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Relationship between Artificial Intelligence Tools and Academic Performance of TVET Students in Higher Education

Ogbebor, Samuel Osamede
Department of Vocational and Technical Education, Faculty of Education, Ambrose Alli University Ekpoma 310103, Edo, Nigeria

Corresponding author: ogbebor@aauekpoma.edu.ng

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Abstract

This research investigated the correlation between artificial intelligence (AI) tools and the academic achievements of Technical Vocational Education and Training (TVET) students in public universities in the South-South region of Nigeria. A correlational survey design was employed, targeting a population of 3,986 regular undergraduate students for the 2024/2025 academic year. A multi-stage sampling procedure was used to select a sample of 600 students from both federal and state universities. Data was collected using a validated questionnaire (Relationship between Artificial Intelligence Tools and Academic Performance of TVET Students in Public Universities in South-South Nigeria Questionnaire, assessed by expert lecturers from Ambrose Alli University and the University of Benin. The instrument demonstrated strong reliability, with a Cronbach's Alpha coefficient of .79. Pearson Product Moment Correlation Coefficient (PPMCC) analysis revealed significant positive relationships between AI tool usage and: Student learning abilities, Problem-solving skills and Critical thinking abilities. Based on these findings, it is recommended that TVET students actively adopt AI tools, pursue relevant integrated courses, and remain informed about advancements in AI technologies within South-South Nigerian public universities.

Keywords: *Artificial Intelligence*, *TVET Students*, *Academic Performance*, *Learning Capacities, Problem-Solving Abilities*

INTRODUCTION

Education is widely recognized as a cornerstone for individual and societal advancement, providing the essential knowledge, skills, and aptitudes necessary for progress. Individuals with advanced education often exhibit a stronger drive to achieve their objectives. Furthermore, practical education plays a vital role in bolstering societal welfare and prosperity (Dube & Mlotshwa, 2018; Wang et al., 2018), positioning education as a catalyst for national development and transformative change.

Nigeria's educational framework encompasses higher education, senior secondary education (including pre-technical and vocational training), and universal basic education (comprising elementary and junior secondary levels). The Federal Republic of Nigeria (2013) defines Technical Vocational Education and Training (TVET) as a holistic approach to education that integrates the study of technologies and related sciences with the acquisition of practical skills, fostering the attitudes, comprehension, and expertise relevant to various professions across the economy and social fabric.

The Federal Republic of Nigeria's (FRN) education policy framework outlines the core objectives of TVET as follows: Workforce Readiness and Economic Contribution: Equip students with immediately applicable skills and knowledge, directly fueling national economic advancement. Continuous Professional Development: Foster a culture of lifelong learning and upskilling to ensure workforce adaptability in the face of technological disruption and evolving industry demands; Entrepreneurial Capacity Building: Cultivate innovation and self-sufficiency by empowering individuals with the competencies to create and manage their own ventures. Equitable Access and Social Mobility: Promote inclusivity by providing diverse populations with access to quality training across a spectrum of vocational field. Holistic Educational Advancement: Elevate overall educational standards through the synergistic integration of theoretical and practical learning, creating well-rounded and capable individuals. In essence, the FRN envisions TVET as a dual-purpose engine, simultaneously driving individual career success and propelling Nigeria's broader socioeconomic progress.

The stated objectives reveal a consensus between federal and state governments on the importance of Technical and Vocational Education and Training (TVET) in cultivating skills, abilities, and competencies necessary for individual livelihoods and national development in Nigeria. TVET is positioned to produce the skilled technicians, craftsmen, and artisans crucial for bolstering the nation's economy. Successful TVET implementation is essential for fostering technological advancement, facilitating Nigeria's transition from a consumer-based economy to a producer-based one, and driving its progression from a developing to a developed nation, especially if technology is integrated with TVET university education.

The modern era is marked by a focus on information, innovation, and invention, superseding traditional methodologies. Artificial Intelligence (AI) is a central driving force behind this transformation. Both nationally and internationally, AI is recognized as a pivotal technology for the future (Krstić et al., 2022). Recent global advancements in AI aim to replicate human intelligence, enabling computers to learn and adapt. Given its diverse applications, AI resists a singular definition. It can manifest in various forms, from thinking robots to systems capable of language comprehension, problem-solving, medical diagnosis, autonomous vehicle operation, and creative endeavors (Tuomi, 2018). More precisely, AI should be defined as the capability of a computer system to perform tasks typically requiring human intelligence (Tuomi, 2018). A more pragmatic definition focuses on creating machines that can operate effectively within their environment.

Artificial intelligence defined as a high-performance computational system equipped with advanced processing power and adaptable features, including human-thought-simulating sensors, thereby enhancing human interaction. AI's capacity to execute tasks mirroring human actions underscores its foundation in computer science and technological progress. Undeniably, AI stands as a transformative force in global education, possessing the potential to revolutionize teaching and learning methodologies. By tailoring learning experiences, AI could cater to individual student needs, delivering targeted support. Furthermore, AI could streamline administrative responsibilities, freeing educators to concentrate on enriched student engagement and personalized instruction. Artificial intelligence is poised to revolutionize education, offering data-driven insights into student performance that empower educators to refine curriculum and instruction.

As AI technology matures, its role in 21st-century learning will only intensify. In the realm of Technical Vocational Education and Training (TVET), AI could addresses systemic complexities and shortcomings of conventional teaching methods. The data deluge from e-learning platforms fuels AI's capacity to generate innovative solutions. AI's significance in TVET may lies in its provision of adaptable learning pathways via cutting-edge technologies. Platforms such as ChatGPT, Scikit Learn, TensorFlow, PyTorch, and Grammarly may hold the potential to foster more effective and efficient teaching and learning environments. The influence of AI tools on TVET student academic outcomes has already been substantial, and is set to grow further. Students' learning outcomes, such as grades, test scores, attendance, engagement, study habits, and other indicators of success, are evaluated based on their academic achievement (González-López, 2023).

Artificial intelligence offers transformative potential for university-level TVET students, specifically in bolstering critical thinking, refining study methodologies, improving organizational skills, and facilitating personalized learning experiences. AI-driven tools empower students to meticulously track academic progress, strategically optimize study schedules, access tailored support mechanisms, and sharpen crucial problem-solving capabilities (Leisterer, & Paschold, 2022). This could fosters self-regulated learning habits, enhances analytical prowess, and cultivates a deeper understanding of individual learning requirements. Recognizing this impact, educational institutions globally, including those in Nigeria, are increasingly integrating AI solutions. This research focuses on examining the correlation between the utilization of AI tools and the academic performance of TVET students within public universities in the South-South region of Nigeria. The study specifically aims to: (1) examine the relationship between artificial intelligence (AI) technologies and TVET students' learning capacities in South-South Nigerian public universities. (2) to investigate the relationship between TVET students' problem-solving abilities and artificial intelligence (AI) tools in South-South Nigerian public universities. (3) to ascertain the relationship between TVET students' critical thinking skills and artificial intelligence (AI) tools in public universities in South-South Nigeria. The study was directed by the following research questions: (1) what is the relationship between artificial intelligence (AI) tools and the learning abilities of TVET students in public universities in South-South Nigeria? (2) what is the relationship between artificial intelligence (AI) tools and the problem-solving skills of TVET students in public universities in South-South Nigeria? (3) what is the relationship between artificial intelligence (AI) tools and the critical thinking abilities of TVET students in public universities in South-South Nigeria?

THEORETICAL FRAMEWORK AND HYPOTHESIS DEVELOPMENT

Atkinson and Shiffrin's multi-store memory model (1968), positing sensory, short-term, and long-term memory stages, provided the bedrock for Sweller's Cognitive Load Theory (CLT) (1988). This model underlines the necessity of short-term memory processing as a gateway for information transfer to long-term memory. CLT, in turn, analyzes the impact of varying cognitive load types on learning efficacy. Specifically, CLT identifies: Intrinsic Cognitive Load: Inherent complexity of the material, governed by the interconnectedness of its constituent elements. Extraneous Cognitive Load: Cognitive burden imposed by suboptimal instructional design or distracting environmental factors. A supportive social environment is critical for maximizing learning potential.

Self-Determination Theory (SDT) posits that intrinsic motivation flourishes when individuals experience fulfillment in three fundamental psychological needs: relatedness, competence, and autonomy. Satisfying these interconnected needs fuels enhanced motivation and, consequently, superior performance. Research indicates that both beneficial and detrimental instructional practices within TVET programmes can significantly influence these needs. Moreno-Murcia et al. (2024) advanced SDT by emphasizing the role of perceived competence in driving motivational intensity and the desire to learn. Their research suggests that students' perceived competence directly impacts their motivational drive and learning intensity, ultimately shaping their inclination to study and their overall academic success. This study leverages both SDT and Cognitive Load Theory (CLT) to examine the impact of Artificial Intelligence (AI) tools on TVET students' learning, problem-solving, and critical thinking skills within South-South Nigerian institutions. The overarching objective is to determine the relationship between AI tool utilization and academic performance, specifically focusing on learning abilities, problem-solving proficiency, and critical thinking capabilities within this context. Based on these objectives, the following hypotheses were put forward:

$H0_1$: There is no significant relationship between artificial intelligence (AI) tools and the learning abilities of TVET students in public universities in South-South Nigeria.

$H0_2$: There is no significant relationship between artificial intelligence (AI) tools and the problem-solving skills of TVET students in public universities in South-South Nigeria.

$H0_3$: There is no significant relationship between artificial intelligence (AI) tools and the critical thinking abilities of TVET students in public universities in South-South Nigeria.

LITERATURE REVIEW

Artificial intelligence is reshaping the academic landscape for TVET students. AI's capacity to deliver tailored information addresses specific learning needs, although its integration within education remains nascent. By leveraging natural language processing, AI could boosts student engagement and facilitates the acquisition of personalized knowledge, accelerating learning outcomes. Moreover, AI's role may extends to fostering advanced and impactful learning methodologies, providing students with access to cutting-edge technology that sharpens focus and enhances knowledge retention. The future of education hinges on the transformative impact of Artificial Intelligence (AI) on student outcomes. AI-powered educational tools are revolutionizing the learning landscape by providing data-driven insights into student performance, encompassing skills and competencies (Tian, & Shen, 2023). AI's applicability may extends to diverse areas within education. Sentiment analysis gauges student emotions, classroom monitoring optimizes the learning environment, intelligent tutoring delivers personalized instruction, and predictive models enhance student retention. Furthermore, AI streamlines student assessment, providing a comprehensive and nuanced understanding of academic achievement (Carriedo, et al., 2023). These applications collectively demonstrate AI's potential to reshape the educational paradigm and foster improved learning outcomes.

AI's integration into education is reshaping student support and academic advancement. Research highlights AI's capacity to identify and address the needs of underperforming students, providing tailored resources and analytical insights to improve their outcomes (Means et al, 2010). Beyond student support, AI may streamlines administrative tasks, automates aspects of teaching, and ultimately lightens educators' workloads. Crucially, AI fosters critical skills like knowledge synthesis, innovation, collaboration, and technological proficiency (Wang et al., 2023), solidifying its role as a catalyst for both educational and societal progress.

Artificial intelligence offers a data-rich lens through which to analyze contemporary learning methodologies. AI's influence could extends to predictive analytics for student performance, automated assessment, intelligent tutoring systems, and comprehensive learning management platforms. These applications systematically impact educational ecosystems by providing tools that personalize instruction and cater to diverse learning styles. AI-driven automation could facilitates real-time feedback, informs instructional design, promotes educator development, and enhances inclusive learning environments. Ultimately, AI may has the potential to reshape pedagogical approaches, foster creativity in learning, and deliver customized educational experiences tailored to individual student needs.

AI maybe poised to reshape student learning through personalized, adaptive educational experiences. Real-time feedback and interactive platforms powered by AI could hone critical thinking abilities. AI's capacity to analyze student performance data may allow for customized learning paths, ensuring optimal pacing and comprehension. This tailored approach may enhances student engagement and academic outcomes, thus streamlining the educational process around the individual learner. Furthermore, AI could acts as a dynamic resource, offering research assistance, answering queries, and providing comprehensive academic overviews. This support could empowers students to refine their study habits and achieve specific learning objectives, marking a significant transformation in digital learning.

Owolabi et al. (2022) assessed Nigerian polytechnic students' understanding and readiness for artificial intelligence, revealing that exposure during orientation programmes fostered awareness of AI's application in library services. Conversely, research by Moreno-Murcia et al. (2024). in Lagos State indicated limited acceptance of AI among students, while also establishing a correlation between social networking aptitude and AI analytical skills. In a different context, Fabregas et al. (2016) found that

Jordanian tenth-grade computer science students using AI-driven educational software showed significantly improved academic performance and expressed moderately positive attitudes towards the technology.

Complementing this, Tamayo et al. (2025) research delves into AI's impact on academic performance, revealing its efficacy in personalizing education to meet individual student needs. This tailored approach fosters more comprehensive learning experiences by identifying struggling learners and facilitating targeted interventions. Tamayo et al., work further demonstrates AI's ability to refine students' attitudes towards learning, bolster motivation for effective study habits, and provide insightful feedback through adaptive learning mechanisms, ultimately guiding students toward optimized learning pathways.

Razia et al. (2023) investigated the relationship between artificial intelligence (AI) and its aspects in higher education. This paper aims to provide better understanding on this phenomenon, as well as some recommendations to assist in preparing Al technology and its related aspects during crisis like Covid period and beyond. The study consisted of two phases. Phase one focused on identifying top higher education institutions according to the QS world university ranking. As a result, 180 higher education institutions in the Arab region were found, with the 2022 QS Arab region university ranking. The study selected top 20 performing institutions. Each institution has been assessed according to six metrics including: international student ratio, international research network, international ration, Web impact, citation per page and paper per faculty. Phase two explored the adapted Al applications and their related aspects that are used in each institution using a learning online questionnaire. Pilot tests were used to determine the validity and reliability of the measures. Among the finding are numerous factors that lead to enhancing high education using Artificial Intelligence in higher education institutions have emerged from this study. Students and faculty academics perceive things and use Al technology differently, many higher education institutions have adapted great Al technology applications.

In a similar studied conducted by Owan et al. (2023) on exploring the potential of artificial intelligence tools in educational measurement and assessment. The paper explores the various applications of AI tools in educational measurement and assessment. Specifically, it discusses the integration of large language AI models in classroom assessment, in specific areas such as test purpose determination and specification, developing, test blueprint, test item generation/development, preparation of test instructions, item assembly/selection, test administration, test scoring, interpretation of test results, test analysis/appraisal, and reporting. It analyses the role of teachers in AI-based assessment and the challenges of using AI-powered tools in educational assessment. Finally, the paper presents strategies to address these challenges and enhance the effectiveness of AI in educational assessment. In conclusion, using AI in educational assessment has benefits and limitations. Artificial intelligence (AI) is transforming various industries, and education is no exception. Rapid advancements in AI technology have become essential for educators and educational assessment professionals to enhance teaching and learning experiences. AI-powered educational assessment tools provide numerous benefits, including improving the accuracy and efficiency of assessments, generating personalized feedback for students, and enabling teachers to adapt their teaching strategies to meet the unique needs of each student. Therefore, AI has the potential to revolutionize the way education is delivered and assessed, ultimately leading to better educational outcomes for students. The application of AI in educational assessment can ultimately transform education, improve learning outcomes, and equip students with the skills needed to succeed in the 21st century.

The purpose of the study was to assess the impact of Artificial Intelligence (AI) on education. Premised on a narrative and framework for assessing AI identified from a preliminary analysis, the scope of the study was limited to the application and effects of AI in administration, instruction, and learning. A qualitative research approach, leveraging the use of literature review as a research design and approach was used and effectively facilitated the realization of the study purpose. Artificial intelligence is a field of study and the resulting innovations and developments that have culminated in computers, machines, and other artifacts having human-like intelligence characterized by cognitive abilities, learning, adaptability, and decision-making capabilities. The study ascertained that AI has extensively been adopted and used in education, particularly by education institutions, in different forms. AI initially took the form of computer and computer related technologies, transitioning to web-based and online intelligent education systems, and ultimately with the use of embedded computer systems, together with other technologies, the use of

humanoid robots and web-based chatbots to perform instructors' duties and functions independently or with instructors. Using these platforms, instructors have been able to perform different administrative functions, such as reviewing and grading students' assignments more effectively and efficiently, and achieve higher quality in their teaching activities. On the other hand, because the systems leverage machine learning and adaptability, curriculum and content has been customized and personalized in line with students' needs, which has fostered uptake and retention, thereby improving learners experience and overall quality of learning.

Artificial Intelligence (AI) has become an important technology affecting the development of society and education, and it is crucial to explore AI to enhance students' creativity and learning performance. Wang et al. (2023) carried out a study on effects of higher education institutes artificial intelligence capability on students' self-efficacy, creativity and learning performance. This study focuses on AI applications within the HEI, confirms the new explanatory power of resource-based theory in technological practices, and deconstructs the intrinsic mechanics, especially in relationships between students' creativity, self-efficacy, and learning performance. The research proposes the model and hypothesis based on the resource-based theory and related research. AI of higher education institute (HEI) affects students' learning performance and combines the existing literature to develop measurement tools and to obtain a formal questionnaire after pre-research and received 561 valid questionnaires collected from HEIs in China that have applied AI. Then SmartPLS 3.0 was used to construct a partial least squares structural equation model (PLS-SEM) for data analysis on the received data samples. The research results show that: 1) HEIs' artificial intelligence capability is a three-order variable and formed by three formative second-order variables such as resources (data, technical, basic resources), skills (technical skills, teaching applications, collaboration competencies), and consciousness (reform, innovation consciousness); 2) HEIs' artificial intelligence capability significantly affects students' self-efficacy and creativity; 3) HEIs' artificial intelligence capability affects students' learning performance via two mediating variables: student creativity and self-efficacy and concluded that using AI aid to drive teaching and learning, and improve students' creativity and learning performance.

Oyeyemi et al. (2024) established a significant positive relationship between AI tool utilization and enhanced learning capabilities among students in Anambra State's public universities. Similarly, Ren et al. (2024) demonstrated that AI tools in vocational music education notably improved reading abilities and fostered positive attitudes, with specific advantages in Melody and Structure within listening skills. However, a gap exists in the literature concerning the impact of AI tools on the academic performance of TVET students within South-South Nigerian universities, which this study aims to address.

METHOD

1. Research Design

To investigate the relationship between artificial intelligence (AI) technologies and the academic performance of TVET students in public universities within South-South Nigeria, a correlational survey research design was employed. This approach focuses on collecting data to determine the existence and strength of association between two or more quantifiable variables.

2. Population of Study

Based on data obtained from the Registrar's Office of 12 public universities in South-South Nigeria, the study population for the 2024/2025 academic year consisted of 3,986 undergraduate students enrolled in regular TVET programmes. These students, spanning levels 100 through 400, were affiliated with the Department of Vocational and Technical Education, with specific figures provided by the respective Heads of Department (HODs). A detailed stratification of this population is presented in Table 1.

Table 1 Population for the 2024/2025 academic year undergraduate students enrolled in regular TVET programmes.

No.	**Federal Universities in South-South, Nigeria**	**Number of Students**
1.	University of Benin, Benin City: Edo State	308
2.	University of Calabar: Cross River State	403
3.	University of Port-Harcourt, Choba: Rivers State	379
4.	University of Uyo: Akwa Ibom State	412
5.	Federal University, Otuoke: Bayelsa State	297
	Total	1819
No.	**State Universities in South-South, Nigeria**	**Number of Students**
6	Ambrose Alli University, Ekpoma : Edo State	315
7	Cross River State University of Technology: Cross River State	356
8	Delta State University, Abraka : Delta State	378
9	Edo University Iyamho : Edo State	47
10	Ignatius Ajuru University of Education : Rivers State	467
11	Niger Delta University: Bayels State	289
12	Rivers State University of Science and Technology: Rivers State	315
	Total	2167
	Grand total	3986

3. Sample and Sampling Technique

To obtain a representative sample for this study, a multi-stage sampling approach was employed. The target population comprised 600 undergraduate TVET students enrolled in public universities within the South-South region of Nigeria. Initially, both federal and state universities in the region were purposefully selected. Subsequently, from this pool, three federal and three state universities were chosen via simple random sampling. Finally, within each of the selected university campuses, 100 students were recruited using accidental sampling, resulting in a total sample size of 600 respondents.

4. Instrument For Data Collection

Data acquisition was achieved through a structured questionnaire, designated Relationship between Artificial Intelligence Tools and Academic Performance of TVET Students in Public Universities in South-South Nigeria Questionnaire (RAITAPTSPUSSNQ). This instrument, adapted from the work of Oyeyemi et al. (2024) to align with the research inquiries, is organized into three distinct sections. The first section, comprising eight items, investigates the perceived correlation between artificial intelligence (AI) tools and the learning aptitudes of TVET students within public universities in South-South Nigeria. The second section, encompassing seven items, explores the association between AI tools and the problem-solving proficiencies of the same student population. Finally, the third section, with six items, probes the link between AI tools and the critical thinking capabilities of TVET students. The questionnaire utilizes a four-point Likert scale for responses, offering options of Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD) across the 21 items.

5. Validation of the Instrument

To ensure the questionnaire's validity, it underwent expert review. Three lecturers, two from the Department of Vocational and Technical Education at Ambrose Alli University and one from the Department of Measurement and Evaluation at the University of Benin—both institutions located in Edo State, Nigeria—received copies. These copies were accompanied by documentation outlining the study's title, purpose, scope, and research questions. Their feedback was subsequently incorporated to refine the instrument prior to its finalization.

6. Reliability of the Instrument

A pilot study was undertaken to ascertain the instrument's reliability. Administered to a cohort of 20 TVET students at Nnamdi Azikiwe University (South-East Nigeria), the resulting data underwent Cronbach's Alpha analysis. The yielded reliability coefficient of 0.79 confirms the instrument's suitability for the intended research.

7. Method of Data Collection

To gather data for this study, questionnaires were administered to TVET students within the selected universities. Two trained research assistants, familiar with the researcher, aided in the distribution process. The Direct Delivery Method (DDM) was employed to facilitate immediate retrieval of the completed questionnaires.

8. Method of Data Collection

Data analysis for this study was performed using SPSS version 23. The statistical approach encompassed both descriptive and inferential statistics, with a focus on correlation analysis. Specifically, Pearson Product Moment Correlation Coefficient (PPMCC) was employed to address the three research questions and examine relationships within the dataset.

RESULTS AND DISCUSSION

Research Question (1): What is the relationship between artificial intelligence (AI) tools and the learning abilities of TVET students in public universities in South-South Nigeria?

Table 1 shows that there was a positive significant relationship of artificial intelligence (AI) tools and the learning abilities of TVET students in public universities in South-South Nigeria ($r = .504$, $N= 600$, $p <.05$).

Table 1 Result of PPMCC showing the significant relationship of artificial intelligence (AI) tools and the learning abilities of TVET students

Variable	Mean	Std. Dev.	N	R	P	Remark
Academic Performance	40.28	6.72	600	.504 **	.000	Sig.
The Learning Abilities	39.39	5.34				

Research Question (2): What is the relationship between artificial intelligence (AI) tools and the problem-solving skills of TVET students in public universities in South-South Nigeria?

Table 2 shows that there was a positive significant relationship of artificial intelligence (AI) tools on the problem-solving skills of TVET students in public universities in South-South Nigeria ($r = .471$**, $N= 600$, $p <.05$). The result shows that there was a positive significant relationship of artificial intelligence (AI) tools on the problem-solving skills of TVET students in public universities in South-South Nigeria.

Table 2 Result of PPMC showing the significant relationship of artificial intelligence (AI) tools on the problem-solving skills of TVET students in public universities in South-South Nigeria

Variable	Mean	Std. Dev.	N	R	P	Remark
Academic Performance	40.38	5.62	600	.471**	.000	Sig.
The Problem Solving Skills	39.27	5.43				

Research Question (3): What is the relationship between artificial intelligence (AI) tools and the critical thinking abilities of TVET students in public universities in South-South Nigeria?

Table 3 shows that there was a positive significant relationship of artificial intelligence (AI) tools on the critical thinking abilities of students in public universities in South-South Nigeria ($r = .651^{**}$, $N= 600$, $p<.05$). The result shows that there was a positive significant relationship of artificial intelligence (AI) tools on the critical thinking abilities of TVET students in public universities in South-South Nigeria.

Table 3 Result of PPMC showing the significant relationship of artificial intelligence (AI) tools on the critical thinking abilities of students in public universities

Variable	Mean	Std. Dev.	N	R	P	Remark
Academic Performance	40.27	5.62	600	.651**	.000	Sig.
The critical thinking abilities	38.73	5.34				

Field data analysis concerning the initial research question – the correlation between AI tools and the learning capabilities of TVET students in South-South Nigerian public universities – demonstrates a significant impact. Specifically, AI platforms like ChatGPT, Scikit Learn, TensorFlow, PyTorch, CNTK, Caffe, Apache MXNet, Keras, OpenNN, AutoML, H2O, OpenAI, Grammarly, and Quillbot facilitate personalized learning, catering to individual academic requirements. This personalization translates to improved comprehension, enhanced retention of lecture material, and immediate, actionable feedback, enabling students to rectify errors across diverse TVET subjects. Furthermore, these AI tools foster deeper conceptual understanding, facilitate access to supplementary educational resources, and offer objective, accurate information, thereby augmenting students' grasp of course content presented by instructors. In essence, AI tools are demonstrably contributing to a more effective and tailored learning experience for TVET students.

This observation corroborates the findings of Qasem et al. (2023), who highlight the potential of AI tutoring systems to deliver personalized instruction, support, and feedback adaptive to individual student learning styles and proficiency levels. Furthermore, it aligns with Tian and Shen (2023) detailed analysis of student competency and skill development within educational environments. Similarly, in agreement with Tamayo et al. (2025), the study acknowledges the facilitative role of AI in learning, providing a platform for student development and enhanced academic performance by exploring learning domains and their contribution to student outcomes. In addition, the study is in tandem with that of Khan et al. (2025) that examined artificial intelligence-based learning and its effect on academic performance revealed that AI has extensively been adopted and used in education, particularly by education institutions, in different forms. Using these platforms, instructors have been able to perform different administrative functions, such as reviewing and grading students' assignments more effectively and efficiently, and achieve higher quality in their teaching activities. On the other hand, because the systems leverage machine learning and adaptability, curriculum and content has been customized and personalized in line with students' needs, which has fostered uptake and retention, thereby improving learners experience and overall quality of learning.

Furthermore, AI has become an important technology affecting the development of education, and it is crucial to explore AI to enhance students' creativity and learning performance. The finding of the study is in harmony with that of Wang et al. (2023) that carried out a study on effects of higher education institutes artificial intelligence capability on students' self-efficacy, creativity and learning performance. Artificial intelligence capability is a three-order variable and formed by three formative second-order variables such as resources (data, technical, basic resources), skills (technical skills, teaching applications, collaboration competencies), and consciousness (reform, innovation consciousness); 2) HEIs' artificial intelligence capability significantly affects students' self-efficacy and creativity; 3) HEIs' artificial intelligence capability affects students' learning performance via two mediating variables: student creativity and self-

efficacy and concluded that using AI aid to drive teaching and learning, and improve students' creativity and learning performance.

Analysis of field data pertaining to the second research question—specifically, the correlation between AI tools and problem-solving skills in South-South Nigerian public university TVET students—demonstrates a positive relationship. Platforms like ChatGPT, Scikit Learn, TensorFlow, and others offer readily accessible learning resources that foster effective problem-solving strategies within TVET curricula. Furthermore, these AI tools furnish personalized instruction, facilitating the progressive refinement of students' problem-solving capabilities. The provision of a secure digital environment for practical application and AI-driven assistance with assignments further contributes to skill enhancement. This aligns with Fazil et al. (2024) observation of AI's role in improving student intervention and academic performance, as well as Wang et al. (2018) finding that AI promotes learning through risk-free experimentation. Furthermore, the finding of the study is in agreement with that of Owan et al. (2023) on exploring the potential of artificial intelligence tools in educational measurement and assessment, using AI in educational assessment has benefits including improving the accuracy and efficiency of assessments, generating personalized feedback for students, and enabling teachers to adapt their teaching strategies to meet the unique needs of each student. Therefore, AI has revolutionize the way education is delivered and assessed, ultimately leading to better educational outcomes for students and that the application of AI in education can ultimately transform education, improve learning outcomes, and equip students with the skills needed to succeed in the 21st century.

Empirical evidence gathered for the third research question indicates that AI-powered tools, including ChatGPT, Scikit Learn, TensorFlow, and others, offer students in TVET programmes expanded access to information crucial for their studies. Critically, data analysis suggests these tools do not stifle creative thinking, impede critical analysis of results, or discourage independent conceptual understanding within the TVET curriculum. This observation aligns with Tuomi's (2018) proposition that AI can personalize learning, accelerate cognitive growth, and foster a more stimulating educational experience. Also the finding of the study corroborate with that of Razia et al. (2023) that investigated the relationship between artificial intelligence (AI) and its aspects in higher education that numerous factors that lead to enhancing high education using Artificial Intelligence in higher education institutions have emerged. Students and faculty academics perceive things and use Al technology differently, many higher education institutions have adapted great Al technology applications thereby expanded access to information crucial for their studies. Critically, data analysis suggests these tools do not stifle creative thinking, impede critical analysis of results, or discourage independent conceptual understanding in education.

IMPLICATIONS OF FINDINGS AND FUTURE RESEARCH DIRECTIONS

This research pioneers a cost-effective AI-driven solution to bridge the educational gap for students in underserved learning environments. Focused on TVET programmes within Southern Nigerian public universities, the study develops comprehensive assessments based on 17 key indicators of learning aptitude, problem-solving proficiency, and critical thinking faculties.

The study demonstrates that integrating AI tools with conventional teacher-led instruction enhances student performance in TVET programmes. These findings emphasize the potential of AI to mitigate educational disparities in underserved communities. The research offers significant theoretical and practical implications for designing and implementing effective TVET curricula. Future research directions include: Personalized AI interventions: Developing AI tools tailored to individual student needs. Optimized integration: Investigating effective strategies for combining AI with traditional pedagogy to maximize learning outcomes. Longitudinal impact assessment: Evaluating the long-term effects of AI on students' cognitive abilities, problem-solving aptitude, and critical thinking skills. Cross-cultural studies: Conducting comparative research across diverse TVET programmes to determine the universal and context-specific

applications of AI. Mechanistic analysis: Examining the underlying mechanisms through which AI-driven instruction improves student performance to identify key contributing factors.

CONCLUSION

The study's results firmly establish a significant, positive correlation between the utilization of Artificial Intelligence (AI) tools and the enhanced learning aptitude, problem-solving capabilities, and critical thinking faculties of TVET students within public universities in South-South Nigeria.

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DATA AVAILABILITY STATEMENT

Data will be made available on request

CONFLICT OF INTEREST

The author has declared no conflicts of interest related to the publication of this paper.

DECLARATION OF GENERATIVE AI

During the preparation of this work, the author used digital literacy skills in order to draft the paper. After using this service, the author reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

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