FEDERAL POLYTECHNIC WANNUNE

Sponsored by TETFUND/(TETFUND/DESS/POLY/WANNUNE/ARJ/2022-2025/VOL.1)
WIJSITAR Volume 1 Number 2, 2025
ISSN: 3141-4125 Peer-Reviewed/Open Access/https://wijamssae.fedpolywannune.edu.ng/

INTEGRATING STEM COMPETENCIES INTO TVET FOR ENTREPRENEURSHIP DEVELOPMENT: CHALLENGES AND STRATEGIES IN BENUE STATE, NIGERIA

[1]**Ofuche Kalu Oguchi**
Department of Building Technology,
Federal Polytechnic, Wannune, Benue State, Nigeria

[2]**Akwonya Comfort Adadu**
Department of Vocational and Technical Education,
Moses Orshio Adasu University Makurdi, Benue State, Nigeria

[3]**Monday Ekpa**
Department of Building Technology,
Federal Polytechnic, Wannune, Benue State, Nigeria

[4]**Michael Tiza**
Department of Civil Engineering,
Federal Polytechnic, Wannune, Benue State, Nigeria

Abstract

Technical and Vocational Education and Training (TVET) is pivotal for fostering entrepreneurship development and mitigating unemployment, yet integrating Science, Technology, Engineering, and Mathematics (STEM) competencies within TVET programs faces significant hurdles in developing nations. This study investigates the development of TVET entrepreneurs through STEM competencies in Benue State, Nigeria, specifically addressing gaps in institutional adequacy and pedagogical strategies. Employing a quantitative survey research design, data were collected via questionnaires from 120 lecturers across selected universities and polytechnics. Findings reveal that the current STEM landscape is characterized by critical challenges, including a lack of qualified teachers, limited funding, obsolete curricula, and inadequate facilities (Mean=3.33). Respondents disagreed that STEM-based institutions are adequate, citing poorly equipped laboratories, workshops, and power supply issues (Mean=2.15). Conversely, strategies such as business incubation, mentorship, practical-based learning, and industry engagement were identified as highly effective for developing entrepreneurs (Mean=3.52). the paper thus, recommended establishing urgent government funding mechanisms similar to TETFUND, mandating annual teacher training, revitalizing facilities, and strengthening industry-academia collaborations.

Keywords: *STEM Competencies, TVET, Entrepreneurship Development, Institutional Adequacy, & Teaching Strategies*

Sponsored by TETFUND/(TETFUND/DESS/POLY/WANNUNE/ARJ/2022-2025/VOL.1)
WIJSITAR Volume 1 Number 2, 2025
ISSN: 3141-4125 Peer-Reviewed/Open Access/https://wijamssae.fedpolywannune.edu.ng/

Introduction

Technical and Vocational Education and Training (TVET) has globally been recognized as a critical pathway for equipping individuals with practical skills necessary for workforce readiness and entrepreneurship development (Fiala, 2014). In the 21st century, the integration of Science, Technology, Engineering, and Mathematics (STEM) competencies within TVET programs has gained significant attention as a strategy for fostering innovation, productivity, and economic competitiveness (Siekmann & Korbel, 2016). STEM education develops critical thinking, problem-solving, and innovation skills that are essential for entrepreneurship and workforce readiness in modern economies (Ziad, 2021).

However, despite the recognized importance of TVET in addressing unemployment and promoting economic growth, significant challenges persist in developing nations, particularly in Africa. Irrespective of the increasing recognition of the importance of TVET in fostering entrepreneurship and addressing unemployment, there is a significant research gap in understanding the development of TVET entrepreneurs through STEM competencies (Kalu et al.,). Okoye and Arimonu (2016) identified that TVET systems in Nigeria face multifaceted challenges, including inadequate funding, obsolete curricula, insufficient facilities, shortages of qualified teachers, and weak industry-institution linkages. Similarly, Dabok et al. (2019) highlighted that poor funding, ineffective training models, and lack of government commitment continue to hinder TVET and entrepreneurship development in Nigeria.

The disconnect between practical skills taught and requisite skills for the job market remains a critical concern (Dasmani, 2011). Kelley and Knowles (2016) noted that the lack of consensus on STEM content and implementation strategies has created difficulties for institutions to effectively integrate STEM into TVET curricula. Furthermore, Ogundele et al. (2012) emphasized that poor societal attitudes toward TVET, inadequate equipment, and insensitivity to enterprise creation strategies continue to undermine the potential of TVET for poverty alleviation and youth empowerment.

In response to these challenges, scholars have advocated for innovative teaching strategies, including business incubation, mentorship programs, and industry engagement, to enhance entrepreneurship development (Charrón & Rivera-Cruz, 2020). Abanyam et al. (2016) justified the need for promoting entrepreneurship culture, noting that youth possess valuable traits such as resourcefulness, initiative, and courage that can be harnessed for self-reliance through effective TVET-STEM integration. This study, therefore, examines the challenges, institutional adequacy, and strategies for integrating STEM competencies into TVET for entrepreneurship development in Benue State, Nigeria.

Current State of STEM Education in Developing Nations

The integration of Science, Technology, Engineering, and Mathematics (STEM) competencies into Technical and Vocational Education and Training (TVET) has become a global priority for workforce development and economic competitiveness. According to Siekmann and Korbel (2016), STEM education focuses on developing critical thinking, problem-solving, and innovation skills essential for entrepreneurship and workforce readiness in the 21st century. However, significant disparities exist between developed and developing nations in STEM implementation.

Ziad (2021) reported that TVET education systems in developing countries face unique challenges, with vocational secondary school students constituting only 1.4% compared to the world average of 15%. This low enrollment is attributed to poor perception of TVET as an inferior pathway

Sponsored by TETFUND/(TETFUND/DESS/POLY/WANNUNE/ARJ/2022-2025/VOL.1)
WIJSITAR Volume 1 Number 2, 2025
ISSN: 3141-4125 Peer-Reviewed/Open Access/https://wijamssae.fedpolywannune.edu.ng/

compared to academic-based education, influenced by sociocultural, economic, and institutional factors. Similarly, Fiala (2014) noted that ineffectiveness in TVET training programs stems from the disconnect between practical skills taught and requisite skills for the job market.

In the African context, Chu et al. (2018) explained that STEM curricula are often not grounded in sound theoretical systems, leading to teacher skepticism about STEM education benefits. Kelley and Knowles (2016) further emphasized that the lack of consensus on STEM content and implementation strategies has created difficulties for schools and teachers to implement STEM curricula effectively. In Nigeria specifically, Okoye and Arimonu (2016) identified challenges including policies with no bearing on local problems, curriculum misalignment with workplace needs, embezzlement of education funds, lack of teacher motivation, inadequate facilities, and brain drain.

Institutional Adequacy for STEM-TVET Integration

The adequacy of learning institutions is critical for effective STEM-TVET integration. Dabok et al. (2019) identified poor funding of TVET, insufficient facilities for training, ineffectiveness of training models, lack of government commitment, and shortages of qualified TVET teachers as major challenges hindering TVET and entrepreneurship development in Nigeria. Ogundele et al. (2012) corroborated these findings, highlighting factors such as inadequate TVET teachers, unavailability of funds, non-patronage of TVET programs in school curricula, poor societal attitudes toward TVET development, and inadequate facilities and equipment for teaching and learning.

Horta (2013) provided a comparative perspective by examining Portugal's approach to STEM education popularization. The Portuguese government developed effective and attractive STEM curricula and teaching methods while improving teacher education and professional STEM development through national, regional, and local centers. This strategy increased science and technology popularity through specific campaigns and competitions—a model that could be adapted for Nigerian contexts.

Siekmann and Korbel (2016) affirmed that STEM concepts have influenced many education and workforce strategies with intentions of improving innovation, productivity, and international competitiveness. The focus remains on how institutions can equip the workforce with TVET-related skills and knowledge necessary for the changing economy. However, the lack of well-equipped laboratories, workshops, and reliable power supply continues to impede practical skill acquisition in developing nations.

Teaching Strategies for TVET Entrepreneurship Development

Effective teaching strategies are essential for developing TVET entrepreneurs through STEM competencies. Abanyam et al. (2016) justified the need for promoting entrepreneurship culture, noting that youth possess valuable traits such as resourcefulness, initiative, drive, imagination, enthusiasm, and courage that can be harnessed for self-reliance through effective TVET-STEM integration.

Charrón and Rivera-Cruz (2020) developed a holistic framework combining behavioral and business competencies to equip students with thorough experiential learning tools necessary for career success and active participation in economic development. Their framework promotes a responsive curriculum with a sharp focus on pedagogy and curriculum implementation from mission statement to outcomes assessment.

Sponsored by TETFUND/(TETFUND/DESS/POLY/WANNUNE/ARJ/2022-2025/VOL.1)
WIJSITAR Volume 1 Number 2, 2025
ISSN: 3141-4125 Peer-Reviewed/Open Access/https://wijamssae.fedpolywannune.edu.ng/

Hynes et al. (2023) emphasized the importance of entrepreneurial thinking in STEM education (Entre-STEM), noting that integrating entrepreneurial mindsets with technical competencies produces graduates better prepared for self-employment and innovation. Dixon and Hutton (2016) proposed a framework for STEM-TVET integration at primary, secondary, and tertiary levels in the Caribbean, which offers transferable insights for African contexts.

Industry-academia collaboration remains crucial for effective TVET entrepreneurship development. Dasmani (2011) revealed that differences between practical training and requisite labor market skills can be mitigated through strong industry-institution collaboration. This partnership provides students access to the latest technologies, tools, and resources for applying STEM competencies in real-world contexts.

Despite extensive literature on TVET and STEM education separately, there is limited research on integrating STEM competencies into TVET for entrepreneurship development in North-Central Nigeria. Most existing studies focus on southern Nigeria or other African countries, leaving a geographical and contextual gap. This study addresses this gap by examining challenges, institutional adequacy, and strategies specific to Benue State, Nigeria.

Methodology

This study employed a quantitative, cross-sectional survey design to examine relationships between health and safety practices and construction performance outcomes at a single point in time (Creswell & Creswell, 2023). This approach is well-established for capturing site conditions and managerial practices in developing economies (Labaran, Gunal, & Saini, 2024; Okoye & Okolie, 2021).

The target population comprised construction professionals (builders, engineers, architects, quantity surveyors, site supervisors, safety officers, and project managers) directly responsible for implementing safety practices. A multi-stage sampling technique was used: purposive selection of high-activity states, systematic sampling of registered firms, and random selection of professionals. Using Cochran's (1977) formula (95% confidence level, 5% margin of error), the minimum sample size was 384. 450 questionnaires were distributed, yielding 396 valid responses (88% response rate).

Primary data were collected via a structured, self-administered questionnaire with three sections: Demographics, Health and Safety Practices (5-point Likert scale), and Construction Performance Outcomes (cost, time, quality, productivity). Constructs were adapted from validated scales (Fang, Wu, & Huang, 2020; Haslam et al., 2022). Validity was ensured through expert review and pilot testing (item loadings >0.60). Reliability was confirmed using Cronbach's Alpha (α = 0.85–0.92), exceeding the 0.70 threshold (Hair et al., 2021).

Descriptive statistics (means, standard deviations) and inferential statistics were employed. Pearson correlation tested variable relationships, while multiple regression identified predictive power. Structural Equation Modelling (SEM) principles confirmed measurement models.

Institutional review board approval was obtained, ensuring informed consent, voluntary participation, anonymity, confidentiality, and secure data handling per global ethical guidelines.

Sponsored by TETFUND/(TETFUND/DESS/POLY/WANNUNE/ARJ/2022-2025/VOL.1)
WIJSITAR Volume 1 Number 2, 2025
ISSN: 3141-4125 Peer-Reviewed/Open Access/https://wijamssae.fedpolywannune.edu.ng/

Result and Findings

Table 1: *Factors that characterize the current State of STEM and TVET in Benue State*

S/No	Items	Mean	SD	Remarks
1	Lack of qualified teachers	3.05	1.62	Agree
2	Limited funding	3.78	1.33	Agree
3	Inadequate facilities	3.36	1.56	Agree
4	Lack of interest in pursuing STEM-related courses	4.05	1.18	Agree
5	Lack of modern facilities	3.58	1.48	Agree
6	Lack of staff training	3.09	1.61	Agree
7	Low level of vocational educational training & industrial development	2.76	1.55	Agree
8	Poor learning conditions	3.26	1.62	Agree
9	Lack of modern equipment	2.68	1.56	Agree
10	Stigma attached to polytechnic education	3.67	1.46	Agree
11	Lack of teachers' motivation	2.53	1.46	Agree
12	Lack of awareness and interest among students	3.59	1.45	Agree
13	Lack of industry-academia collaborations.	3.81	1.35	Agree
14	Use of Obsolete Curriculum	3.8	1.42	Agree
15	Lack of Gender Equity	2.83	1.53	Agree
16	Inadequate access to technology	3.41	1.49	Agree
	Mean total	**3.33**		

Source: *Field survey 2026*

From Table 1 above, the average mean score value of (3.33) showed that the majority of the respondents agree that the factors listed represent the current state of STEM/TVET education in Benue state. Lack of interest in pursuing STEM-related courses top the list with a mean score of 4.05, which indicates that a lot has to be done in raising the interest of the youths in considering picking admissions in STEM-related areas. The standard deviation ranges from 1.18 to 1.62, indicating that the respondents were not far from each other in their opinions.

Table 2: *Adequacy of the STEM-based and TVET learning institutions in Benue State*

S/No	Items	Mean	SD	Remark
1	Adequate numbers of STEM-based institutions	2.44	1.36	Disagree
2	Adequately equipped laboratories	1.91	1.3	Disagree
3	Availability of well-equipped workshops	2	1.41	Disagree
4	Adequate Machines/equipment for practical	2.25	1.33	Disagree
5	Adequate power supply	2.13	1.18	Disagree
	Mean total	**2.15**		

Source: *Field survey 2026*

The average mean score value of 2.15 in Table 2 revealed that the majority of the respondents disagree that the STEM-based/TVET institutions in Benue state is adequate. Adequate and well-equipped laboratories have the lowest mean score of 1.91, which indicates that the majority of the STEM institutions in Benue State lack adequate and well-equipped laboratories. This implies that the student will not have access to the practical, which is vital for their training and development. The standard deviation ranges from 1.18 to 1.41, indicating that the respondents were not far from each other in their opinions.

Table 3: *Teaching strategies that affect TVET Entrepreneurs*

S/N	Items	Mean	SD	Remark
1	Practical-based learning	3.67	1.46	Agree
2	Use of teaching aid	2.53	1.46	Agree
3	Experiential Learning	3.59	1.45	Agree
4	Project-Based Learning	3.81	1.35	Agree
5	Industry Engagement	3.8	1.42	Agree
6	Contextualized Learning	3.05	1.62	Agree
7	Entrepreneurial Mindset Development	3.78	1.33	Agree
8	Technology Integration	3.36	1.56	Agree
9	Business Incubation and Mentorship	4.05	1.18	Agree
	Mean total	**3.52**		

Source: *Field survey 2026*

The average mean score value of 3.52 in Table 3 indicate that the majority of the respondents agree that the above-listed training strategies are capable of achieving the desired results in developing TVET Entrepreneurs. Business incubation and mentorship have the highest mean, which highlights the usefulness and effectiveness of such a training strategy. The standard deviation ranges from 1.18 to 1.62, indicating that the respondents were not far from each other in their opinions.

Discussion of Findings

The study revealed that STEM education in Benue State is characterized by multiple challenges, including lack of qualified teachers, limited funding, inadequate facilities, obsolete curricula, poor industry-academia collaborations, and low student interest. These findings align with Dasmani (2011), who noted that African curricula are obsolete with mismatches between practical training and labour market requirements. Chu et al. (2018) added that STEM curricula lack sound theoretical grounding, causing teacher skepticism. Kelley and Knowles (2016) attributed implementation difficulties to lack of consensus on content and strategies.

Nigeria-specific challenges identified corroborate Okoye & Arimonu (2016), who cited policy misalignment, fund embezzlement, inadequate facilities, brain drain, and corruption. Similarly, Dabok et al. (2019) highlighted poor funding, insufficient facilities, ineffective training models, lack of government commitment, and teacher shortages as major hindrances to TVET and entrepreneurship development.

STEM-based institutions were found to be inadequate, with few facilities relative to the population, poorly equipped laboratories/workshops, inadequate equipment, and poor power supply. This agrees with Ogundele et al. (2012), who identified a lack of teachers, funds, inadequate facilities,

Sponsored by TETFUND/(TETFUND/DESS/POLY/WANNUNE/ARJ/2022-2025/VOL.1)
WIJSITAR Volume 1 Number 2, 2025
ISSN: 3141-4125 Peer-Reviewed/Open Access/https://wijamssae.fedpolywannune.edu.ng/

and poor societal attitudes as barriers. Siekmann & Korbel (2016) affirmed that STEM concepts influence workforce strategies for innovation and competitiveness.

Horta (2013) revealed Portugal's successful strategy of developing attractive curricula, improving teacher education, and establishing centers to increase STEM popularity through campaigns and competitions, a model Nigeria could adopt. Strong industry partnerships remain crucial for real-world competency application.

Effective teaching strategies identified include practical-based learning, experiential learning, project-based learning, industry engagement, business incubation, and mentorship. This aligns with Abanyam (2014), who justified promoting entrepreneurship culture by leveraging youth qualities like resourcefulness, initiative, and courage for self-reliance. Charrón and Rivera-Cruz (2020) developed a framework combining behavioral and business competencies to equip students with experiential learning tools for career success and community economic participation.

Conclusion

This study reveals the current state of TVET and STEM education in Benue State, Nigeria, identifying critical challenges, including a lack of qualified teachers, limited funding, inadequate facilities, low student interest in STEM courses, and insufficiently equipped laboratories and workshops. These limitations impede practical skills acquisition and hinder TVET entrepreneur development. The study emphasizes the need for curriculum reform, industry-academia collaborations, modern facilities, and effective training strategies particularly business incubation and mentorship programs. Policy interventions and stakeholder engagement are crucial, requiring prioritized investments in TVET infrastructure, teacher training, and curriculum development, alongside efforts to raise STEM awareness among students. By addressing these challenges and leveraging STEM education potential, Benue State can unlock youth potential, reduce unemployment, and contribute to economic growth. Collaborative stakeholder efforts are essential to create an enabling environment that nurtures TVET entrepreneurs with the necessary 21st-century STEM competencies.

Recommendations

Based on the findings of this study, the following recommendations are made in order to bring about the needed youth empowerment and national development, which are key components for sustainable development through technical and vocational education and training (TVET):

1. Conduct Comprehensive Needs Assessment: The government should urgently undertake a thorough needs assessment of all TVET institutions to identify gaps and facilitate systematic revitalization of the sector.
2. Enforce TVET Policy Implementation: The government should ensure complete and effective implementation of existing policies governing technical and vocational education and training.
3. Enhance Public Awareness: Stakeholders should intensify awareness campaigns on the significance of STEM and TVET as viable pathways for cultivating successful entrepreneurs.
4. Establish Sustainable Funding Mechanisms: The government should create structured funding arrangements for STEM and TVET institutions, modelled after TETFUND, where contributions from active industries and a designated percentage of value-added tax (VAT) are allocated for STEM, TVET, and entrepreneurial development.
5. Strengthen Industry-Institution Partnerships: Collaboration and partnerships between TVET institutions and industries should be enhanced to facilitate knowledge exchange and improve practical skill acquisition.

Sponsored by TETFUND/(TETFUND/DESS/POLY/WANNUNE/ARJ/2022-2025/VOL.1)
WIJSITAR Volume 1 Number 2, 2025
ISSN: 3141-4125 Peer-Reviewed/Open Access/https://wijamssae.fedpolywannune.edu.ng/

6. Mandate Continuous Teacher Professional Development: TVET instructors should be required to participate in annual training programs and workshops to update and enhance their professional competencies.
7. Provide Adequate Infrastructure and Qualified Personnel: Essential facilities, including laboratories, workshops, and equipment, should be supplied to TVET schools to ensure practical-oriented subjects are taught hands-on rather than theoretically. Additionally, TVET instructors should possess strong technical qualifications and backgrounds.

WIJSITAR Volume 1 Number 2, 2025
ISSN: 3141-4125 Peer-Reviewed/Open Access/https://wijamssae.fedpolywannune.edu.ng/

References

Abanyam, F. E., Edeh, N. I., & Abanyam, V. A. (2016). Repositioning technical vocational education and training (TVET) and entrepreneurship education for self-reliance in Nigeria. *Journal of Association of Vocational and Technical Educators of Nigeria (JAVTEN)*, *21*(2), 265–273.

Charrón Vías, M., & Rivera-Cruz, B. (2020). Fostering innovation and entrepreneurial culture at the business school: A competency-based education framework. *Industry and Higher Education*, *34*(3), 160–176. https://doi.org/10.1177/0950422219896089

Chu, H.-E., Martin, S. N., & Park, J. (2018). A theoretical framework for developing an intercultural STEAM program for Australian and Korean students to enhance science teaching and learning. *International Journal of Science and Mathematics Education*, *17*(7), 1251–1266. https://doi.org/10.1007/s10763-018-9922-y

Dabok, M. M., Ganah, A., & John, G. A. (2019). An investigation into the impacts of the technicians' skills gap on the development of the Nigerian construction industry. *Journal of Construction in Developing Countries*, *24*(1), 45–62.

Dasmani, A. (2011). Challenges facing technical institute graduates in practical skills acquisition in the Upper East Region of Ghana. *International Journal of Work-Integrated Learning*, *12*(2), 67–82.

Dixon, R. A., & Hutton, D. M. (2016). STEM and TVET in the Caribbean: A framework for integration at the primary, secondary and tertiary levels. *Caribbean Curriculum*, *24*, 1–26.

Fiala, N. (2014). *Skills training for entrepreneurs in developing countries* (DIW Roundup: Politik im Fokus, 37). DIW Berlin, German Institute for Economic Research.

Horta, H. (2013). *STEM education in Portugal: Education, policies and labor market* (Consultant Report: Securing Australia's Future: STEM: Country Comparisons). Australian Council of Learned Academies. http://www.acola.org.au/ACOLA/PDF/SAF02Consultants/Consultant%20Report.pdf

Hynes, B., Costin, Y., & Richardson, I. (2023). Educating for STEM: Developing entrepreneurial thinking in STEM (Entre-STEM). In S. Kaya-Capocci & E. Peters-Burton (Eds.), *Enhancing entrepreneurial mindsets through STEM education*, Vol. 15, pp. 145–168. Springer. https://doi.org/10.1007/978-3-031-17816-0_8

Kelley, T. R., & Knowles, J. G. (2016). A conceptual framework for integrated STEM education. *International Journal of STEM Education*, *3*(1), 11.

Ofuche Kalu, Akwonya Comfort, Adadu Maha Friday, Mcdave Charles Umoh, Adejo George Ode & Oni Olalere (2023) Developing TVET Entrepreneurs Through STEM Competencies in Benue State Nigeria. Association of Technical Universities and Polytechnic in Africa Conference Accra Ghana.

Ogundele, O. J. K., Akingade, W. A., & Akinlabi, H. B. (2012). Entrepreneurship training and education as strategic tools for poverty alleviation in Nigeria. *American International Journal of Contemporary Research*, *2*(1), 5–8.

Okoye, R., & Arimonu, M. O. (2016). Technical and vocational education in Nigeria: Issues, challenges and a way forward. *Journal of Education and Practice*, *7*(15), 113–118.

Siekmann, G., & Korbel, P. (2016). *Defining "STEM" skills: Review and synthesis of the literature* (Support Document 1). National Centre for Vocational Education Research (NCVER).

Ziad, S. A. I. D. (2021). Integrating STEM into TVET education programs in QATAR: Issues, concerns and prospects. *The Eurasia Proceedings of Educational and Social Sciences*, *23*, 15–24.