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Impact of Technology Integration on Learning Outcomes and Educational Sustainability in Secondary Schools in AMAC, FCT Abuja

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ABSTRACT

This study examines the Impact of Technology Integration on Learning Outcomes and Educational Sustainability in AMAC, FCT Abuja, Abuja, between 2020 and 2023. Utilising a mixed-methods longitudinal design, we assessed how digital tools affected students' academic performance, engagement, and classroom participation. Our sample included 400 students who completed questionnaires and 40 teachers who participated in semi-structured interviews, drawn from 40 public and private schools. While many schools have adopted basic digital tools such as computers, projectors, and tablets, their daily use in instruction remains inconsistent. Despite this, students reported improved academic performance and heightened interest, especially in science and mathematics, due to visual aids and interactive platforms. Teachers corroborated these benefits, noting enhanced content delivery, comprehension, and collaboration. However, significant challenges persist, including inadequate infrastructure, unequal access to devices, poor internet connectivity, and insufficient teacher training. Teachers advocated for ongoing professional development, equitable distribution of resources, and localised digital content. The study recommends strategic investments in infrastructure, teacher capacity-building, and policy enforcement to ensure a sustainable digital transformation in education.

Keywords: *Technology Integration, Learning Outcomes, Educational Sustainability, Secondary Schools and Digital Tools*

INTRODUCTION

Technology has become a defining feature of contemporary education, reshaping how instruction is delivered and how learners engage with content (Magaji & Adelabu, 2012). Across the globe, schools are implementing digital tools from classroom computers and interactive whiteboards to learning management systems and educational apps with the dual aims of improving student achievement and making schooling more resilient and adaptable (OECD, 2015; Means et al., 2010; Gabdo et al., 2025). In Nigeria, national policy has long recognised information and communication technology (ICT) as a component of educational development, and urban districts such as the Abuja Municipal Area Council (amac) present both opportunities and constraints for technology uptake because of varying infrastructure and resource allocation (Federal Ministry of Education [FME], 2013; Gabdo & Magaji, 2025). Investigating technology integration in secondary schools, therefore, helps illuminate local patterns of access, use, and impact within a national policy context and a global push toward digitised learning (Okon et al., 2025).

Technology integration in education is commonly understood as the meaningful incorporation of digital tools into curriculum, pedagogy, and assessment so that technology enhances rather than merely supplements learning processes (Selwyn, 2016). Empirical reviews indicate that when technology is strategically aligned with pedagogy and supported by teacher training, it can positively influence learning outcomes, particularly in areas such as learner engagement, formative assessment, and differentiated instruction (Means et al., 2010; OECD, 2015). However, effectiveness depends heavily on how technologies are used: passive substitution (e.g., replacing a printed worksheet with an onscreen copy) yields negligible gains, whereas pedagogically rich applications (e.g., adaptive software, project-based digital activities) are more likely to produce measurable improvements in student achievement (Means et al., 2010).

Beyond immediate test scores, technology has implications for educational sustainability, the capacity of schools to maintain quality learning over time while adapting to social, economic, and environmental change (Magaji et al., 2025). Sustainable integration requires stable infrastructure (reliable electricity and internet), ongoing professional development for teachers, institutional maintenance plans, and policies that address equity so that all students benefit (UNESCO, 2017). Studies show that without long-term planning and funding, technology investments risk becoming short-lived: devices fall into disrepair, teacher skills become outdated, and initial gains diminish (World Bank, 2019). Thus, assessing sustainability alongside learning outcomes provides a fuller picture of whether technology investments in AMAC schools will produce durable educational improvements.

Contextual factors within the AMAC, such as school leadership, teacher preparedness, the socio-economic diversity of student populations, and local government support, shape both the extent and the quality of technology use (Selwyn, 2016; FME, 2013). For example, schools with proactive principals who prioritise teacher training and create schedules for device use often report more coherent integration than schools that receive hardware without accompanying capacity-building (OECD, 2015). Moreover, equity issues (gender, household income, urban–peri-urban divides) can mediate who benefits from technology, making localised research essential to identify barriers and enabling conditions specific to AMAC secondary schools (Magaji, 2008).

This study, therefore, aims to examine how technology integration affects learning outcomes and the sustainability of educational improvements in secondary schools in AMAC, FCT Abuja. By combining measures of student achievement, teacher practice, infrastructure readiness, and school-level sustainability planning, the research will contribute evidence for policymakers, school leaders, and development partners seeking to maximise the return on educational technology investments. Findings from AMAC can inform practical recommendations for strengthening the pedagogical, technical, and governance components required to translate digital inputs into sustained learning gains (Means et al., 2010; UNESCO, 2017).

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 Conceptual Review

2.1.1 Technology Integration

Technology integration in education refers to the purposeful and systematic use of digital tools, resources, and platforms to enhance teaching, learning, and assessment processes and improve educational outcomes. It goes beyond mere hardware availability to encompass pedagogical alignment, teacher competence, curriculum relevance, and institutional support structures (Selwyn, 2016). Effective technology integration enables interactive learning, real-time feedback, collaborative problem-solving, and access to diverse learning resources, thereby improving student engagement and achievement (Means et al., 2010). In secondary schools, successful integration often depends on teacher training, leadership commitment, and reliable infrastructure, as poorly planned technology use can yield minimal or uneven learning benefits (OECD, 2015).

2.1.2 Educational Sustainability

Educational sustainability refers to the ability of an education system or institution to maintain and improve quality learning outcomes over time while efficiently managing resources and adapting to social, technological, and environmental changes (UNESCO, 2017). In the context of technology-driven education, sustainability involves long-term planning for infrastructure maintenance, continuous teacher professional development, equitable access for learners, and policy coherence that ensures innovations endure beyond short-term projects or donor funding (World Bank, 2019). Sustainable educational practices support resilience, inclusiveness, and relevance, enabling schools to respond effectively to future challenges without compromising present learning quality (OECD, 2018; Bello et al., 2025).

2.1.3 Secondary Schools

Secondary schools are formal educational institutions that provide instruction to learners typically between the ages of 12 and 18, serving as a critical transitional stage between primary education and tertiary or vocational pathways. At this level, students develop advanced cognitive, social, and technical skills that prepare them for higher education, employment, and responsible citizenship (Federal Ministry of Education [FME], 2013). Schools also play a strategic role in national human capital development (Magaji et al., 2025b), as they are key sites for introducing subject-specific technologies, digital literacy, and problem-solving competencies (UNESCO, 2015; Magaji, 2023). The effectiveness of secondary schools in fulfilling these roles depends on curriculum quality, teacher capacity, learning resources, and supportive governance structures (Ahmad & Magaji, 2024).

2.2 Theoretical Review

2.2.1 Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM), developed by Davis (1989), is highly relevant to this study on technology integration, learning outcomes, and educational sustainability in secondary schools in AMAC, FCT Abuja. TAM explains users' adoption and effective use of technology through two core constructs: perceived usefulness (the degree to which an individual believes that using a technology will enhance performance) and perceived ease of use (the degree to which the technology is free of effort) (Davis, 1989; Oluwalosijibomi et al., 2025). In the school context, teachers' and students' perceptions of the usefulness and usability of digital tools significantly influence their willingness to integrate technology into teaching and learning, which, in turn, affects student engagement, achievement, and the long-term sustainability of technology initiatives (Venkatesh & Davis, 2000). By applying TAM, this study can systematically examine how acceptance-related factors shape the successful and sustained integration of educational technologies in AMAC secondary schools, offering insights for policy, training, and infrastructure planning.

2.3 Empirical Review

Empirical studies indicate that technology integration significantly enhances students' academic performance, particularly in secondary schools. Warschauer and Matuchniak (2010) found that the use of digital tools such as computers and interactive software improved understanding and knowledge retention, especially in STEM subjects. Similarly, Ifenthaler and Schweinbenz (2013) reported that students exposed to structured technology-enhanced lessons outperformed peers taught using traditional methods. These findings suggest that effective integration of digital tools can directly impact learning outcomes and promote better academic achievement.

Hew and Brush (2007) highlighted that multimedia content, interactive lessons, and online quizzes increase motivation, attentiveness, and active learning, ultimately improving educational outcomes. Lei (2010) similarly emphasised that self-directed learning platforms allow students to learn at their own pace, fostering intrinsic motivation and engagement. These studies demonstrate that digital tools can create more dynamic and participatory learning environments, enhancing both academic performance and classroom involvement.

Studies highlight that infrastructural and institutional challenges often limit the effectiveness of technology integration in schools. Bebell and O'Dwyer (2010) found that limited access to devices, poor internet connectivity, and inadequate teacher training reduce the positive impact of technology on learning outcomes. Tondeur et al. (2012) also reported that even when tools are available, the absence of pedagogical integration and support mechanisms hinders effective use. These findings underscore the importance of addressing systemic barriers to ensure sustainable and equitable adoption of digital technologies in education.

De Jong, Linn, and Zacharia (2013) demonstrated that simulations, virtual laboratories, and interactive models improve conceptual understanding and problem-solving skills in science and mathematics. Papadakis, Kalogiannakis, and Zaranis (2018) similarly found that integrating tablets, multimedia content, and educational software increased student engagement and achievement in STEM subjects compared with traditional teaching methods. These findings highlight that STEM disciplines are among the primary beneficiaries of technology integration.

Teacher competence is critical for effective and sustainable technology integration. Ertmer and Ottenbreit-Leftwich (2010) found that the lack of teacher confidence and knowledge in using digital tools limits their impact on student learning, even when devices are available.

Conversely, ongoing professional development, mentoring, and institutional support improve teachers' ability to integrate technology effectively, thereby enhancing student engagement and academic performance. These studies suggest that investment in teacher training is essential for achieving sustainable educational technology outcomes.

2.4 Research Gap

Despite extensive evidence demonstrating that technology integration can enhance student engagement, academic performance, and STEM learning, the empirical literature also highlights persistent challenges such as unequal access to devices, poor internet connectivity, and limited teacher competence, particularly in public schools (Bebell & O'Dwyer, 2010; Ertmer & Ottenbreit-Leftwich, 2010; Tondeur et al., 2012). Most prior studies have focused on either technology use in well-resourced schools or specific subjects like science and mathematics, with limited longitudinal research assessing the sustained impact of digital tools on overall learning outcomes and educational sustainability in under-resourced contexts. Furthermore, while student engagement and academic performance have been widely studied, few studies have explored the intersection of technology integration, teacher capacity, and infrastructural limitations in shaping sustainable educational practices in secondary schools within developing urban contexts like AMAC, FCT Abuja. This study addresses these gaps by examining both student and teacher perspectives, assessing the frequency, types, and effectiveness of technology use, and identifying barriers to sustainable digital education in a representative sample of public and private secondary schools.

RESEARCH METHOD

3.2 Research Design

This research will employ a mixed-methods design, combining qualitative and quantitative data collection and analysis techniques. This approach is efficient in educational research, as it enables deeper exploration of participants' experiences and perceptions while also quantifying relationships among variables. By integrating these two methods, the study aims to provide a robust analysis of technology integration in education.

3.3 Study Area

This study will be conducted in the AMAC of the Federal Capital Territory (FCT) of Abuja, Nigeria. This region presents a unique educational landscape characterised by a mix of public and private schools, varying levels of technology integration, and diverse socio-economic factors. FCT Abuja is selected as the study area due to its strategic importance as the nation's capital and its ongoing efforts to enhance educational quality through technology.

3.4 Sample Size

The population of this study comprises secondary school students in Senior Secondary classes (SS1–SS3) within Abuja Municipal Area Council (AMAC), Federal Capital Territory (FCT). According to records from the FCT Secondary Education Board, there are 90 government secondary schools in the FCT, with 32 located in AMAC. These schools collectively account for a significant proportion of the student population, making AMAC one of the most educationally active councils in the territory.

Based on enrolment statistics, the total number of students in FCT public secondary schools is about 88,721, with AMAC estimated to accommodate roughly 35% of this figure. This translates to approximately 31,000 students in public secondary schools within the council. When private schools are factored in, the estimated population of SS1–SS3 students in AMAC falls between 30,000 and 40,000, providing a robust base for sampling and generalisation in this study.

3.5 Sampling Techniques

To select the schools for the study, a combination of simple random sampling and purposive sampling techniques will be employed: Simple Random Sampling: This technique will be used to randomly select schools from the larger population of schools in FCT Abuja, ensuring each school has an equal chance of being included in the sample. This helps to mitigate selection bias and enhances the generalizability of the findings. Purposive Sampling: In addition to random selection, purposive sampling will be used to ensure specific criteria are met. For example, schools with notable differences in technology integration levels or those that have implemented specific technology initiatives will be included. This approach helps enrich the data by focusing on schools relevant to the research objectives.

3.6 Data Instruments

The data collection will utilise two main instruments: Semi-Structured Interview Questions: Teachers will participate in semi-structured interviews designed to explore their experiences and perceptions regarding technology integration in their teaching practices. This format allows for in-depth discussions while also providing the flexibility to explore new ideas that may arise during the interviews. Close-Ended Questionnaire: Students will complete structured questionnaires that include closed-ended questions to quantify their experiences with technology in the classroom. The questionnaire will assess aspects such as the frequency of technology use, perceived benefits, and challenges faced in technology-integrated learning environments.

3.7 Method of Data Collection

The method of data collection will involve two main groups:

1) Teachers: Data will be collected through interviews conducted with teachers from the selected schools. These interviews will provide qualitative insights into how teachers integrate technology into their lessons and the perceived impact on student learning outcomes.
2) Students: Data will be collected through the administration of questionnaires to students. This will allow for the collection of quantitative data on students' engagement, performance, and experiences related to technology use in their education.

3.8 Validity and Reliability

Ensuring the validity and reliability of the data instruments is crucial for the credibility of the study: Validity: The instruments will undergo validation through expert reviews to ensure they accurately capture the constructs of interest. This may involve piloting the questionnaires and interview questions with a small group of participants before the main data collection. Reliability: The reliability of the instruments will be assessed using Cronbach's alpha for the questionnaire to determine internal consistency. A reliability score above 0.7 will be considered acceptable, indicating that the items within the instrument are measuring the same construct.

3.9 Method of Data Analysis

Data analysis will be conducted using different techniques for quantitative and qualitative data: Quantitative Data Analysis (Questionnaire): The data collected from student questionnaires will be analysed using inferential statistics, with a focus on frequency distributions and percentages. This will provide insights into trends and patterns related to technology integration and its impact on academic performance and engagement. Qualitative Data Analysis (Interviews): The data from the teacher interviews will be analysed using thematic analysis. This involves coding the responses to identify recurring themes and patterns related to technology integration in education. The thematic analysis will provide rich qualitative insights that complement the quantitative findings.

RESULTS AND DISCUSSION

4.2 Analysis of Questionnaire Responses

4.2.1. Demography of the Respondents

Table 4.1: Students' Demographic Profile

Demographic Variable	Category	Frequency (n=400)
Gender	Male	169
	Female	231
Age	10–12 years	67
	13–15 years	152
	16–18 years	179
	19 and above	2
School Type	Public	200
	Private	200
Class Level	Junior Secondary	200
	Senior Secondary	200

Source: Field Survey 2025

Table 4.1 presents the demographic characteristics of the 400 student respondents involved in the questionnaire phase of the study. The gender distribution shows a higher proportion of female students (57.8%) compared to male students (42.3%), providing perspectives from both sexes for meaningful comparison. In terms of age, the majority of respondents (82.8%) fall within the 13–18 years range, which corresponds with the typical age bracket for secondary school education and indicates that the sample effectively represents students at a key academic and developmental stage. The sample was evenly distributed across school type, with equal representation from public and private schools (50.0% each), and across class level, with 50.0% of respondents drawn from junior secondary schools and 50.0% from senior secondary schools.

Overall, the demographic composition reflects a balanced and diverse sample, enhancing the representativeness, comparability, and validity of the findings on technology integration across different school contexts and student categories.

4.2.2. Technology Integration in Teaching and Learning

Table 4.2: Use of Digital Tools for Teaching and Learning

Does your school use digital tools for teaching and learning?	**Frequency (n)**	**Percentage (%)**
Yes	295	73.8%
No	105	26.3%
Total	**400**	**100.0%**

Source: Field Survey 2025

Table 4.2 shows that 295 students (73.8%) reported that digital tools are used in their schools for teaching and learning, while 105 students (26.3%) indicated that such tools are absent. This finding suggests that a substantial proportion of secondary schools within the Abuja Municipal Area Council (AMAC), FCT Abuja, have adopted some level of technology integration in instructional activities. Nevertheless, the relatively high percentage of students reporting no access to digital tools highlights persistent disparities in technology adoption across schools, indicating that integration remains uneven and may be influenced by factors such as school type, funding, and infrastructure availability.

Table 4.3: Frequency of Technology Use in the Classroom

Response	**Frequency (n)**	**Percentage (%)**
Daily	4	1.0%
Weekly	137	34.3%
Rarely	191	47.8%
Never	68	17.0%
Total	**400**	**100.0%**

Source: Field Survey 2025

The data presented in Table 4.3 shows that only four students (1.0%) reported that technology tools are used daily in their classrooms, while 137 students (34.3%) said such tools are used weekly. A much larger portion, 191 students (47.8%), stated that digital tools are used rarely, and 68 students (17.0%) reported that technology tools are never used in their classrooms. These findings indicate that although a significant number of schools may have adopted digital tools (as shown in Table 4.2), the frequency of actual classroom use remains relatively low. Less than 2% of students experience daily interaction with classroom technology, while almost 65% either rarely or never use technology in their lessons.

Table 4.4: Most Commonly Used Technologies in Schools

Technology Type	Frequency (n)	Percentage (%)
Smartboards	38	9.5%
Tablets	78	19.5%
Computers (Laptop or Desktop)	329	82.3%
Online Learning Platforms (e.g., Google Classroom)	4	1.0%
Projectors	179	44.8%
None	67	16.8%

Source: Field Survey 2025

Table 4.4 highlights the prevalence of various educational technologies in schools within the AMAC local government of FCT Abuja. The data reveal that a significant majority, 82.3%, of students identified computers (laptops or desktops) as the most commonly used digital tools, underscoring the dominance of computer-based learning. Projectors follow as the second most prevalent technology, with 44.8% of students reporting their use. Tablets are less common, mentioned by 19.5% of students, likely due to cost and accessibility issues. Smartboards and online learning platforms are notably underutilised, indicating that advanced digital tools and cloud-based learning models remain limited. Additionally, 16.8% of respondents reported that no digital technologies are used in their schools at all, highlighting ongoing digital disparities. In essence, while computer-based learning is widespread, the limited use of more advanced, internet-dependent technologies underscores the need for more equitable and comprehensive digital integration across AMAC schools.

4.2.3 Impact on Academic Performance

Table 4.5: Perceived Impact of Technology on Academic Performance

Response	Frequency (n)	Percentage (%)
Yes, significantly	214	53.5%
Somewhat	118	29.5%
No, it has not improved	68	17.0%
Total	**400**	**100.0%**

Source: Field Survey 2025

The data from Table 4.5 shows that over half of the students (53.5%) perceive a significant improvement in their academic performance due to technology use, while 29.5% acknowledge some positive impact. However, 17.0% of students reported no noticeable improvement, highlighting that technology alone is not a panacea. This suggests that the effectiveness of educational technology depends on proper implementation, teacher competence, and alignment with curriculum objectives. The mixed responses underscore the need for continuous teacher training, context-sensitive strategies, and supportive policies to ensure equitable benefits from digital education tools.

Table 4.6: Subjects Most Improved Through Technology Use

Subject Area	Frequency (n)	Percentage (%)
Science	294	73.5%
Mathematics	255	63.8%
English Language	155	38.8%
Social Studies	72	18.0%
Biology (from “Other”)	41	10.3%
None	67	16.8%

Source: Field Survey 2025

Table 4.6 shows that students perceive Science and Mathematics as the subjects most positively affected by technology use, with 73.5% and 63.8% of respondents, respectively, reporting improvements, reflecting the strong suitability of digital tools for STEM learning. English Language also benefited, as indicated by 38.8% of students, while Social Studies recorded a comparatively lower impact at 18.0%, possibly due to its narrative-based nature and limited digital support. A smaller proportion of students (10.3%) identified Biology as notably improved, highlighting the value of animated and virtual learning tools in science sub-disciplines. However, 16.8% of respondents reported no improvement in any subject, suggesting challenges such as inadequate access, limited integration, or infrastructural constraints. Overall, the findings underscore that technology has the most significant impact on Science and Mathematics in secondary schools within AMAC, Abuja.

Table 4.7: Effectiveness of Technology in Aiding Understanding

Response	Frequency (n)	Percentage (%)
Yes	333	83.3%
No	67	16.8%
Total	**400**	**100.0%**

Source: Field Survey 2025

Table 4.7 indicates that a substantial majority of students (83.3%) believe that technology has enhanced their understanding of topics more effectively than traditional teaching methods, while 16.8% report no additional benefit. This strong positive perception highlights the role of educational technology in improving comprehension through interactive, visual, and self-paced learning approaches, particularly in complex subject areas. Nevertheless, the minority who reported no benefit points to existing challenges such as ineffective pedagogical use of technology, limited digital skills, content misalignment, or technical constraints, reinforcing the view that technology's effectiveness depends largely on how well it is integrated into teaching practices.

4.2.4 Impact on Engagement and Participation

Table 4.8: Student Interest in Technology-Integrated Lessons

Response	Frequency (n)	Percentage (%)
Yes	400	100.0%
No	0	0.0%
Total	**400**	**100.0%**

Source: Field Survey 2025

Table 4.8 reveals that all the students (100.0%) reported increased interest in lessons when technology is used, indicating a unanimous perception that digital tools make learning more engaging and enjoyable. This finding suggests that technology enhances student motivation and attentiveness by introducing interactive elements, multimedia content, and opportunities for active participation. Although unanimous responses should be interpreted cautiously, the result aligns with existing research showing that technology-integrated classrooms tend to foster higher levels of engagement, particularly among digitally inclined learners.

Table 4.9: Student Participation and Technology Availability

Response	Frequency (n)	Percentage (%)
Yes	283	70.8%
No	117	29.3%
Total	**400**	**100.0%**

Source: Field Survey 2025

Table 4.9 indicates that a majority of students (70.8%) agreed that the availability of technology in their schools makes it easier for them to participate in class activities, suggesting that digital tools enhance classroom interaction and inclusiveness. These tools likely support participation through interactive features, such as online quizzes, collaborative tasks, and multimedia presentations, which encourage student involvement. However, 29.3% of respondents did not perceive improved participation, highlighting challenges related to the quality of access, instructional use, or effective facilitation of technology, and underscoring the need for improved pedagogical strategies to ensure technology actively promotes engagement for all learners.

Table 4.10: Most Engaging Features of Educational Technology

Feature	Frequency (n)	Percentage (%)
Interactive lessons	353	88.3%
Visual aids (videos, images)	353	88.3%
Group activities using digital tools	235	58.8%
Online quizzes	255	63.8%
Other (unspecified)	1	0.3%
None	0	0.0%

Source: Field Survey 2025

Table 4.10 shows that Interactive lessons and Visual aids, such as videos and images, were each identified by 88.3% of students as the most engaging aspects of technology-enhanced learning, emphasising the importance of interactivity and multimedia in capturing attention and simplifying complex concepts. Online quizzes (63.8%) and group activities using digital tools (58.8%) also contributed to engagement by providing immediate feedback and fostering collaboration. No students selected "None," confirming that all respondents found at least one technology feature engaging, which aligns with the 100% interest reported in Table 4.8. Overall, the findings underscore that effective technology integration relies not just on access but on the use of interactive, visually rich, and participatory learning formats to enhance student engagement and learning outcomes.

Section E: Challenges of Technology Integration

Table 4.11: Challenges Faced When Using Technology in the Classroom

Challenge	Frequency (n)	Percentage (%)
Lack of access to devices	396	99.0%
Poor internet connection	231	57.8%
Lack of teacher support or guidance	117	29.3%
Frequent technical issues	42	10.5%

Source: Field Survey 2025

Table 4.11 highlights the key challenges students face when using technology in the classroom. The most significant barrier is the lack of access to devices, reported by 99.0% of students, indicating that nearly all learners face hardware availability limitations. Poor internet connectivity affects 57.8% of respondents, restricting access to online resources and cloud-based learning platforms. Additionally, 29.3% of students cited insufficient teacher support or guidance, suggesting that gaps hinder effective integration in instructional facilitation. Frequent technical issues, reported by 10.5% of students, further impede smooth technology use. Overall, these findings underscore that both infrastructural limitations and pedagogical support are critical factors influencing the successful adoption of educational technology in schools.

Table 4.12: Perception of Equal Access to Technology

Response	Frequency (n)	Percentage (%)
Yes	224	56.0%
No	176	44.0%

Response	Frequency (n)	Percentage (%)
Total	**400**	**100.0%**

Source: Field Survey 2025

Table 4.12 presents students' perceptions of equal access to technology in their schools. A slight majority of 224 students (56.0%) believed that access to digital tools is equitable, while 176 students (44.0%) disagreed, indicating that a substantial proportion of learners perceive disparities. This suggests that although many students feel they have fair opportunities to use technology, significant gaps remain, potentially influenced by factors such as school type, classroom resources, or socioeconomic differences. The data highlights the need for policies and interventions that ensure more uniform access to educational technology across all students.

4.3. Analysis of Interview Questions

Interview Question 1: Can you describe the types of technology used in your school for teaching and learning?

Teacher interviews revealed that technology is present in both public and private schools within the AMAC local government in Abuja, but its availability and use vary considerably. Private schools reported broader access to digital tools, including computers, laptops, projectors, tablets, and smartboards, as well as occasional use of online platforms. In contrast, public schools mainly relied on computer labs for ICT lessons, shared projectors, and personal devices used informally by teachers. Computers and projectors were the most commonly used tools across all schools, but advanced or interactive technologies were mainly limited to private schools. Challenges such as electricity issues, poor internet connectivity, and limited teacher training further constrained effective integration. Teachers also demonstrated adaptive strategies, using personal devices to supplement inadequate resources, though such practices are not sustainable. Overall, the findings indicate that while basic educational technology exists, its depth, consistency, and equity of use are heavily influenced by school type, funding, and institutional support.

Interview Question 2: How often do you incorporate technology into your teaching methods?

Teacher responses revealed a marked disparity in the frequency of technology use between private and public schools in the AMAC local government of Abuja. Private school teachers reported integrating technology into their lessons weekly, and in some cases daily, using laptops, projectors, tablets, and multimedia resources to enhance lesson delivery, student engagement, and collaborative activities. In contrast, public school teachers described sporadic and occasional use, often limited by insufficient devices, poor infrastructure, unreliable electricity, and a lack of institutional support, with some relying on personal smartphones or laptops to supplement lessons. These findings align with student reports showing limited daily technology use, particularly in public schools. Overall, the responses highlight that while private schools benefit from consistent and structured technology integration, public schools face systemic barriers that limit regular use, underscoring the need for targeted policies, infrastructure investment, and teacher training to promote equitable and sustainable technology adoption across all schools.

Interview Question 3: What specific tools or platforms have been most beneficial for lesson delivery?

Teacher interviews revealed that the most beneficial tools for lesson delivery in AMAC schools are those that are simple, accessible, and visually engaging. Private school teachers reported using a broad range of tools, including projectors, laptops for PowerPoint presentations, educational videos (e.g., YouTube), interactive whiteboards, online platforms such as Google Classroom, and assessment apps like Kahoot! or Google Forms. These tools support interactive, multimedia-based learning and facilitate assignment distribution and feedback. In contrast, public school teachers primarily relied on computers and projectors, with occasional use of personal devices, and had limited or no access to online platforms due to infrastructural and connectivity challenges. Both groups valued tools that enhance comprehension through visual and auditory learning, consistent with students' perceptions that interactive lessons and visual aids are most engaging (Table 4.10). Overall, while private schools demonstrate more integrated and diversified technology use, public schools face a persistent digital divide, underscoring the need for targeted investments in infrastructure, internet connectivity, and teacher training to enable equitable access to effective educational technologies.

Interview Question 4: In your experience, how has the use of technology influenced students' academic performance?

Teacher interviews indicate that technology has generally had a positive influence on students' academic performance in AMAC schools, particularly when applied consistently and with proper support. Private school teachers reported clear improvements in comprehension, retention, and test scores, especially in subjects like science, mathematics, and geography, often attributing gains to visual and interactive teaching methods, increased student motivation, and engagement. Public school teachers also acknowledged benefits when digital tools were used, but emphasised that limited access, shared devices, unreliable electricity, and poor internet connectivity restrict consistent academic impact. Some students, particularly those with limited prior exposure to technology, faced adaptation challenges, highlighting that benefits are not automatic. Overall, the findings align with student survey data (Table 4.5), showing that technology can enhance understanding, participation, and learning outcomes. Teachers emphasised that sustainable academic improvement depends on regular use, appropriate content alignment, teacher competence, and adequate infrastructure, underscoring that effective integration is as important as mere availability of technology.

Interview Question 5: Have you observed any differences in the academic outcomes of students before and after technology was introduced?

Teacher responses indicate that the introduction of technology has generally improved student academic outcomes across both private and public schools in FCT Abuja. Private school teachers reported sustained and measurable gains, including higher test scores, better comprehension, improved retention, increased engagement, and enhanced classroom behaviour, mainly due to regular use, structured integration, and strong administrative support. In contrast, public school teachers observed episodic improvements, often limited by inconsistent access to devices, unreliable electricity, and poor internet connectivity, with short-term gains typically tied to ad hoc use of personal devices. Some students initially struggled with digital tools but adapted quickly with teacher guidance and peer support. Overall, the findings align with student-reported benefits (Table 4.5), particularly in STEM subjects, and underscore that the effectiveness of technology in improving academic performance depends on consistent access, teacher competence, and institutional support. Sustained improvements require integrating technology

into daily teaching practices, backed by adequate infrastructure, policy frameworks, and professional development, especially in public schools.

4.4. Discussion of Findings

The findings of this study indicate that technology integration in secondary schools within AMAC, FCT Abuja, has a generally positive impact on learning outcomes, student engagement, and overall educational experience. Quantitative data from 400 students revealed that the majority (73.8%) reported using digital tools in their schools, with computers (82.3%) and projectors (44.8%) the most commonly used technologies. Students perceived that technology enhanced their academic performance (53.5% significant improvement, 29.5% moderate improvement) and facilitated better understanding of topics (83.3%). Additionally, all students (100%) reported increased interest in lessons involving technology, while 70.8% indicated that it improved classroom participation. Interactive lessons, visual aids, and online quizzes were identified as the most engaging features, reinforcing the importance of multimedia and interactive content for effective learning. However, challenges such as lack of access to devices (99.0%), poor internet connectivity (57.8%), and limited teacher support (29.3%) remain significant barriers to equitable technology use.

Qualitative insights from teacher interviews corroborate and contextualise these findings, highlighting disparities between private and public schools. Private schools demonstrated more frequent and structured use of technology, employing laptops, projectors, tablets, and online platforms such as Google Classroom to deliver lessons and monitor performance, leading to measurable improvements in STEM subjects and overall student motivation. Public schools, on the other hand, faced infrastructural and resource limitations, relying on outdated computer labs, shared projectors, or personal devices, which resulted in intermittent and inconsistent integration. Teachers emphasised that while technology has the potential to enhance comprehension, participation, and academic outcomes, its effectiveness depends on consistent use, teachers' competence, and institutional support. Overall, the study underscores that technology integration can positively influence learning outcomes and educational sustainability, but systemic barriers must be addressed to ensure equitable and effective adoption across all schools.

CONCLUSION AND RECOMMENDATIONS

In conclusion, this study has shown that technology integration in secondary schools within AMAC, FCT Abuja, significantly enhances learning outcomes, student engagement, and comprehension, particularly in STEM subjects. Students and teachers alike reported that digital tools such as computers, projectors, interactive lessons, and multimedia content improve academic performance and classroom participation. However, the study also highlighted persistent disparities between private and public schools, with infrastructural limitations, inconsistent access to devices, unreliable electricity, and limited teacher training constraining the effectiveness of technology in many public schools. These findings emphasise that while educational technology holds substantial potential to improve learning outcomes, its success depends not only on availability but also on structured integration, teacher competency, and institutional support.

Based on these findings, several recommendations are proposed to enhance the effectiveness and sustainability of technology in education. First, expanding ICT infrastructure and ensuring equitable access across all schools, particularly under-resourced public schools, is critical, including the use of offline solutions and solar-powered systems. Second, continuous teacher capacity building in digital pedagogy is essential, focusing on subject-specific tools, integration methods, and practical troubleshooting skills. Third, schools should institutionalise ICT support and monitoring through dedicated coordinators, KPIs, and regular evaluations. Fourth, digital literacy should be integrated into the student curriculum to foster responsible, creative, and effective use of technology. Finally, collaboration through public–private partnerships should be promoted to

create sustainable digital ecosystems, combining infrastructure, localised content, maintenance, and innovative teaching practices to ensure long-term educational benefits.

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