

The connection between students' attitudes toward mathematics and their performance in the subject has attracted considerable interest from researchers. Yet, previous studies have reported mixed results about the nature of this relationship. To address this, Hwang and Son (2021) investigated different profiles of students' mathematical attitudes and how these profiles relate to achievement. Drawing on data from the 2019 Trends in International Mathematics and Science Study (TIMSS) conducted in Singapore, they applied latent profile analysis and identified four categories of attitudes: very negative (5.44%), negative (41.38%), neutral (38.77%), and positive (14.41%). Their research also supported existing literature that views attitudes toward mathematics as a multidimensional construct, encompassing three key aspects: enjoyment of mathematics, valuing mathematics, and confidence in one's mathematical ability. Furthermore, in a later study, Hwang and Son (2022) confirmed a positive association between students' attitudes and their achievement in mathematics.

Specifically, they found that students are more likely to excel in mathematics if they: (a) enjoy engaging with the subject and related activities, (b) perceive mathematics as useful for academic success and future career opportunities, and (c) have confidence in their mathematical competence.

Technology Integration in Education

The integration of ICT in education has been linked to improved student outcomes. The study conducted by Mdhalose and Mlambo (2023) examined how technology influences education, particularly teaching and learning. Their research relied entirely on secondary data, drawing information from diverse sources such as peer-reviewed journal articles, published and unpublished theses, textbooks (both online and print), and encyclopedias. The review of existing literature revealed mixed findings on the impact of technology in education. On one hand, advances in information technology have enhanced classroom interaction between teachers and learners, expanding their academic and intellectual capacities and allowing students to become more adaptable (Mdhalose & Mlambo, 2023).

Challenges of Mathematics Education in Nigeria

Challenges include inadequate resources, poor instructional strategies, lack of teacher training in technology use, and students' math anxiety. In their study, Wilhelmina and Abaver (2024) examined several challenges encountered by both teachers and students in the teaching and learning of mathematics.

Their discussion was framed within the Radical Constructivism theory and addressed issues such as students' anxiety or fear of mathematics, reliance on teacher-centered methods, the presence of underqualified or inexperienced instructors, linguistic, social, and cultural barriers associated with mathematical language, gender-related biases, and limited access to practical resources (Eravwoke, 2025).

They also emphasized concerns surrounding learner-centered approaches to teaching, learning, and assessment. Furthermore, the authors proposed a range of interventions aimed at improving mathematics education (Wilhelmina & Abaver, 2024). When effectively implemented, the researcher believes that these measures could enhance the learning process, support better teaching practices, and help students progress from being low performers to achieving higher success in mathematics (Gonzalez & Maxwell, 2018).

THEORETICAL FRAMEWORK

Constructivist Learning Theory

The constructivist perspective emphasizes that learners play an active role in their educational process, with knowledge being shaped through personal experiences. As individuals encounter new events, they reflect on them and integrate these insights with their existing understanding. To make sense of information, learners form mental frameworks, often called schemas, which help organize what they have acquired. This approach was firmly established in educational theories by scholars such as Dewey, Piaget, Vygotsky, Gagne, and Bruner. Constructivist learning theory is therefore essential in explaining how students acquire knowledge. At its core, it proposes that learners do not passively absorb information; rather, they construct meaning by building new experiences upon their prior knowledge base.

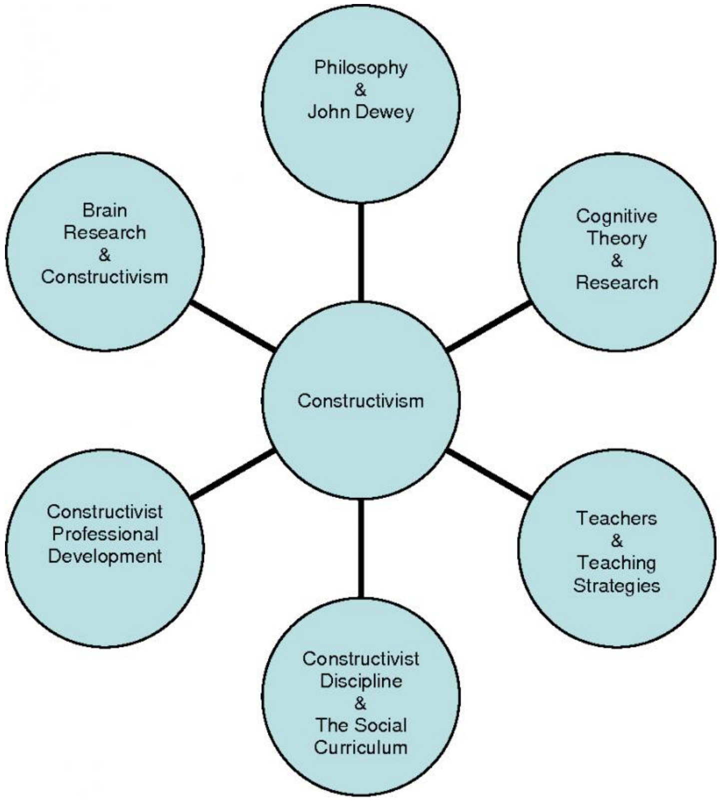

Fig. 2.1: Image showing the models of Constructivism entrenched in learning theories by Dewey, Piaget, Vygotsky, and Bruner

Constructivism as a learning theory incorporates several guiding principles that collectively explain how students acquire and develop knowledge.

The major elements are as follows:

#1 Knowledge is built progressively.

The first principle of the constructivism learning theory is that every learner begins with prior understanding, which forms the foundation for new insights, and as they process experiences they decide what to incorporate, resulting in knowledge that is distinct to each individual.

#2 Learning is inherently social

The second principle of constructivism is that collaboration with peers, group discussions, and interpersonal interactions are essential for constructing knowledge. Reflection on past experiences often reveals how connections with others shaped what was learned (Cherry, 2024).

#3 Learning requires active involvement

The third principle is that students must participate in meaningful activities and dialogue to internalize new concepts.

#4 Learning is tied to context

The fourth principle of constructivism is that knowledge does not develop effectively in isolation, instead, it emerges through links with prior beliefs and real-life situations (Cherry, 2024).

#5 Learning enhances metacognition

The fifth is that as students advance, they become more skilled at organizing, classifying, and synthesizing information. They begin to recognize the simultaneous acquisition of skills which for instance can be for example, studying history may also develop grammar and chronological reasoning (Umar and Abdullahi, 2023).

#6 Learning exists within cognition

The sixth principle is that While practical activities support learning, retention requires mental engagement and reflective thought. True comprehension depends on processing experiences within the mind.

#7 Knowledge is individualized

The seventh principle entails that each learner's perspective shapes how information is interpreted and retained.

#8 Motivation drives learning

Just as active participation is vital, so too is the willingness to engage with prior knowledge and new experiences. The eighth principle of constructivism provides that without motivation, students are unlikely to develop meaningful understanding (Krochinak et al., 2023).

Technology Acceptance Model (TAM)

Early explanations came from psychology, particularly the Theory of Reasoned Action (TRA) (Ajzen & Fishbein, 1980) and later the Theory of Planned Behavior (TPB) (Ajzen, 1985). Building on these foundations, Fred Davis (1986) adapted TRA to create the Technology Acceptance Model (TAM), with the goal of predicting the actual use of technological systems. He argued that using a system is a form of human behavior, and therefore behavioral theories were suitable for explaining technology adoption.

TAM introduced three central determinants of technology adoption: perceived usefulness, perceived ease of use, and attitude toward usage. Davis (1986) described perceived usefulness as the extent to which an individual believes a system improves job performance, while perceived ease of use refers to the degree to which the system is considered effortless to operate. He further suggested that users' attitudes strongly influence whether they accept or reject a system.

Over time, TAM underwent refinements through experimental studies, leading to adjustments in its variables and relationships. Other researchers extended the model by introducing additional constructs that shape the core elements. Today, TAM has become one of the most influential frameworks for studying technology acceptance, often referred to in its extended versions as "TAM++", where one or two new variables are incorporated (Benbasat & Barki, 2021).

The model's adaptability has been validated across numerous contexts. Examples include studies on the adoption of the Internet (Lee, Xiong, & Hu, 2022), digital libraries (Hong et al., 2002), email systems (Serenko, 2018), online education (Farahat, 2022), e-commerce (Pavlou, 2023), Internet banking (Nasri & Charfeddine, 2022), and hedonic information systems (Van der Heijden, 2024). In addition, multiple literature reviews and meta-analyses confirm TAM's versatility. These include reviews of e-shopping adoption, technology use in e-health (Chauhan & Mahadeo, 2021), factors influencing e-business adoption, acceptance of aging-related technologies (Peek et al., 2024), technology use in social media (Wirtz & Goettel, 2022), and TAM studies on wireless Internet (Lu et al., 2023). More recently, comprehensive reviews like Lee et al. (2023) have emphasized TAM's ongoing relevance across diverse technological domains.

METHODOLOGY

This study adopted a quasi-experimental research design with a pre-test, treatment, and post-test approach. The design was chosen because it allows the researcher to examine the causal effect of mobile learning apps and instructional strategies on students' mathematics achievement. Three public secondary schools in Enugu State were purposively selected based on their accessibility and readiness to integrate mobile learning into classroom instruction. The study was conducted over a five-week period, during which students in the treatment groups were exposed to mathematics lessons using mobile learning apps alongside interactive instructional strategies, while the control group received conventional teacher-centered instruction.

The target population consisted of all SSII students offering mathematics in selected secondary schools in Enugu State. A total of 300 students were sampled using simple random sampling. Each school was allocated 100 survey instruments. After the data collection process, 248 responses were returned, out of which 230 questionnaires were valid for analysis (18 were discarded due to incomplete responses and duplications). Control variables included gender, age, and academic track (science, arts, commercial, or technical). Content validity was established through expert review by three mathematics education specialists. Reliability of the questionnaire was tested using Cronbach's Alpha, yielding a coefficient of 0.84, which indicates high internal consistency. Analysis of Variance (ANOVA) was employed because the independent variables (mobile learning apps, instructional strategies, and demographics such as gender and academic track) involved more than two groups or conditions, while the dependent variable (mathematics achievement) was continuous. The data for the study were collected in three phases:

The first was pre-test, and was employed to assess students' baseline mathematics achievement. The second was treatment which entailed that the experimental groups were given lessons via two mobile learning apps which are Udemy App, and Khan Academy. These applications are integrated with learner-centered instructional strategies. The third was the post-test which was used to measure achievement gains after the intervention.

The data collection lasted five weeks. These data were analyzed using descriptive statistics (frequency, mean, percentages), t-test to determine the effect of mobile learning apps and instructional strategies on mathematics achievement. The results are presented below in tables and charts.

RESULTS

Table 4.1: Demographic Information of Respondents (N = 230)

Variable	Category	Frequency	Percentage (%)
Gender	Male	132	54.7
	Female	98	42.6
Age	12 – 16 years	92	40.0
	17 – 20 years	83	36.1
	Above 20	55	23.9

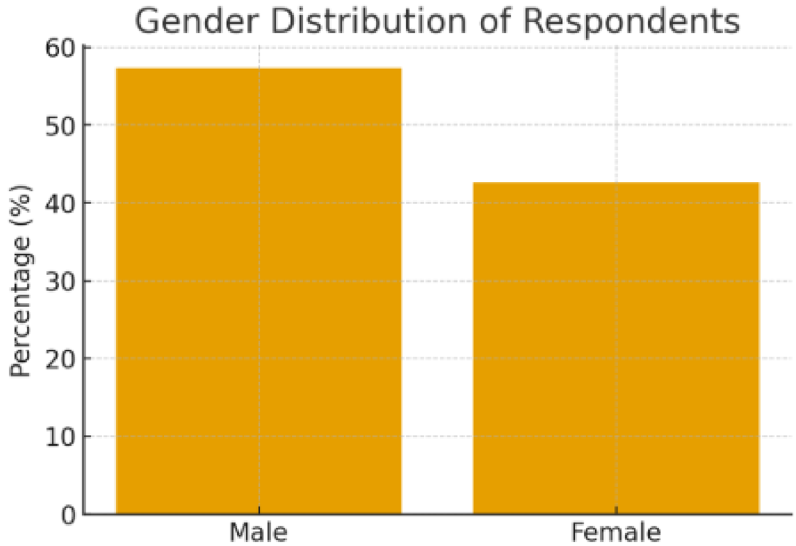

Fig. 4.1: Chart shows Gender distribution of respondents

The gender distribution chart showed that 57.4% of the respondents were male, while 42.6% were female. This indicates that the sample had more male than female students, but the distribution was reasonably balanced. The slight male dominance in the sample reflects the typical enrollment pattern in mathematics-related tracks in Nigerian secondary schools, where male students often outnumber females.

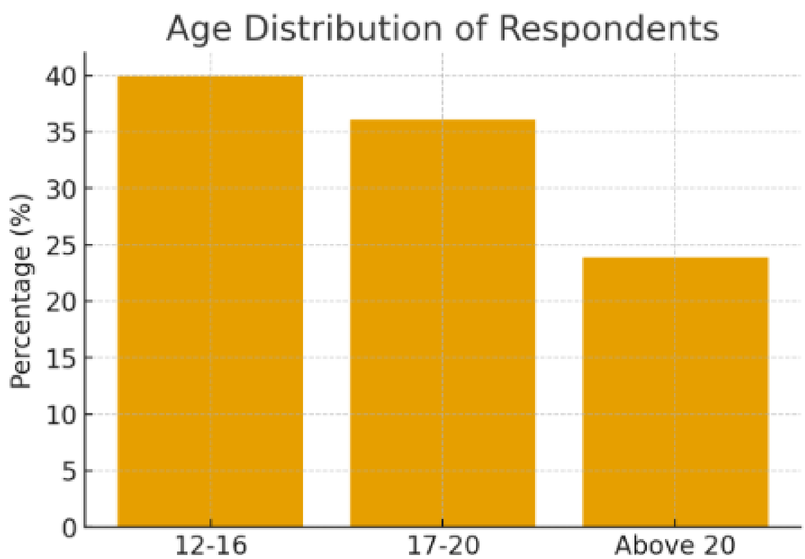

Fig. 4.1: Average Distribution of Respondents

The age distribution in fig. 4.1, reveals that 40.0% of students were between 12–16 years, 36.1% were between 17–20 years, while 23.9% were above 20 years. The largest group, therefore, fell within the early to mid-adolescent range (12–16 years), consistent with the typical age of senior secondary school students in SSII. The presence of a notable proportion of students above 20 years suggests some level of delayed schooling or repetition which is common in the Nigerian schooling system.

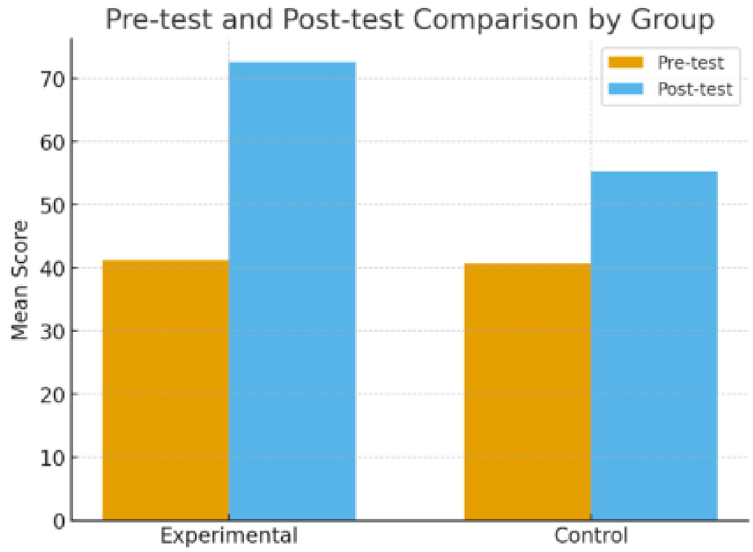

Fig. 4.2: Pre-test and Post-test Comparison by Group

The pre-test and post-test comparison chart in fig. 4.2, illustrates that the experimental group (mobile learning + instructional strategy) had a significant improvement in mathematics achievement, moving from a mean score of 41.2 in the pre-test to 72.6 in the post-test. In contrast, the control group (traditional method) improves from 40.7 to 55.3.

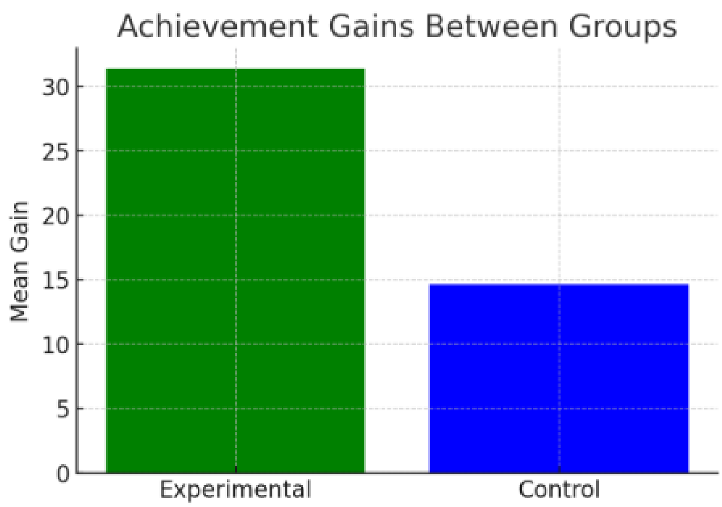

Fig. 4.3: Chart showing achievement gains between groups

The achievement gains chart in fig. 4.3 above shows a mean improvement of +31.4 points for the experimental group, compared to only +14.6 points for the control group. Students who were taught mathematics through mobile apps combined with interactive instructional strategies nearly doubled their learning gains compared to those taught traditionally.

The results for the hypotheses using ANOVA is presented also in the tables below:

Table 4.3: One-Way ANOVA for Effect of Mobile Learning Apps on Mathematics Achievement

Source of Variation	SS	df	MS	F	Sig. (p)
Between Groups	842.3	1	842.3	18.72	0.000*
Within Groups	10273.6	228	45.05		
Total	11115.9	229			

Significant at $p < 0.05$

There was a significant effect of mobile learning apps on mathematics achievement, $F(1,228) = 18.72$, $p < 0.05$. Students in the experimental group achieved significantly higher scores than those in the control group.

Table 4.4: Two-Way ANOVA for Effect of Instructional Strategy and Mobile Learning Achievement

Source	SS	df	MS	F	Sig. (p)
Mobile Learning	842.3	1	842.3	15.61	.001*
Instructional Strategy	623.5	1	623.5	11.54	.002*
Interaction (Mob. L x Instruct. S)	328.7	1	328.7	7.12	.008*
Error	9500.1	226	42.04		
Total	11294.6	229			

*Significant at $p < 0.05$

Both mobile learning and instructional strategies had significant main effects, and the interaction effect was also significant. This implies that the effectiveness of mobile learning apps was moderated by the type of instructional strategy employed.

Table 4.3: ANOVA for Differences in Achievement by Gender and Academic Work

Source	SS	df	MS	F	Sig. (p)
Gender	124.2	1	124.2	2.13	.145*
Academic Track	932.4	3	310.8	6.29	.001*
Error	10981.3	225	48.8		
Total	12037.9	229			

Significant at $p < 0.05$

No significant difference was found in mathematics achievement between male and female students, $p > 0.05$. However, significant differences were found across academic tracks, $F(3,225) = 6.29$, $p < 0.05$, with science students performing slightly better than peers in arts, business, and technical tracks.

DISCUSSION OF FINDINGS

The findings revealed that the integration of mobile learning apps in mathematics instruction significantly enhanced students' performance compared to traditional methods. Students in the experimental group achieved a mean gain of +31.4 points, almost double that of the control group. This aligns with previous meta-analysis studies (2010–2020), which reported positive effects of mobile learning on mathematics outcomes. The study further found that instructional strategies also played a significant role. Learner-centered approaches, when combined with mobile apps, created interactive and engaging learning experiences that increased students' motivation and confidence in mathematics. This supports the Constructivist Learning Theory, which emphasizes active knowledge construction, and the Technology Acceptance Model (TAM), which explains students' willingness to adopt mobile learning tools when they are useful and user-friendly.

CONCLUSIONS

The present study examined the effect of mobile learning applications and instructional strategies on secondary school students' achievement in mathematics in Enugu State. Drawing upon responses from 230 valid participants, the study provided compelling evidence that the integration of mobile learning apps, when paired with innovative instructional strategies, significantly enhances mathematics achievement. The findings revealed that students exposed to mobile learning apps (Khan Academy, and Udemy apps) alongside interactive instructional strategies recorded substantially higher mean gains (+31.4 points) compared to their peers taught using traditional chalk-and-talk methods (+14.6 points). This demonstrates that m-learning does not merely supplement mathematics instruction, but actively transforms students' engagement and learning outcomes.

RECOMMENDATIONS

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

1. The Ministry of Education should formally integrate mobile learning apps into the mathematics curriculum. Apps like GeoGebra, Khan Academy, and Udemy should not just be recommended, but strategic partnerships should be made with the owners of these platforms in order for them to become learning aids in classrooms.
2. Mathematics teachers should be properly trained in the use of technology and learner-centered instructional strategies. Also, continuous professional development

workshops should focus on designing engaging lessons that combine technology and pedagogy effectively.

3. Government and school administrators should invest in providing reliable ICT facilities such as projectors, tablets, and internet connectivity to facilitate mobile learning in secondary schools.
4. Teachers should shift away from the dominance of traditional chalk-and-talk approaches and adopt strategies that foster collaboration, inquiry, and problem-solving through mobile apps.
5. Parents should be sensitized about the importance of supporting their children's use of educational mobile apps at home.

Future studies should explore the long-term impact of mobile learning on other aspects of mathematics education, like problem-solving skills, critical thinking, and retention.

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