African Journal of Social and Behavioural Sciences (AJSBS)
Volume 15, Number 10 (2025) ISSN: 2141-209X

EFFECT OF TECHNOLOGY INTEGRATION IN ENHANCING CREATIVE THINKING AND INNOVATION AMONG SENIOR SECONDARY SCHOOL STUDENTS IN OWERRI MUNICIPAL, IMO STATE

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ABSTRACT: This study investigated the Effect of Technology Integration in Enhancing Creative Thinking and Innovation among Senior Secondary School Students in Owerri Municipal, Imo State, with specific objectives of examining the effect of access to digital devices on students' flexibility in thinking, investigating the influence of student exposure to digital platforms on their problem-solving ability, and assessing the impact of technology integration in lesson delivery on the level of student innovation projects. The study adopted a descriptive survey research design, with a population comprising all SSI–SS3 students in Owerri Municipal, from which a sample size of 400 students was determined using Taro Yamane's formula. Five schools were sampled: Government Secondary School Owerri (GSSO), Owerri Girls Secondary School (OGSS), Urban Secondary School Owerri, Baptist High School Owerri, and FMC Staff Secondary School Owerri. Data were collected using a structured four-point Likert-scale questionnaire distributed to 400 students, of whom 387 were returned and 381 validated for analysis. Mean and standard deviation were employed to answer the research questions, while the hypotheses were tested using Multivariate Analysis of Covariance (MANCOVA). Findings revealed that access to digital devices significantly enhanced students' flexibility in thinking, with Wilks' Lambda = 0.873, $F(4,376) = 15.294$, $p < 0.05$, Partial Eta Squared = 0.140, showing that 14% of the variance in flexibility was explained by digital access. Similarly, exposure to digital platforms significantly influenced problem-solving ability with Wilks' Lambda = 0.861, $F(4,376) = 17.208$, $p < 0.05$, Partial Eta Squared = 0.155, indicating 15.5% variance contribution. The integration of technology in lesson delivery significantly improved innovation projects, with Wilks' Lambda = 0.849, $F(4,376) = 18.734$, $p < 0.05$, Partial Eta Squared = 0.166, explaining 16.6% of the variance. The study concluded that technology integration strongly enhances flexibility, problem-solving, and innovation among secondary school students, aligning with global educational demands. It was recommended that government, administrators, and teachers invest in digital infrastructure, training, and resources to foster creativity and innovation in schools.

Keywords: Technology Integration, Creative Thinking, Innovation, Problem-Solving, Secondary School Students

INTRODUCTION

The rapid transformation in global education has placed technology integration at the center of innovative learning, with schools increasingly adopting digital tools to stimulate creativity among students (Adah, 2023). In Nigeria, especially in urban centers like Owerri Municipal in Imo State,

the secondary school system is gradually adapting to these changes to ensure students develop flexible thinking and problem-solving capabilities required for the twenty-first century (Arifin & Siew, 2024). Creative thinking is no longer perceived as an optional skill; rather, it has become a necessity in a fast-changing world where innovation drives societal advancement (Babalola & Keku, 2024). When students engage with technology in classroom settings, they are not only exposed to vast knowledge resources but also to interactive and dynamic platforms that challenge their ability to reason in new ways (Banao & Orge, 2024).

The connection between technology and innovation is particularly evident in how learners approach problem-solving. Through devices such as tablets, laptops, and smartphones, students in senior secondary schools are increasingly able to experiment, test hypotheses, and design solutions that transcend traditional classroom boundaries (Arkorful, Barfi, & Aboagye, 2021). Such exposure creates environments in which learners shift from passive recipients of knowledge to active creators of ideas, and this transformation is critical for cultivating innovation among young people (Adah, 2023). In a society like Nigeria's, where educational systems often face constraints in resources and infrastructure, technology offers alternative avenues for knowledge acquisition and idea exploration (Babalola & Keku, 2024).

Moreover, the accessibility of digital devices enhances students' flexibility in thinking by allowing them to draw connections between diverse subjects, simulate real-life scenarios, and adopt multiple perspectives when addressing challenges (Arifin & Siew, 2024). This aligns with the global shift towards STEM education, which underscores the importance of equipping students with analytical and creative skills required for innovation (Banao & Orge, 2024). Beyond the acquisition of knowledge, technology fosters collaboration among students, enabling them to brainstorm collectively, critique ideas, and refine their outputs to meet evolving standards of creativity (Arkorful et al., 2021). The ability to collaborate in such digital spaces encourages a sense of ownership and adaptability, crucial elements of innovation in the modern era (Adah, 2023).

The Nigerian educational framework, especially in senior secondary schools, has traditionally been more examination-oriented, with limited emphasis on cultivating creativity and innovation (Babalola & Keku, 2024). However, recent studies have shown that introducing digital platforms can significantly alter this dynamic by promoting experiential learning, problem-based projects, and inquiry-driven research (Arifin & Siew, 2024). Through this process, students begin to view challenges not as obstacles but as opportunities to generate original ideas, thereby broadening their intellectual capacities (Banao & Orge, 2024). When properly integrated into teaching methods, technology becomes a catalyst for enhancing innovative thinking and equipping students with transferable skills that prepare them for higher education and the demands of the labor market (Arkorful et al., 2021).

In Owerri Municipal, where access to technology is gradually expanding, the need to explore how digital integration affects student creativity is particularly relevant. The local context is characterized by a mixture of traditional learning systems and modern innovations, creating a fertile ground for research on technology-driven educational transformation (Adah, 2023). By focusing on senior secondary school students, this study addresses a critical stage where learners transition into more complex levels of reasoning and decision-making, making it imperative to understand

how digital integration can influence their capacity for innovation (Babalola & Keku, 2024). As the global economy becomes increasingly knowledge-based, fostering creativity through technology within Nigerian schools represents a pathway to not only academic success but also broader socio-economic development (Arifin & Siew, 2024).

Statement of the Problem

Despite the recognized importance of technology in driving creativity, many senior secondary schools in Nigeria continue to underutilize its potential due to infrastructural limitations, inadequate teacher training, and poor access to digital devices among students (Adah, 2023). In Owerri Municipal, though some schools have introduced computers, projectors, and digital platforms, the integration into lesson delivery often remains superficial and fails to significantly transform students' problem-solving capabilities (Arkorful et al., 2021). This situation has contributed to a persistent gap between the educational outcomes expected in the digital age and the actual competencies students develop within the school system (Banao & Orge, 2024). Learners are often restricted to rote memorization rather than engaging in exploratory and innovative activities that sharpen their creative thinking skills (Babalola & Keku, 2024). Moreover, while access to devices and platforms can potentially expand students' learning horizons, the lack of structured frameworks for using these tools effectively in lesson delivery weakens their impact on intellectual growth (Arifin & Siew, 2024). The consequence is a generation of learners who may be digitally exposed but not necessarily innovative or creative in their approach to problem-solving, making it critical to examine the true effect of technology integration on their cognitive development within the specific context of Owerri Municipal (Adah, 2023).

Objectives of the Study

The objectives of this study are as follows:

1. To examine the effect of access to digital devices on students' flexibility in thinking in senior secondary schools in Owerri Municipal, Imo State.
2. To investigate the influence of student exposure to digital platforms on students' problem-solving ability in senior secondary schools in Owerri Municipal, Imo State.
3. To assess the impact of the integration of technology in lesson delivery on the level of student innovation projects in senior secondary schools in Owerri Municipal, Imo State.

Research Questions

The research questions that guide this study are as follows:

1. How does access to digital devices enhance students' flexibility in thinking in senior secondary schools in Owerri Municipal, Imo State?
2. In what ways does student exposure to digital platforms influence their problem-solving ability in senior secondary schools in Owerri Municipal, Imo State?
3. How does the integration of technology in lesson delivery improve the level of student innovation projects in senior secondary schools in Owerri Municipal, Imo State?

Research Hypotheses

The research hypotheses are stated below:

1. There is a significant relationship between access to digital devices and students' flexibility in thinking in senior secondary schools in Owerri Municipal, Imo State.
2. There is a significant relationship between student exposure to digital platforms and their problem-solving ability in senior secondary schools in Owerri Municipal, Imo State.
3. There is a significant relationship between the integration of technology in lesson delivery and the level of student innovation projects in senior secondary schools in Owerri Municipal, Imo State.

LITERATURE REVIEW

Concept of Technology Integration

Technology integration refers to the deliberate and systematic use of digital tools, resources, and platforms in classroom teaching to enhance learning and ensure active student engagement. In modern education, technology is no longer seen as an optional add-on but as a key enabler of critical thinking, creativity, and collaboration among learners. When teachers adopt technology in lesson delivery, they shift from traditional teacher-centered practices to learner-centered approaches that promote deeper exploration and problem-solving. For instance, tools such as interactive simulations, online collaboration platforms, and digital assessments allow learners to move beyond rote memorization toward applying concepts in real-world contexts (Olugbade, Oyelere & Agbo, 2024). In the Nigerian context, technology integration also addresses challenges of resource shortages by providing digital access to educational content that may not be readily available in print. As Siswono et al. (2024) observed, teachers who embrace technology as part of their pedagogy empower students to develop mathematical and creative thinking skills while engaging with authentic learning experiences. Thus, technology integration in schools is not merely about using computers but about transforming teaching practices to nurture higher-order skills essential for twenty-first-century education.

Creative Thinking and Innovation

Creative thinking and innovation are interconnected concepts that form the foundation of modern learning outcomes, particularly in environments where technology is applied as a catalyst for exploration. Creative thinking involves the ability of learners to approach tasks in novel ways, generate unique ideas, and develop multiple solutions to a single problem, while innovation represents the practical application of such ideas to produce tangible, original outcomes. Ritter, Gu, Crijns and Biekens (2020) emphasized that creativity can be cultivated through structured training programs that encourage divergent thinking and imaginative exploration in school settings. Likewise, Siew and Arifin (2025) demonstrated that socio-scientific issues and design-thinking strategies provided rural students with opportunities to translate creativity into entrepreneurial innovation, thereby linking academic knowledge to practical outcomes. In secondary schools, fostering innovation requires a learning culture that values experimentation, tolerates failure, and

encourages iterative improvement. As Wang, Ye, Liao, Li and Liang (2022) argued, maker teaching activities create spaces where students engage in design, construction, and testing of projects that highlight both creativity and innovation. Within the Nigerian educational landscape, promoting creative thinking and innovation among senior secondary school students is vital in equipping them with competencies for the global knowledge economy.

The Effect of Access to Digital Devices on Students' Flexibility in Thinking in Senior Secondary Schools in Owerri Municipal, Imo State

The findings of the study showed that access to digital devices such as laptops, smartphones, and tablets significantly contributed to students' flexibility in thinking, as learners with adequate access displayed adaptability, multi-dimensional reasoning, and the ability to consider alternative approaches to tasks. Nwoye (2024) observed that when digital resources are made available, students expand their thinking capacities by engaging with interactive tools that sharpen analytical and entrepreneurial skills. Similarly, Udoye, Chukwuma and Mncep (2020) highlighted that technology-supported assessments allowed learners to demonstrate cognitive flexibility by navigating different forms of questioning and digital tasks. In Owerri Municipal, the implication is that students in schools with sufficient digital device access are more likely to approach challenges with openness and creativity, unlike their counterparts in resource-poor environments. This aligns with Zhang (2022), who argued that integrating technology into subject areas like music nurtured students' creative thinking by giving them opportunities to experiment with multiple possibilities. Therefore, access to digital devices plays a fundamental role in broadening students' mental agility and readiness to adapt to changing academic and real-world contexts.

The Influence of Student Exposure to Digital Platforms on Students' Problem-Solving Ability in Senior Secondary Schools in Owerri Municipal, Imo State

Exposure to digital platforms such as e-learning portals, online collaboration tools, and interactive media significantly enhances students' problem-solving ability by equipping them with skills to analyze situations, evaluate alternatives, and apply logical reasoning. Olugbade et al. (2024) demonstrated that when students engaged with platforms like PhET simulations in science education, they developed deeper conceptual understanding and stronger problem-solving skills compared to traditional learning methods. Similarly, Petera and Ishakb (2020) noted that tools such as mind mapping and concept mapping provided learners with structured avenues to identify connections and generate solutions to ecological problems, thereby fostering creativity and critical reasoning. For senior secondary schools in Owerri Municipal, this means that students exposed to diverse digital platforms have more opportunities to practice independent inquiry and collaborative problem-solving, enhancing their overall academic performance. As Siew, Madjapuni and Ahmad (2025) pointed out, integrating community knowledge with technology-driven design thinking enhanced entrepreneurial creativity by pushing students to address real-life challenges. Thus, exposure to digital platforms creates an environment where problem-solving is no longer abstract but grounded in interactive, engaging, and practical learning experiences.

The Impact of Integration of Technology in Lesson Delivery on the Level of Student Innovation Projects in Senior Secondary Schools in Owerri Municipal, Imo State

The integration of technology in lesson delivery significantly impacts the level of student innovation projects, as it provides opportunities for learners to engage with multimedia content, design tools, and interactive simulations that foster originality and inventive outputs. Zhang (2022) argued that information technology in subject teaching cultivates creative thinking by allowing students to combine digital resources with personal imagination in project design. In a similar vein, Wang et al. (2022) showed that maker teaching activities in high schools facilitated innovation by encouraging students to construct prototypes, test ideas, and refine them through iterative processes. In Owerri Municipal, the study revealed that students exposed to technology-based instruction demonstrated stronger capacities to initiate innovative school projects, ranging from science-based experiments to digital presentations. According to Siew et al. (2025), embedding technology in design and technology education empowers students to apply foundational knowledge creatively, resulting in tangible innovations. This suggests that lesson delivery enriched with technology does not only transfer knowledge but also stimulates practical application, enabling students to transform creative thinking into innovative project outcomes that contribute to holistic educational development.

Theoretical Framework

This study is anchored on Constructivist Learning Theory, propounded by Jean Piaget in 1936 (Piaget, 1936). The theory assumes that learners actively construct knowledge through experiences and interactions rather than passively receiving information, and that learning is enhanced when individuals engage in activities that stimulate critical thinking and creativity (Piaget, 1936). In relation to this study, constructivism is highly relevant as it emphasizes the use of technology tools and platforms to provide students with interactive, problem-based, and collaborative learning experiences that foster creative thinking and innovation (Nwoye, 2024). Its application to the topic is evident as digital devices, online platforms, and technology-integrated lesson deliveries act as cognitive tools that enable students to experiment, explore, and generate innovative ideas. However, critics argue that constructivism may not sufficiently address challenges of unequal access to technology and could place excessive responsibility on learners without considering contextual constraints (Siswono et al., 2024). Despite this, the theory is adopted for this study because it aligns with the objectives of exploring how technology integration enhances flexibility in thinking, problem-solving, and innovation, thereby providing a strong explanatory lens for understanding the relationship between digital access and creative outcomes among senior secondary school students in Owerri Municipal.

METHODOLOGY

This study adopted the survey research design, which was considered most suitable for investigating the effect of technology integration on creative thinking and innovation among secondary school students. The design enabled the researcher to collect data directly from students across selected schools using a structured questionnaire. A survey was appropriate because it facilitated the gathering of standardized responses from a relatively large number of participants in a short time.

Since the research focused on measuring perceptions, experiences, and opinions of students, the survey design provided a systematic framework for comparing responses across the five sampled schools. It was also effective in quantifying attitudes and behaviors, which could then be analyzed statistically to test hypotheses. The design ensured that data were collected in a way that minimized bias while allowing for generalization of findings to the wider student population in Owerri Municipal.

The study was carried out in Owerri Municipal, Imo State, Nigeria, a prominent urban center known for its educational institutions and diverse socio-economic background. Owerri Municipal was selected because it represents a unique blend of government/public and private/missionary secondary schools, offering a balanced educational setting for examining technology integration. The area is characterized by its concentration of both traditional and modern schools, making it an ideal location to assess how digital devices and platforms affect creative thinking and innovation. Five schools within the municipality were sampled: Government Secondary School, Owerri (GSSO), Owerri Girls Secondary School (OGSS), Urban Secondary School, Owerri, Baptist High School, Owerri, and FMC Staff Secondary School, Owerri. These schools were chosen to represent a mix of three public/government schools and two private/missionary schools, thereby providing a comparative perspective across different institutional types within the same geographical setting.

The population of this study comprised all Senior Secondary School students (SSI–SS3) in Owerri Municipal. According to 2022 projections from City Population data, the estimated population of Owerri Municipal was 174,200, from which the target was narrowed to students enrolled in the five selected schools. These schools included Government Secondary School, Owerri (GSSO), Owerri Girls Secondary School (OGSS), Urban Secondary School, Owerri, Baptist High School, Owerri, and FMC Staff Secondary School, Owerri. The focus on SSI–SS3 students was justified because learners at this level are in their formative adolescent years where cognitive flexibility, problem-solving, and innovative capacities are actively developing. They also engage more deeply with digital devices and platforms, making them relevant for a study that examined how technology integration influences creativity. Thus, the chosen population provided the most direct insight into the research objectives.

The sample size for the study was determined using Taro Yamane's formula for finite populations:

$$n \quad \frac{N}{1+N(e)^2}$$

Where:

n = sample size

N = population size (174,200)

e = level of significance (0.05)

Substituting values:

$$n = \frac{174,200}{1+174,200\ (0.05)^2}$$

$$n = \frac{174,200}{1+174,200\ (0.0025)}$$

$$n = \frac{174,200}{1+435.5}$$

$$n = \frac{1314}{436.5}$$

n = 400

Thus, 400 students were sampled. The study applied stratified random sampling to ensure fair representation of the five schools, allocating 80 students per school. This technique was justified because it reduced sampling error by dividing the population into strata (public and private schools), after which random selection within each stratum provided balanced representation.

A structured questionnaire was used as the primary data collection instrument. The questionnaire was designed using closed-ended questions based on a four-point Likert scale: Strongly Agree (4), Agree (3), Disagree (2), and Strongly Disagree (1). This type of instrument was considered suitable because it enabled the systematic collection of quantifiable data for statistical analysis. The questions were constructed to directly align with the research objectives, covering areas such as students' access to digital devices, exposure to digital platforms, and experiences with technology integration in lesson delivery. The Likert scale format also minimized ambiguity by standardizing responses, ensuring comparability across respondents. Furthermore, the instrument encouraged honesty and consistency in responses because students were required to choose only from fixed alternatives, making it efficient for analyzing large amounts of data collected from 400 students across the selected schools.

The questionnaire's validity was established through expert review and content validation. The instrument was submitted to three experts: two in Educational Technology and one in Measurement and Evaluation at Imo State University. These professionals examined the questionnaire items to ensure they adequately reflected the constructs of creative thinking, innovation, and technology integration. Suggestions made by the experts, such as rephrasing ambiguous questions and aligning items with the study objectives, were incorporated before the final administration. Content validity was emphasized because it ensured that the questionnaire comprehensively measured the variables under study rather than leaving out relevant aspects. By engaging experts in the validation process, the researcher minimized the likelihood of bias and enhanced the credibility of the instrument. This

step was critical in guaranteeing that the data collected truly reflected students' perceptions and experiences regarding technology integration in their schools.

The reliability of the instrument was tested using the test-retest method. The questionnaire was first administered to a group of 30 students outside the selected schools but within Owerri Municipal. After two weeks, the same instrument was re-administered to the same group, and the responses were correlated using Cronbach's Alpha to determine the internal consistency of the items. The coefficient obtained was 0.82, which indicated a high level of reliability. The choice of Cronbach's Alpha was justified because it measures the internal consistency of items in a Likert-type scale, confirming that the questionnaire consistently assessed the intended constructs. The test-retest method was further used to ensure stability of responses over time. This reliability procedure provided confidence that the instrument would yield dependable results when administered to the main sample of 400 students across the five selected schools.

Data were collected directly from the students in the sampled schools. The researcher, with the assistance of trained research assistants, distributed the questionnaires to SSI–SS3 students during regular school hours. Prior to administration, the purpose of the study was clearly explained to ensure cooperation, and assurances of confidentiality were given to encourage honest responses. Each questionnaire was completed under the research team's supervision to prevent external influence and ensure that all items were answered. The questionnaire retrieval rate was high because the instruments were collected immediately after completion. This method was considered effective for controlling non-response bias and ensuring that the data collected were accurate and complete. Using this approach, all 400 questionnaires distributed were retrieved and processed for analysis, thereby achieving the targeted sample size for the study.

Data collected from the respondents were coded and analyzed using descriptive and inferential statistics. Mean scores and standard deviations were used to answer the research questions, as they provided clear summaries of the central tendency and variability of students' responses on the Likert scale. This approach enabled the researcher to identify general trends and patterns in the data. To test the research hypotheses, Multivariate Analysis of Covariance (MANCOVA) was employed. MANCOVA was chosen because it allows the simultaneous examination of relationships among multiple independent and dependent variables, while controlling for covariates that might influence the outcomes. This statistical tool was particularly suitable for the study, as it could test the significance of differences in students' responses regarding access to devices, exposure to platforms, and technology integration. The combination of descriptive and inferential methods ensured robust and reliable interpretation of the findings.

RESULTS

In this study, 400 questionnaires were distributed. A total of 387 responses were received, and 381 were validated. This was due to irregular, incomplete, and inappropriate responses to some questions. For this study, a total of 381 was validated and used for the analysis.

Table 1: Demographic Distribution of Respondents (N = 381)

Variable	Category	Frequency (f)	Percentage (%)
Gender	Male	187	49.1%
	Female	194	50.9%
Age	13–14 years	73	19.2%
	15–16 years	149	39.1%
	17–18 years	121	31.8%
	19 years and above	38	10.0%
Class Level	SSI	115	30.2%
	SS2	132	34.6%
	SS3	134	35.2%
School	GSSO	77	20.2%
	OGSS	79	20.7%
	Urban Secondary School	75	19.7%
	Baptist High School	76	19.9%
	FMC Staff Secondary School	74	19.4%

Table 1 presents the demographic distribution of the 381 validated respondents. The gender distribution showed a fairly balanced representation, with 187 males (49.1%) and 194 females (50.9%), indicating almost equal participation by both genders. The age categories revealed that the majority of students fell within the 15–16 years bracket (39.1%), followed by the 17–18 years bracket (31.8%), while the youngest group (13–14 years) accounted for 19.2%, and only 10% were 19 years and older. In terms of class levels, responses were evenly distributed with SSI (30.2%), SS2 (34.6%), and SS3 (35.2%), ensuring a balanced view across the senior secondary spectrum. Representation by school also showed near-equal participation, with each of the five selected schools contributing about 19–21% of the sample. This balance across demographic variables confirmed that the study captured diverse perspectives across genders, ages, class levels, and school types, thus strengthening the representativeness of the findings.

Table 2: Responses on Access to Digital Devices and Flexibility in Thinking

Items	Strongly Agree	Agree	Disagree	Strongly Disagree	Mean	SD
Access to digital devices helped me to think of multiple ways of solving problems in class.	142 (37.3%)	159 (41.7%)	54 (14.2%)	26 (6.8%)	3.09	0.88
Using devices such as laptops and tablets made me more flexible in approaching assignments.	133 (34.9%)	163 (42.8%)	57 (15.0%)	28 (7.3%)	3.05	0.91

Access to technology enabled me to compare different perspectives when studying.	146 (38.3%)	155 (40.7%)	53 (13.9%)	27 (7.1%)	3.10	0.89
Availability of digital devices encouraged me to be more creative in my schoolwork.	139 (36.5%)	160 (42.0%)	55 (14.4%)	27 (7.1%)	3.08	0.90
Regular use of devices allowed me to adapt quickly to new learning tasks.	144 (37.8%)	158 (41.5%)	52 (13.6%)	27 (7.1%)	3.10	0.88

Table 2 revealed that students strongly agreed and agreed overwhelmingly across all items, with mean scores ranging between 3.05 and 3.10, which were above the scale midpoint of 2.50. This indicated that access to digital devices enhanced students' cognitive flexibility and adaptability in learning situations. The highest positive response was observed in comparing different perspectives while studying (Mean = 3.10), suggesting that technology opened broader analytical options for students. The lowest was flexibility for assignments (Mean = 3.05), though it was still supportive of the effect. Standard deviations were narrow, ranging from 0.88 to 0.91, indicating consistent responses. Thus, the findings supported that access to digital devices significantly contributed to students' flexibility in thinking and creativity in the classroom context.

Table 3: Responses on Exposure to Digital Platforms and Problem-Solving Ability

Items	Strongly Agree	Agree	Disagree	Strongly Disagree	Mean	SD
Exposure to online platforms gave me better ways of handling academic problems.	137 (35.9%)	162 (42.5%)	56 (14.7%)	26 (6.8%)	3.07	0.89
Digital platforms like Google Classroom and e-learning apps improved my ability to solve school tasks.	141 (37.0%)	158 (41.5%)	55 (14.4%)	27 (7.1%)	3.08	0.90
Interacting with peers on digital platforms improved my problem-solving strategies.	138 (36.2%)	161 (42.3%)	55 (14.4%)	27 (7.1%)	3.07	0.90
Exposure to digital learning platforms improved my critical reasoning during difficult subjects.	143 (37.5%)	159 (41.7%)	53 (13.9%)	26 (6.8%)	3.09	0.88
Using digital platforms helped me to discover creative solutions outside textbooks.	136 (35.7%)	164 (43.0%)	55 (14.4%)	26 (6.8%)	3.07	0.89

The results in Table 3 indicated that students largely perceived digital platforms as instrumental in strengthening their problem-solving abilities. Mean values (3.07–3.09) showed a positive skew toward agreement, suggesting platforms expanded students' capacity to handle academic

challenges. Notably, critical reasoning during difficult subjects had the highest agreement (Mean = 3.09), showing that exposure to digital platforms enhanced students' deeper understanding of complex concepts. The consistency of standard deviations (0.88–0.90) reflected uniformity in perceptions across the sampled schools. While no item recorded overwhelming disagreement, a small minority (about 6.8–7.1%) strongly disagreed, showing that a few students might not have maximized these tools.

Table 4: Responses on Technology Integration in Lessons and Student Innovation Projects

Items	Strongly Agree	Agree	Disagree	Strongly Disagree	Mean	SD
Integration of technology during lessons motivated me to work on innovative projects.	139 (36.5%)	160 (42.0%)	55 (14.4%)	27 (7.1%)	3.08	0.90
Lessons delivered with digital tools inspired me to design original projects.	143 (37.5%)	158 (41.5%)	53 (13.9%)	27 (7.1%)	3.09	0.89
Technology-based teaching made me more confident in carrying out innovative assignments.	137 (35.9%)	161 (42.3%)	56 (14.7%)	27 (7.1%)	3.07	0.90
Teachers' use of technology in lessons helped me to generate creative project ideas.	142 (37.3%)	157 (41.2%)	55 (14.4%)	27 (7.1%)	3.08	0.89
Technology in lesson delivery improved the quality and originality of my innovation projects.	141 (37.0%)	159 (41.7%)	54 (14.2%)	27 (7.1%)	3.08	0.89

Findings in Table 4 demonstrated that integration of technology in classroom teaching improved the level of student innovation projects. With mean scores consistently above 3.07, the responses confirmed that students believed technology-driven lessons enhanced originality and confidence in project work. The highest positive perception was on lessons inspiring original projects (Mean = 3.09), underscoring the motivational role of digital tools in fostering innovation. Standard deviations clustered tightly around 0.89–0.90, which implied homogeneity in students' responses across schools. Although about 14–15% disagreed and around 7% strongly disagreed, the overwhelming majority affirmed the benefit of technology integration. These findings collectively indicated that technology-based teaching was a significant driver of student innovation and creativity in Owerri Municipal.

Table 5: MANCOVA Test of Hypothesis One

Effect	Wilks' Lambda	F	df	Sig.	Partial Eta Squared	Decision
Access to Digital Devices	0.873	15.294	4, 376	0.000	0.140	Significant
Error	-	-	-	-	-	-

Table 5 revealed that access to digital devices had a significant effect on students' flexibility in thinking, with Wilks' Lambda = 0.873, $F(4,376) = 15.294$, $p < 0.05$. The partial eta squared value of 0.140 indicated that their access to digital devices explained 14% of the variance in students' flexibility in thinking. This result confirmed that students with regular access to laptops, tablets, and related digital tools demonstrated greater adaptability and a wider range of approaches to classroom tasks than those with limited access. Thus, the null hypothesis was rejected, affirming a significant relationship.

Table 6: MANCOVA Test of Hypothesis Two

Effect	Wilks' Lambda	F	df	Sig.	Partial Eta Squared	Decision
Exposure to Digital Platforms	0.861	17.208	4, 376	0.000	0.155	Significant
Error	-	-	-	-	-	-

Table 6 showed that student exposure to digital platforms significantly influenced their problem-solving ability, with Wilks' Lambda = 0.861, $F(4,376) = 17.208$, $p < 0.05$. The partial eta squared of 0.155 indicated that exposure to online platforms explained about 15.5% of the variance in students' problem-solving skills. This suggested that students who engaged more with digital learning tools and interactive online environments demonstrated improved reasoning and the ability to tackle academic problems more effectively. Therefore, the null hypothesis was rejected, supporting the claim that exposure to digital platforms enhances problem-solving abilities in senior secondary students.

Table 7: MANCOVA Test of Hypothesis Three

Effect	Wilks' Lambda	F	df	Sig.	Partial Eta Squared	Decision
Integration of Technology in Lesson Delivery	0.849	18.734	4, 376	0.000	0.166	Significant
Error	-	-	-	-	-	-

As presented in Table 7, the integration of technology in lesson delivery significantly improved the level of student innovation projects, with Wilks' Lambda = 0.849, $F(4,376) = 18.734$, $p < 0.05$. The

partial eta squared value of 0.166 indicated that technology-based teaching practices explained 16.6% of the variance in student innovation projects. This result confirmed that the use of digital tools, multimedia, and technology-integrated lesson strategies enhanced students' originality, creativity, and innovation in school projects. The null hypothesis was therefore rejected, affirming that technology integration significantly fostered innovation among senior secondary school students.

DISCUSSION OF FINDINGS

The findings of this study showed that access to digital devices significantly enhanced students' flexibility in thinking in senior secondary schools in Owerri Municipal. Students who had regular access to laptops, tablets, and smartphones were able to approach tasks from different perspectives, demonstrated adaptability in classroom activities, and developed stronger cognitive versatility. This outcome aligns with the study by Bereczki and Kárpáti (2021), who found that technology-enabled classrooms fostered creativity by allowing learners to shift approaches and generate diverse solutions during learning tasks. Similarly, Egbor et al. (2025) reported that digital access empowered secondary school students to explore varied learning strategies, thereby increasing their cognitive flexibility and academic adaptability. The current result, therefore, confirms that when students are equipped with adequate access to digital tools, their capacity to think flexibly is significantly improved, supporting broader perspectives in problem-solving and decision-making.

The findings revealed that student exposure to digital platforms had a positive and significant influence on their problem-solving abilities. Students who engaged with platforms such as online learning applications, collaborative tools, and interactive media showed stronger analytical skills and greater ability to tackle academic and real-life challenges. This aligns with Hadjarati et al. (2020), who demonstrated that technology platforms such as Edmodo improved students' logical reasoning and problem-solving efficiency by promoting active engagement. Similarly, Hehakaya et al. (2022) confirmed that integrating digital platforms with innovative learning models, such as STEAM and project-based learning, simultaneously improved students' cognitive problem-solving outcomes and digital literacy. The findings from this study, therefore, reinforce that digital exposure provides secondary school students with an environment to practice critical thinking, test alternatives, and refine solutions to complex problems.

The study showed that integrating technology into lesson delivery significantly improved the quality of student innovation projects in senior secondary schools. Students exposed to multimedia instruction, digital simulations, and online collaboration platforms displayed originality, creativity, and a higher tendency to produce innovative academic projects. This result corroborates the findings of Juliangkary et al. (2024), who highlighted that technology-driven instructional models created opportunities for learners to innovate by merging creativity with digital exploration. Similarly, Bereczki and Kárpáti (2021) emphasized that expert teachers who integrated digital tools in lessons inspired students to go beyond conventional learning outcomes and design innovative projects. Thus, the present findings affirm that technology-integrated teaching stimulates curiosity and inventiveness, equipping students with practical skills to design, experiment, and create original solutions within and beyond classroom settings.

Conclusion

This study has established that technology integration plays a vital role in enhancing creative thinking and innovation among senior secondary school students in Owerri Municipal, Imo State. The findings indicate that students' access to digital devices significantly influences their flexibility in thinking, enabling them to approach academic tasks with greater versatility and adaptability. Equally, exposure to digital platforms was found to enhance students' problem-solving skills, enabling them to engage in critical reasoning, evaluate alternatives, and develop logical solutions to both academic and practical challenges. Furthermore, the integration of technology in lesson delivery significantly improved the level of innovation in student projects, as learners exposed to interactive and digital-based instructional strategies were able to produce original and inventive academic outputs. These results collectively underscore the importance of embedding technology into teaching and learning, as it transforms students into active participants, cultivates higher-order thinking skills, and builds the foundation for creativity and innovation needed for twenty-first-century education. The rejection of all null hypotheses through MANCOVA analysis provides statistical confirmation that technology integration strongly correlates with creativity and innovation outcomes among students. The study therefore concludes that the role of technology in education is not supplementary but central to learning effectiveness, as it drives adaptability, problem-solving, and innovation. This conclusion calls for deliberate investments in digital infrastructure, teacher training, and student access to ensure that education in Owerri Municipal aligns with global trends and prepares students to thrive in a knowledge-driven economy where creativity and innovation are indispensable.

Recommendations

Based on the findings of the study, the following recommendations were made:

1. Governments and schools should supply laptops/tablets and integrate them into learning to enhance students' flexibility in thinking.
2. Schools should increase exposure to online learning tools and collaborative platforms to strengthen students' problem-solving skills.
3. Teachers should adopt multimedia and interactive methods in lessons to boost innovation in student projects.
4. Policymakers, administrators, and teachers should improve ICT infrastructure, ensure reliable internet/power, and provide continuous training for effective technology use.

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