INTERNATIONAL JOURNAL OF GENERAL STUDIES EDUCATION (IJOGSE)
VOLUME 7, ISSUE 1, 2026
ISSN: 1462-2032

Pattern of Functional Science, Technology, Engineering and Mathematics Education in the Age of Artificial Intelligence and Insecurity

[1]Dele-Adisa, Olufunso Caroline & [2]Atoye, Bosede Mercy

[1]Science Education Department, School of General Studies Education, [2]Curriculum and Instructions Department, School of Education, [1, 2]Federal College of Education (Special), Oyo

Abstract

Education globally is undergoing a period of transformation as many innovative ideas are emerging to improve teaching and learning processes. Science, Technology, Engineering and Mathematics (STEM) education is one of the educational innovations which aims at preparing individuals for the world of work. Artificial intelligence is the usage of machines or computers to perform the task that only human beings can perform. The research design for this study is non-experimental research design of descriptive survey type. Three research questions were raised for the study. The population comprises all secondary school students and teachers in Ibadan North local Government Area of Oyo State. Five schools were randomly sampled and simple random sampling was used to select 100 students and 50 teachers. Two instruments were adapted, one for teachers and the other for students. Face and content validity were established by experts in the relevant field, a reliability coefficient of 0.87 was obtained using Cronbach's Alpha. Data were analysed using descriptive statistics, specifically frequency counts, and percentages on a five-point Likert scale. This study found out that the usage of AI among teachers and students has been on the increase in STEM education and that insecurity is posing a lot of threat to teaching and learning in STEM education. The study recommends policy-driven frameworks that harmonise AI adoption with security-conscious educational planning to ensure inclusive, future-ready STEM outcomes.

Keywords: STEM education, artificial intelligence, insecurity, functional education

IJOGSE2026

Introduction

The global landscape of education is undergoing a profound transformation driven by the rapid proliferation of Artificial Intelligence (AI) technologies. Within the domain of Science, Technology, Engineering, and Mathematics (STEM) education, these changes present both extraordinary opportunities and significant challenges. Concurrently, escalating insecurity, ranging from armed conflicts and terrorism to cyber security threats and social unrest, continues to threaten the stability and functionality of educational systems, particularly in developing

countries (UNESCO, 2022). The intersection of these two powerful forces, AI and insecurity, creates a complex environment that demands urgent scholarly attention.

STEM education is globally recognised as a critical driver of innovation, economic growth, and national development (National Science Foundation [NSF], 2023). Functional STEM education refers not merely to the acquisition of content knowledge but to the application of scientific, technological, and mathematical reasoning in real-world problem-solving contexts (Tytler, 2020). However, the degree to which this functionality is being achieved in an era characterised by AI disruption and insecurity remains poorly understood, especially in African contexts.

AI tools such as intelligent tutoring systems, adaptive learning platforms, and automated assessment engines are progressively being integrated into STEM instruction (Roll & Wylie, 2016). These tools have shown promise in personalising learning, improving engagement, and expanding access to quality education (Baker & Smith, 2019). Yet, structural inequities in digital infrastructure, combined with pervasive insecurity in many regions, limit the equitable realisation of these benefits (Adeyemi & Uko, 2021).

Functional education, as conceptualised by Dewey (1916) and later expanded by Freire (1970), refers to education that equips learners with competencies relevant to their social, economic, and professional realities. Applied to STEM, functional education implies that learners should be able to translate disciplinary knowledge into practical application, designing experiments, interpreting data, coding algorithms, and engineering solutions to societal problems (Honey, Pearson, & Schweingruber, 2014). Contemporary discourse positions functional STEM education as foundational to the Fourth Industrial Revolution (4IR), which is characterised by the convergence of physical, digital, and biological systems (Schwab, 2016). In this context, STEM competencies are inseparable from digital literacy, computational thinking, and the ability to work with AI-enabled systems (Voogt & Roblin, 2012).

Artificial Intelligence refers to the simulation of human cognitive processes, such as learning, reasoning, and problem-solving by computer systems (Russell & Norvig, 2021). In education, AI manifests through technologies such as machine learning algorithms, natural language processing, computer vision, and adaptive learning platforms. These technologies are progressively being deployed to customise STEM learning experiences, predict student performance, automate feedback, and scaffold complex problem-solving (Luckin et al., 2016).

IJOGSE 2026

Holmes et al. (2019) argue that AI in education holds the potential to democratise access to quality STEM instruction by enabling real-time personalisation at scale. Intelligent tutoring systems (ITS), for instance, have demonstrated effectiveness in teaching algebra, physics, and programming by dynamically adjusting content difficulty based on learner performance (VanLehn, 2011). Similarly, AI-driven platforms like Khan Academy and Coursera employ learning analytics to identify knowledge gaps and recommend targeted interventions.

Despite these advantages, critics highlight concerns relating to algorithmic bias, data privacy, teacher displacement, and the digital divide (Selwyn, 2019). In under-resourced environments, the promise of AI remains largely theoretical due to inadequate infrastructure, unreliable internet connectivity, and lack of trained personnel (Adeyemi & Uko, 2021). Insecurity in education encompasses a broad spectrum of threats including armed conflict, terrorism, kidnapping, communal violence, and cyber security risks (Save the Children, 2023). These threats directly disrupt schooling by causing school closures, displacing learners and teachers, destroying infrastructure, and engendering psychological trauma that impairs learning (Inter-Agency Network for Education in Emergencies [INEE], 2021). For instance, the Boko Haram insurgency in the Northeast of Nigeria has caused hundreds of thousands of children to be displaced and thousands of schools to close, significantly impeding STEM education in the impacted areas (Orlu, 2022). Beyond physical violence, e-learning and AI-integrated STEM delivery are increasingly threatened by digital insecurity, which includes hacking, phishing, and cyberattacks on educational platforms (Kaspersky, 2023).

Globally, the United Nations Educational, Scientific and Cultural Organisation (UNESCO, 2022) reports that attacks on education increased by 17% between 2020 and 2022, disproportionately affecting STEM infrastructure such as laboratories, computing centres, and libraries. These disruptions undermine the functionality of STEM education and widen existing inequity gaps.

This study is anchored on the Technology Acceptance Model (TAM) proposed by Davis (1989) and the Ecological Systems Theory of Bronfenbrenner (1979). TAM posits that users' behavioural intention to adopt technology is determined by perceived usefulness and perceived ease of use. Applied to STEM education, it explains how educators and students decide to adopt AI tools based on their perceived instructional value and usability.

Bronfenbrenner's ecological model provides a complementary lens by situating STEM learners within nested environmental systems microsystem (classroom), mesosystem (school-community

IJOGSE 2026

interface), exosystem (policy environment), and macrosystem (broader societal conditions including insecurity). Together, these theories frame AI integration and insecurity as ecological factors that shape the pattern and functionality of STEM education. Empirical evidence on AI in STEM education has grown substantially over the past decade. Ma et al. (2014), in a meta-analysis of 107 studies, found that intelligent tutoring systems produced significantly higher learning outcomes than conventional instruction across mathematics and science subjects, with an effect size of 0.76. Similarly, Steenbergen-Hu and Cooper (2014) analysed 26 experimental studies on ITS for STEM and reported a weighted mean effect size of 0.09 relative to human tutoring and 0.35 relative to classroom instruction, suggesting moderate benefits.

In Nigeria, Adeyemi and Uko (2021) conducted a survey of 200 secondary school STEM teachers in Lagos and found that 68% had used at least one AI-based tool in instruction, though only 31% received formal training. Their findings corroborate the present study's concern about the gap between AI availability and pedagogical readiness. Similarly, Ogunyemi and Adedoyin (2022) reported that adaptive learning platforms significantly improved secondary school students' performance in mathematics in Ogun State, with a mean difference of 12.4 marks between treatment and control groups.

Internationally, Zawacki-Richter et al. (2019), in a systematic review of 146 AI-in-higher-education publications, identified personalisation, assessment, and predictive analytics as the three most common AI applications in STEM tertiary education. However, they noted a conspicuous scarcity of studies from sub-Saharan Africa, pointing to a research gap that this study begins to address. Several empirical studies have documented the devastating effects of insecurity on STEM education. Glad et al. (2021), analysing education data from 30 conflict-affected countries, found that STEM laboratory utilisation declined by an average of 43% in regions experiencing high insecurity, due to destruction, looting, and teacher flight. This finding aligns with the conceptual observation by INEE (2021) that STEM education is disproportionately disrupted in conflict zones given the high capital cost of rebuilding laboratory and technology infrastructure.

In Nigeria, Orlu (2022) surveyed 180 teachers in insecurity-prone zones in Borno and Adamawa States and found that 74% reported reduced student enrolment in STEM subjects due to security concerns, while 61% reported that STEM laboratory activities were frequently suspended. This study's empirical data closely mirrors these findings, with 81.3% of respondents agreeing that insecurity reduces STEM school attendance. Eze and Nweze (2023) examined the impact of

IJOGSE 2026

banditry and kidnapping on science education in North-West Nigeria and found that fear for personal safety was the most cited reason for students' abandonment of practical STEM activities (reported by 78.6% of respondents). Their qualitative data further revealed that parents increasingly withdrew wards from schools in insecure zones, citing STEM schools and universities as high-value kidnapping targets.

The empirical literature consistently reveals that policy frameworks in developing nations lag behind the pace of AI-driven transformation in STEM education. Olawale and Fashiku (2023), reviewing national curriculum documents from five West African nations, found that only Ghana had substantively integrated AI literacy into its secondary STEM curriculum as of 2022, while others retained curricula designed for pre-digital instructional environments. Adebowale and Ogunyemi (2022) assessed the AI readiness of 95 STEM teacher-educators in Nigerian universities and found a mean readiness score of 2.71 on a five-point scale, falling below the 3.0 threshold of adequacy. They attributed this deficit to insufficient professional development opportunities, poor digital infrastructure, and the absence of AI-specific pedagogical frameworks in teacher preparation programmes.

At the international level, UNESCO (2021) published its Recommendation on the Ethics of AI, calling on member states to embed AI literacy in national education curricula and invest in teacher training. Despite this, implementation remains uneven, with low-income countries, particularly those also dealing with insecurity facing the greatest challenges in curriculum adaptation (World Bank, 2023). The purpose of this study, therefore, is to investigate the pattern of functional STEM education in the context of AI integration and insecurity, using descriptive statistics derived from a sample of 150 respondents drawn from senior secondary schools, having 50 teachers and 100 students in Ibadan North local government area of Oyo State.

Methodology

The population comprises all senior secondary school students and STEM teachers in Ibadan North local Government Area of Oyo State. Five schools were randomly sampled and simple random sampling was used to select 100 students and 50 teachers. The instrument for data collection was a researcher-designed, five-point Likert-type questionnaire titled 'Functional STEM Education in the Age of AI and Insecurity Scale' (FSTEAIS), with response options ranging from Strongly Agree (5) to Strongly Disagree (1). Two instruments were adapted, one for teachers and the other for students. Face and content validity were established by experts in the relevant field, a reliability

IJOGSE 2026

coefficient of 0.87 was obtained using Cronbach's Alpha. Data were analysed using descriptive statistics, specifically frequency counts, and percentages on a five-point Likert scale. This study adopted a descriptive survey research design, which is appropriate for investigating the characteristics, opinions, and perceptions of a defined population without manipulating variables.

Results and Discussion

Table 1A: Demographic Profile of Students (N = 100)

Variable	Category	Freq. (f)	% (%)
Gender	Male	47	47
	Female	53	53
Age	Below 14 years	24	24
	14-16 years	56	56
	Above 16 years	20	20
Total		100	100.0

Table 1A shows that the majority of respondents were female (53%) with significant male representation (47%). The majority of the students were between the ages of 14 to 16 years having the percentage of 56%

Table 1B: Demographic Profile of Teachers (N = 50)

Table 1B shows that there are 50 teachers sampled. Female teachers are more than the male teachers having 74%. Teachers with the years of experience ranging from 11 to 15 years are many with 32% compared to others.

Variable	Category	Frequency	Percentage
Gender	Male	13	26%
	Female	37	74%
Teacher's Experience	0–5 years	8	16.0
	6–10 years	14	28.0
	11–15 years	16	32.0
	Above 15 years	12	24.0
Total		50	100

Table 2A: AI Integration in STEM Education Students' Response (N = 100)

Item (AI Integration in STEM Education)	Freq.	%
1. I use AI tools to solve problems in STEM education	69	69.0
2. AI personalises learning for individual students	75	75.0
3. AI improves data analysis skills in science	72	72.0
4. AI tools enhance mathematics problem-solving	83	83.0
5. Technology-based curricula improve STEM outcomes	85	85.0

Table 2A shows the responses of students to AI integration in STEM education. 69% of the students agree to the usage of AI tools to solve diverse problems in STEM. 75% of the students submits that AI is capable of providing personalized learning for students. 72% of the students agree that AI improves data analysis skills in science, 83% of the students confirmed that AI tools enhance mathematics problem-solving and 85% of the students agree that technology-based curricula improve STEM outcomes. All these are showing that students are positively disposed to AI integration and this is in consistent with the findings of Adeyemi and Uko (2021) who reported a 68% AI tool adoption rate among Lagos STEM teachers. The item on AI enhancing mathematics problem-solving (83%) corroborates the meta-analytic findings of Ma et al. (2014) on the effectiveness of Intelligent Tutoring System in mathematics.

IJOGSE 2026

Table 2B: AI Integration in STEM Education Teachers' Response (N = 50)

Item (AI Integration in STEM Education)	Freq.	%
1. I use AI tools to support STEM instruction	38	76.0
2. AI personalises learning for individual students	42	84.0
3. AI improves students' ability to do assignments on STEM	37	74.0
4. AI tools enhance mathematics problem-solving	43	86.0
5. Technology-based curricula improve STEM outcomes	32	64.0

Table 2B presents respondents' perceptions of AI integration in STEM education. All five items recorded percentages above average. The table also shows that 76% of teachers in senior secondary schools use AI tools to support STEM instruction. 84% of the teachers agree that AI personalizes learning for individual students while 74% agree that AI improves students' ability to do assignments on STEM. 86% of the teachers agree that AI tools enhance mathematics problem-solving and 64% agree that technology-based curricula improve STEM outcomes. The 76% recorded in the use of AI tools in STEM instruction is consistent with the findings of Adeyemi and Uko (2021) who reported a 68% AI tool adoption rate among Lagos STEM teachers. The item on AI enhancing mathematics problem-solving (86%) corroborates the meta-analytic findings of Ma et al. (2014) on the effectiveness of Intelligent Tutoring System (ITS) in mathematics.

Table 3: Impact of Insecurity on STEM Education (N = 150)

Item (Impact of Insecurity on STEM Education)	Freq.	%
1. Insecurity reduces STEM school attendance	122	81.3
2. Physical insecurity disrupts laboratory activities	115	76.7
3. Digital insecurity threatens STEM e-learning	109	72.7
4. Insecurity leads to loss of qualified STEM teachers	111	74.0
5. Insecurity limits access to STEM infrastructure	104	69.3

Table 3 reveals that all five insecurity-related items recorded percentages substantially above the average. The most strongly endorsed item was that insecurity reduces STEM school attendance (81.3%), corroborating the findings of Orlu (2022) who reported a 74% rate of reduced enrolment

IJOGSE 2026

in STEM subjects in conflict-affected zones. Disruption of laboratory activities (76.7%) and digital insecurity threatening e-learning (72.7%) further confirm that both physical and cyber security threats are impeding functional STEM delivery, consistent with Kaspersky (2023) and UNESCO (2022).

Table 4: Policy and Curriculum Readiness for AI-integrated STEM Education (N = 150)

Item (Policy & Curriculum Readiness for AI-STEM)	Freq.	%
1. Current STEM curriculum reflects AI-era demands	87	58.0
2. Teachers receive adequate AI pedagogical training	63	42.0
3. Policy frameworks address security in STEM delivery	54	36.0
4. Institutions fund AI-integrated STEM resources	49	32.7
5. Government prioritises STEM in insecure regions	44	29.3

Table 4 exposes a critical gap in institutional and policy readiness. Almost all the five items recorded percentages below average, falling below the acceptance threshold. The poorest-rated item which is government prioritisation of STEM in insecure regions (29.3%) reflects the marginalisation of STEM investment in areas most affected by insecurity. These findings align with Adebowale and Ogunyemi (2022), who found that AI readiness among Nigerian STEM teacher-educators fell below the adequacy threshold, and with Olawale and Fashiku (2023), whose curriculum review revealed the near-total absence of AI literacy in West African national STEM frameworks.

Discussion

The study submits that there is a complex picture of STEM education in the age of artificial intelligence. On the one hand, there is mounting evidence that STEM professionals are embracing AI; teachers are increasingly utilising data analytics tools, adaptive platforms, and AI-driven evaluation tools in their work. According to research by Holmes et al. (2019), Roll and Wylie (2016), and Zawacki-Richter et al. (2019), there is a global trend toward AI-enhanced instruction. The favourable reception of AI technologies indicates that teachers and students perceive genuine educational benefits when access is available.

However, the biggest disruptive factor in the effective delivery of STEM education was found to be insecurity. The results support the ecological model's claim that learning settings are undermined by macro-level factors that permeate educational microsystems, such as social

IJOGSE 2026

violence and cyberthreats. This is in line with the alarming figures published by the INEE (2021), UNESCO (2022), and Glad et al. (2021). STEM education is not only disrupted but also fundamentally weakened at the infrastructural, human resource, and psychological levels in areas with high levels of insecurity.

The below-threshold findings for policy and curricular preparation, which confirms that institutional answers to the dual problem of AI integration and insecurity remain insufficient. This is especially disturbing because the quality of the policy ecology that supports STEM education determines its capacity to propel national growth (NSF, 2023; World Bank, 2023). Functional STEM education will remain an ideal rather than a reality in the absence of cogent national plans that concurrently address AI literacy in curricula, teacher professional development, and school safety.

Conclusion

This study has shown that increasing AI adoption, substantial insecurity-driven disruption, and major policy gaps define the pattern of functional STEM education in the era of AI and insecurity. Despite the fact that higher percentage of respondents endorsed and are using AI, inadequate policy formulation and curriculum readiness together with the issue of insecurity are really hindering the achievement of STEM objectives.

Recommendations

Based on these findings, the following recommendations are put forth: The Ministry of Education should immediately incorporate AI literacy into secondary STEM curriculum, using international frameworks like the UNESCO Recommendation on AI Ethics (2021) as a guide. Focused professional development programmes should be created to help STEM instructors improve AI pedagogical competencies, with a focus on populations that are disproportionately impacted by insecurity. In order to guarantee continuity of instruction in unsafe areas, the government and stakeholders should create secure-school zones with protected STEM infrastructure, including cyber-secure digital learning environments. Lastly, funding for educational research should go toward long-term studies that monitor how AI integration affects STEM outcomes in various security scenarios.

IJOGSE2026

References

Adebowale, O. F., & Ogunyemi, B. (2022). Artificial intelligence readiness of STEM teacher-educators in Nigerian universities. *Journal of Science Education and Technology, 31*(4), 412–425. https://doi.org/10.1007/s10956-022-09974-3

Adeyemi, T. O., & Uko, E. S. (2021). Integration of AI-based tools in STEM instruction: Evidence from secondary schools in Lagos State. *African Journal of Educational Studies in Mathematicsand Sciences, 17*(2), 88–104.

Baker, R. S., & Smith, L. A. (2019). A research agenda for artificial intelligence in education. UNESCO Institute for Information Technologies in Education. https://iite.unesco.org

Bronfenbrenner, U. (1979). *The ecology of human development: Experiments by nature and design*. Harvard University Press.

Creswell, J. W., & Creswell, J. D. (2018*). Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). SAGE Publications.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*(3), 319–340. https://doi.org/10.2307/249008

Dewey, J. (1916). *Democracy and education: An introduction to the philosophy of education*. Macmillan.

Eze, C. K., & Nweze, A. U. (2023). Banditry, kidnapping, and science education disruption in North-West Nigeria. *International Journal of Educational Development, 96*, 102706. https://doi.org/10.1016/j.ijedudev.2023.102706

Freire, P. (1970). *Pedagogy of the oppressed*. Herder and Herder.

Glad, T., Nkosi, M., & Elias, R. (2021). STEM laboratory utilisation in conflict-affected countries: A cross-national analysis. *International Journal of Science Education, 43*(11), 1784–1801.

Holmes, W., Bialik, M., & Fadel, C. (2019). *Artificial intelligence in education: Promises and implications for teaching and learning.* Center for Curriculum Redesign.

Honey, M., Pearson, G., & Schweingruber, H. (Eds.). (2014). *STEM integration in K-12 education: Status, prospects, and an agenda for research.* National Academies Press. https://doi.org/10.17226/18612

Inter-Agency Network for Education in Emergencies [INEE]. (2021). *Education under attack 2021: A global study on state-perpetrated attacks against education.* INEE. https://inee.org

Kaspersky. (2023). *Cyberthreats to education in 2022–2023: Global report*. Kaspersky Security Bulletin. https://securelist.com

Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. B. (2016). *Intelligence unleashed: An argument for AI in education*. Pearson.

Ma, W., Adesope, O. O., Nesbit, J. C., & Liu, Q. (2014). Intelligent tutoring systems and learning outcomes: A meta-analysis. *Journal of Educational Psychology, 106*(4), 901–918. https://doi.org/10.1037/a0037123

National Science Foundation [NSF]. (2023). *STEM education for the future: Strategic plan 2023–2028.* NSF. https://www.nsf.gov

Nwana, O. C. (1982). *Introduction to educational research*. Heinemann.

IJOGSE 2026

Ogunyemi, A. A., & Adedoyin, O. (2022). Adaptive learning platforms and mathematics achievement of secondary school students in Ogun State, Nigeria. *Journal of Mathematics Education*, *15*(1), 44–59.

Olawale, S. K., & Fashiku, C. O. (2023). AI literacy in West African STEM curricula: A document analysis. *Curriculum and Teaching, 38*(1), 65–82. https://doi.org/10.7459/ct/38.1.05

Orlu, A. D. (2022). Armed insurgency and STEM teacher retention in North-East Nigeria. *Journal of Education in Developing Areas*, *30*(1), 57–72.

Roll, I., & Wylie, R. (2016). Evolution and revolution in artificial intelligence in education. *International Journal of Artificial Intelligence in Education*, *26*(2), 582–599. https://doi.org/10.1007/s40593-016-0110-3

Russell, S., & Norvig, P. (2021). *Artificial intelligence: A modern approach* (4th ed.). Pearson.

Save the Children. (2023). *Attacks on education: The impact of armed conflict on education 2010–2022.* Save the Children International. https://www.savethechildren.net

Schwab, K. (2016). *The Fourth Industrial Revolution*. World Economic Forum.

Selwyn, N. (2019). *What is digital sociology*? Polity Press.

Steenbergen-Hu, S., & Cooper, H. (2014). A meta-analysis of the effectiveness of intelligent tutoring systems on college students' academic learning. *Journal of Educational Psychology*, *106*(2), 331–347. https://doi.org/10.1037/a0034752

Tytler, R. (2020). STEM education for the twenty-first century. In B. Akpan & T. Kennedy (Eds.), Science education in theory and practice (pp. 79–96). Springer.

UNESCO. (2021). *Recommendation on the ethics of artificial intelligence.* UNESCO. https://unesdoc.unesco.org

UNESCO. (2022). *Education under attack: Global annual report 2022.* UNESCO. https://unesdoc.unesco.org

VanLehn, K. (2011). The relative effectiveness of human tutoring, intelligent tutoring systems, and other tutoring systems. *Educational Psychologist*, *46*(4), 197–221. https://doi.org/10.1080/00461520.2011.611369

Voogt, J., & Roblin, N. P. (2012). A comparative analysis of international frameworks for 21st century competences. *Journal of Curriculum Studies*, *44*(3), 299–321. https://doi.org/10.1080/00220272.2012.668938

World Bank. (2023). *Building skills for a digital world: STEM education and the future of work.* World Bank Group. https://worldbank.org

Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education — where are the educators? *International Journal of Educational Technology in Higher Education*, *16*(1), 39. https://doi.org/10.1186/s41239-019-0171-0

IJOGSE 2026