



*Sustaining STEM Education in Conflict-affected Region in ... Abimbola, A. F. (2026)*

## **Sustaining STEM education in Conflict-Affected Region in Nigeria: Adaptive Strategies for Teaching and Learning in Insecure Environments**

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### **Abstract**

*Nigeria confronts a profound paradox. The country faces an urgent national need to boost STEM education to drive innovation and global competitiveness while also facing a pervasive insecurity that has severely curtailed access to education for millions of children. Neglecting STEM education while the government battles insecurity creates a challenge of future skill deficit that can put the country in a worse crisis than it is currently facing. This has raised the question of whether STEM education can be sustained in the face of persistent insecurity without jeopardising quality. This study combines a synthesis of peer-reviewed literature, policy evaluations, and recent field interventions to an evidence-based, three-pillar Adaptive Resilience Framework (ARF) for STEM education in security-challenged environment. This framework is based on technology-enabled resilient pedagogy, community–industry integration, and teacher capacity building for crisis contexts. The paper argues that while insecurity remain a significant challenge to STEM education in Nigeria, recent innovations such as blended learning, mobile science laboratories, and strategic public–private partnerships demonstrate that sustainable, quality STEM education is both achievable and scalable. This paper contributes to the growing global literature on education in emergencies (EiE) by offering a contextualised, operationalisable framework transferable to analogous conflict-affected settings across Sub-Saharan Africa and beyond.*

**Keywords:** STEM education, conflict-affected Region, mobile science laboratories, blended learning, insecurity

### **Introduction**

STEM Education is an approach to teaching and learning that focuses to providing learners with practical education to make them contribute meaningfully to the technologically developing society. STEM stands for Science, Technology, Engineering and Mathematics. STEM education teaches learners about effective interdisciplinary communication. Science is the bedrock of STEM Education, Scientists makes inquiry on observations they make in the environment, then experiment on them to reach logical conclusions, offering the team discoveries. Science enable learners to under the world and to become critical thinkers. Technology experts apply knowledge from scientific discoveries to make tools and appliances, technology enables learners to become innovators and inventors. Engineers use knowledge acquired from science and technology to create, design systems and make use of scientific principles to solve practical problems, engineering provide learners with problem solving and creativity skills. Mathematics is the language of science, it provides tools for measurement, calculations, analysis and problem solving. Mathematicians analyze information to eliminate mistakes and provide precise calculations. Mathematics provide learners with ability to analyse data, eliminate errors and make reasonable decisions when designing projects. The approach of STEM education to teaching is to be able to produce learners who can transform the society through innovation and new technologies. Science, Technology, Engineering, and Mathematics (STEM) education occupies a foundational role in contemporary frameworks of national development, human capital formation, and economic competitiveness. Nigeria, as the largest economy in Sub-Saharan Africa's and the most populous nation, more than any other African country need to see STEM education as the most viable pathway for development. It is essential in harnessing power of



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its largely youthful population to drive technological innovation and securing meaningful participation in the Fourth Industrial Revolution. Even as the country is taking baby steps toward widening access to STEM education, the efforts are been significantly affected by factors such as insecurity in larger parts of the country. Ebun-Olu (2023) explained that security of lives and property has to be accorded priority attention by government of different countries irrespective of the type of administration. He asserted further that an atmosphere free from fear, anxiety, threat, harm and threat to lives and properties of citizens as well as economic development assures political stability. The insecurity problem has migrated into the educational institutions. All forms of educational institutions in Nigeria are under attacks from the bandits, civil crisis, Boko-haram, criminal elements, sit at home orders.

Nigeria's educational settings are confronted by acute and worsening security crisis. The largest victim group of insecurity in Nigeria have been vulnerable people such as women and children. Since the 2014 Chibok mass abduction, over 2,000 students have been abducted from educational institutions, more than 800 schools have been forcibly shut across northern regions, and at least 20 major attacks have occurred across 10 states (Chizoba & Nwakwesiri, 2023). The Safe Schools Initiative (SSI), launched with US\$30 million in international funding, has struggled to operationalise protection at scale, with over 42,000 primary and secondary institutions still lacking basic perimeter security (Ogunode et al., 2024). These conditions do not merely interrupt schooling, they structurally undermine the very possibility of equitable, quality STEM education for millions of Nigerian children. This paper situates Nigeria's experience within the broader global discourse on Education in Emergencies (EiE), contributing empirically grounded analysis and an actionable adaptive framework to a conversation of urgent relevance to conflict-affected contexts worldwide.

### **Statement of the Problem**

The impact of insecurity on education, particularly STEM education, is distinctively severe. Unlike many humanities disciplines, STEM learning depends on laboratory access, specialised equipment, sustained sequential instruction, and cumulative hands-on practice. Therefore, an atmosphere dominated by unexpected school closures, constant damage to infrastructure, population displacement, and regular traumatic experience for students and students and educators collectively undermine STEM learning outcomes both in the short and long term. This can be discouraging for educators and policy makers alike. However, this paper argues that these challenges, while formidable, are not insurmountable. Recent policy innovations and technology-enabled interventions have shown that adaptive, resilient approaches can help in establishing meaningful STEM education even in highly insecure environments. The challenge lies not in the absence of solutions, but in the absence of systemic commitment to scale and sustain them.

### **Methodology**

This conceptual paper employs an integrative literature review approach, synthesising findings from peer-reviewed journals, policy reports, government documents, and intervention evaluations. It incorporates empirical observations from ongoing educational programmes across Nigeria's northeast region. The review is guided by the Education in Emergencies (EiE) framework, with particular attention to STEM-specific challenges and innovations in conflict-affected low- and middle-income country (LMIC) contexts.

### **The Educational Security Crisis in Nigeria**

Magnitude of the Crisis



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The scope of Nigeria's educational security crisis is of such magnitude that it has attracted global attention. Nigerian schools are virtually sitting ducks in this highly insecure environment with many schools lacking basic infrastructure for protecting students and educators. Survey has shown that 42,000 primary and secondary schools across northern Nigeria lack perimeter fencing, with 4,270 secondary schools in 21 northern states and the Federal Capital Territory exposed to security threats. Bauchi State records the highest number of unsecured secondary schools (574), followed by Kano (500), Benue (447), Adamawa (379), and Jigawa (269) (Lawal, 2025; Adeleke, 2026). Similarly, Asubiojo (2025) reported that many schools in South-west Nigeria still rely on inadequate traditional security measures such as weak perimeter fencing and poorly trained guards, while ICT-based security systems remain largely absent. These are not peripheral statistics; they represent systemic institutional vulnerability of tens of millions of school-age children. This weak security has exposed students to regular abductions. School abductions have assumed a normalised, routine character that represents a profound humanitarian failure. According to the Nigerian Senate Ad-hoc Committee on the Safe Schools Initiative, over 1,680 schoolchildren have been kidnapped and 180 schools attacked since 2014. Recent incidents include the November 2025 abduction of 303 students and teachers from St. Mary's School in Niger State and the kidnapping of 25 schoolgirls from Government Girls Comprehensive Secondary School in Kebbi State, illustrating the continued and geographically expanding nature of the threat (Eze, 2025). Recently, there was another report that gunmen attack schools, kill teacher, kidnapped pupils in Ogbomoso, Oyo State, leading the government to close about 14 schools indefinitely (Ogunrinde, 2026). These recurrent assaults on the educational system have been linked to systemic failure with initiatives set up to correct the situation.

**Structural Failure of the Safe Schools Initiative**

Successive Nigerian governments have made effort to ensure that insecurity does not truncate the education of children in conflict-ridden areas. following the Chibok abduction The Safe Schools Initiative (SSI) was established with a fund of about US\$30 million sourced from local and international donors including Norway, the African Development Bank, Switzerland, the United States, Qatar, and the Nigerian private sector (Manjo, 2024; Ogunode et al., 2024). At the policy level, the federal government of Nigeria also introduced the National Policy on Safety, Security and Violence-Free Schools as well as the Minimum Standards for Safe Schools (Odo et al., 2025; Ibrahim & Ibrahim, 2025). Despite this substantial resource mobilisation, implementation has been undermined by bureaucratic fragmentation, institutional ambiguity, political discontinuity, and inadequate accountability mechanisms. According to Ogunode et al (2024), funding shortage, corruption, weak monitoring and evaluation, poor involvement of stakeholders, insecurity problems and lack of political will affected the implementation of the Safe School Initiative Programme. Similarly, Ibrahim & Ibrahim (2025) added that insecurity, inadequate funding, lack of adequate safety measures in schools, lack of awareness, and corruption and mismanagement of funds. The level of failure was so significant that, in December 2025, the Nigerian Senate launched a formal investigation into the "collapse" of the SSI, summoning the Ministers of Finance, Education, and Defence to account for the programme's failure to protect school communities. The Senate Committee Chair declared the continued targeting of schools by terrorist and criminal actors "unacceptable" (Ripples Nigeria, 2025). This inquiry was driven by empirical studies that have outlined the failure of the safe school initiative and other programmes designed to protect children (Gever, 2016; Opara et al. 2025). This institutional accountability moment underscores a central argument of this paper: technology-enabled adaptive strategies cannot substitute for, but must complement, functional governance and political commitment to educational security.



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### STEM-Specific Vulnerabilities

While all educational sectors are adversely affected by insecurity, STEM instruction faces compound and distinctive vulnerabilities. Empirical evidence demonstrates that insecurity disproportionately affects STEM education because of its dependence on specialised infrastructure, sequential curriculum delivery, laboratory experimentation, and highly skilled teachers. Studies conducted in conflict-affected regions of Nigeria show that school closures disrupt practical science instruction, infrastructure destruction limits access to laboratories and equipment, displacement interrupts continuity of learning, and teacher attrition weakens instructional quality (Han & Hur, 2022; Nnaemedo & Ugwu, 2025). Additionally, psychological trauma and irregular attendance negatively affect students' cognitive engagement and mastery of foundational STEM concepts necessary for progressive learning (Jacob, 2020; Kanu et al., 2025). Table 1 synthesises these disruption mechanisms and their specific impacts:

Table 1: Synthesis of Disruption Mechanisms and their Specific Impacts on STEM Education

Disruption Mechanism	STEM-Specific Impact	Affected Dimension	Source
School closures	Disrupted laboratory sequences, broken experimental continuity	Practical skills acquisition	United Nations Children's Fund. (2025).
Infrastructure damage	Destroyed science labs, theft of equipment, unsafe facilities	Resource availability	Han & Hur, (2022; Nnaemedo & Ugwu, 2025).
Displacement	Loss of access to specialised STEM resources and mentors	Continuity of learning	(Jacob, 2020; Kanu et al., 2025).
Teacher attrition	Over 50% of STEM workforce lost in northeast Nigeria	Instructional quality	Ukozor et al (2024).
Student psychological trauma	Reduced cognitive engagement with complex STEM concepts	Learning outcomes	Nwaubani (2024).
Irregular attendance	Missed foundational knowledge required for sequential STEM learning	Curriculum coherence	(Jacob, 2020; Kanu et al., 2025).

### Adaptive Strategies for Resilient STEM Education

Despite acute systemic challenges, recent interventions across northern Nigeria demonstrate that STEM education can be sustained through adaptive, technology-enabled, and community-embedded approaches (UNICEF, 2025; Ojo, 2025). The evidence reviewed below informs the three-pillar Adaptive Resilience Framework (ARF) proposed in Section 4.

#### Technology-Enabled Resilient Pedagogy

##### Mobile Laboratories and Virtual Reality

The idea of modular teaching and learning centers is not new to Nigeria. Indeed, the federal government's Accelerated Senior Secondary Education Programme (ASSEP) represents a substantive policy innovation. In January 2025, the government deployed 30 mobile laboratories and virtual



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reality (VR) headsets across northeastern Nigeria. Among the beneficiaries are security-challenged states such as Adamawa, Bauchi, Borno, Gombe, Taraba, and Yobe states (The Nation, 2025). These deployable science units circumvent the problem of damaged or inaccessible laboratory infrastructure by bringing experimental equipment directly to communities. VR headsets extend this innovation further, enabling immersive learning experiences that approximate physical laboratory work. Students can conduct virtual dissections, chemical titrations, and engineering simulations without physical apparatus. Research on VR-based science education demonstrates that immersive simulations improve conceptual understanding, knowledge retention, engagement, and practical skill acquisition compared with conventional instructional approaches (Krause et al., 2023; AlGerafi et al., 2023). Studies from northeastern Nigerian educational institutions further indicate that VR-supported pedagogy can enhance STEM learning outcomes despite infrastructure constraints and insecurity-related disruptions (Ezra, 2025).

### **Blended Learning as Educational Infrastructure**

The disruptions caused by insecurity or unsafe learning environment can be mitigated through blended learning. Abubakar and Lawal (2024) characterise blended learning which combines digital tools with face-to-face instruction, as a “lifeline” for teacher education and student learning during crises. Their research, grounded in Nigeria’s northeast, identifies several critical advantages in conflict-affected settings: (i) Instructional continuity when schools are closed or unsafe; (ii) Reduced student mobility requirements, enabling learning from safer locations (iii) Self-paced modular design that accommodates irregular attendance patterns (iv) Digital record-keeping that tracks student progress despite physical disruption

The LabXchange Teacher Ambassador Program provides empirical support for this approach. In 2024, the programme trained 54 Nigerian educators across all six geopolitical zones in designing pedagogically aligned STEM lessons using a platform offering over 29,000 freely accessible digital resources. Preliminary evaluation indicates measurable improvements in teacher digital confidence and lesson quality (Sawka, 2024).

### **Digital Literacy and AI-Integrated Instruction**

Effective technology integration requires deliberate, sustained investment in teacher capacity. In April 2026, the Office of the Vice President and the North-East Development Commission (NEDC) trained 100 teachers in Adamawa State on digital literacy, including artificial intelligence integration and inclusive teaching methods. Comparable programmes have been delivered in Borno, Yobe, Gombe, and Bauchi states, creating a nascent foundation for a digitally capable STEM teaching workforce.

The NEDC’s Managing Director contextualised this intervention explicitly within the insurgency narrative, noting that the region’s 16-year experience of Boko Haram and related violence had produced an educational deficit requiring urgent, targeted remediation. This framing—positioning digital teacher training as a post-conflict reconstruction tool, has important implications for international development financing and programme design.

### **Community–Industry Integration**

#### **Community-Based STEM Learning Infrastructure**

Onwubuya (2025) makes a compelling case for partnerships with private sector organisations and non-governmental organisations to establish community-based STEM labs in underserved and insecure regions. Beyond expanding access to equipment, these distributed facilities serve a critical risk management function: dispersing learning infrastructure across multiple sites reduces single-



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point vulnerability to attack or closure while simultaneously embedding educational assets within protective community networks.

### **Public-Private Partnerships for Practical Relevance**

The ASSEP x Social Innovation and Entrepreneurship Bootcamp (SIEB) Initiative exemplifies a promising public-private partnership model. This 21-day immersive programme targets vulnerable youth aged 15–20 across northeast Nigeria, combining STEMA (Science, Technology, Engineering, Mathematics, and Arts) education with entrepreneurial skills development and psycho-social support. By integrating economic relevance with educational content and attending explicitly to student wellbeing, the programme addresses the holistic needs of conflict-affected learners that conventional academic programmes frequently neglect.

### **Contextualised, Problem-Oriented STEM Learning**

A consistent finding across the reviewed literature is the motivational value of connecting STEM learning to students' lived experiences and community challenges. In conflict-affected regions characterised by disrupted infrastructure, water insecurity, healthcare deficits, and communication gaps, STEM education oriented towards solving local problems acquires both pedagogical and psychological value. When students see their learning as directly relevant to their survival and community wellbeing, engagement and retention improve markedly, a finding with direct implications for curriculum design in insecure environments.

### **Teacher Capacity Building for Crisis Contexts**

#### **Addressing the Structural Teacher Shortage**

The northeast region has lost over 50% of its teaching workforce due to insurgency, displacement, and school closures. Rebuilding this workforce requires strategies that go beyond conventional recruitment and retention, addressing the specific deterrents and risks that characterise teaching in insecure environments. The ASSEP teacher training component explicitly targets STEMA educators in senior secondary schools, combining digital and technical skills development with AI integration, inclusive pedagogy, and technology-enhanced instruction.

#### **Trauma-Informed Pedagogy and Educator Wellbeing**

Teaching in conflict zones imposes significant and well-documented psychological burdens on educators. The ASSEP x SIEB Initiative's explicit incorporation of psycho-social support alongside professional skills training represents an important evolution in crisis education programming. The evidence base on trauma-informed pedagogy in EiE contexts consistently demonstrates that teacher wellbeing is a significant predictor of educational quality and student learning outcomes. Neglecting this dimension in programme design is not merely an ethical oversight, it is an evidence-based error.

#### **Professional Learning Communities Across Regions**

The LabXchange Teacher Ambassador model, creating cohorts of trained educators who form mutual support networks across geopolitical zones, illustrates the strategic value of professional learning communities in conflict-affected contexts. These networks distribute knowledge and capacity across multiple nodes, provide structured peer support for educators facing isolation and danger, and create resilient communities of practice that persist through institutional disruption. The model has direct transferability to other fragile state education systems.

#### **The Adaptive Resilience Framework (ARF): A Proposed Model**

Synthesising the evidence reviewed above, this paper proposes the Adaptive Resilience Framework (ARF), a three-pillar operational model for sustaining quality STEM education in insecure and conflict-affected contexts. The ARF is designed to be modular, context-adaptable, and transferable beyond Nigeria to analogous settings across Sub-Saharan Africa and globally.



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**Pillar 1: Infrastructure Resilience**

Component	Implementation Strategy	Evidence Base
Mobile laboratories	Deployable science units reaching multiple communities on rotation	ASSEP deployment, Northeast Nigeria (2025)
Virtual reality equipment	Immersive simulation tools for laboratory experiences without physical apparatus	ASSEP VR deployment (2025)
Offline digital resources	Pre-loaded tablets and local servers for low-connectivity environments	LabXchange programme
Secure school infrastructure	Perimeter fencing, access control, biometric entry, emergency communication	SSI mandate (unimplemented at scale)
Distributed learning sites	Multiple small community facilities rather than single large, high-risk schools	Onwubuya (2025)

**Pillar 2: Pedagogical Adaptability**

Component	Implementation Strategy	Evidence Base
Blended learning	Online-offline hybrid models maintaining instructional continuity during disruption	Mukhtar & Amina (2025)
Modular, self-paced curricula	STEM content units designed for non-linear, interrupted delivery	EiE curriculum design literature
Community-based problem projects	Learning embedded in authentic local problem-solving contexts	Onwubuya (2025)
Virtual laboratories	Simulation-based experimental learning when physical labs are inaccessible	ASSEP VR programme
Emergency continuity plans	Pre-prepared school-level protocols for closures and displacement scenarios	Best practice EiE frameworks

**Pillar 3: Systemic Human Capital Support**

Component	Implementation Strategy	Evidence Base
Teacher digital literacy	Nationwide pre-service and in-service training in technology-enhanced teaching	NEDC-OVP training (2026)
Teacher psycho-social support	Structured mental health and peer support resources for educators in conflict zones	ASSEP x SIEB (2025)



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Component	Implementation Strategy	Evidence Base
Industry and civil society partnerships	Internships, mentorship, and real-world STEM applications through private sector	ASSEP x SIEB model
Community protection networks	Local community oversight and early warning systems for school security	Community-based EiE models
Coordinated security response	Clear inter-agency protocols linking schools, security forces, and emergency services	Policy gap identified in SSI review

### Policy Recommendations

#### Federal and State Governments

1. Protect educational financing: Fully implement and transparently audit the National Financing Plan for school security (projected at ₦32.58 billion, rising to ₦38.03 billion by 2026), with ring-fenced allocations that cannot be diverted during security emergencies.
2. Nationalise mobile laboratory deployment: Scale the 30 mobile laboratory units deployed in the northeast to a national programme, with priority allocation to high-risk states in the northwest and north-central regions.
3. Establish a unified school safety command: Resolve the current fragmentation of school security responsibilities between the NSCDC, Nigeria Police Force, and military by establishing a dedicated School Safety Command with clear authority and accountability.
4. Establish protected education zones: Model protected education corridors on humanitarian safe zone frameworks, guaranteeing safe access to schooling for communities in active conflict zones.
5. Mandate blended learning as policy: Institutionalise blended learning as permanent educational infrastructure, not a crisis measure, embedded in the national curriculum delivery framework.

#### Educational Institutions

1. Each school in conflict-affected states should develop, test, and regularly review a school-level emergency learning continuity plan with clear protocols for instruction during security incidents.
2. Schools should establish formal community-school security committees with local community leaders, parents, and relevant authorities, creating structured early warning and response mechanisms.
3. STEM departments should maintain offline, pre-loaded digital resource libraries to ensure learning continuity during internet disruptions.

#### Teacher Training Institutions

1. Integrate digital literacy and technology-enhanced pedagogy as core competencies in all pre-service teacher education programmes, ensuring every graduate is equipped for blended delivery.
2. Introduce crisis pedagogy as a discrete subject within teacher education curricula, covering trauma-informed teaching, flexible curriculum delivery, and psychological first aid for educators.
3. Establish inter-institutional professional learning community networks modelled on the LabXchange Ambassador approach, providing structured peer support and resource sharing across insecure regions.



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## Conclusion

Nigeria's STEM education crisis is both profound and urgent, but it is not without remedy. The evidence synthesised in this paper demonstrates convincingly that adaptive, technology-enabled, and community-embedded approaches can sustain quality STEM learning even in highly insecure environments. The deployment of mobile laboratories across the northeast, the training of teachers in digital literacy and AI-integrated pedagogy, and the emergence of blended learning as a structural educational lifeline all constitute proof of concept for the Adaptive Resilience Framework proposed here. However, these innovations currently operate at pilot scale. Thirty mobile units serve a fraction of the 42,000 unfenced schools. One hundred teachers trained in Adamawa represent a modest beginning against a workforce that has lost more than half its members to insurgency. Bridging this gap between proof of concept and systemic impact requires something beyond innovative programming: it requires sustained political will, protected funding, coordinated multi-sectoral action, and a fundamental reconceptualisation of educational resilience as a national security priority.

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