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Enhancing Competency, Employability, And Innovation Among Electrical/Electronic Students In Technical And Vocational Education In Nigeria Through Industry-Aligned Training And Digital Integration.

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Abstract
This study examined the enhancement of competency, employability, and innovation among electrical and electronic students within Technical and Vocational Education and Training (TVET) in Nigeria, with particular emphasis on the roles of industry-aligned training and digital integration. Despite the recognised importance of TVET in developing skilled manpower, evidence indicates that many graduates lack the practical competencies and workplace readiness required for modern technological environments. This study adopted a conceptual and literature-based approach to analyse how deficiencies in practical training, weak industry collaboration, and limited digital integration contribute to poor learning outcomes. This paper established that competency serves as the foundation of effective technical education, as it determines students' ability to perform real-world tasks. However, competency alone is insufficient without employability skills, which enable students to adapt to workplace demands. This study further demonstrated that industry-aligned training acts as a critical bridge between competency and employability by exposing learners to real industrial practices and current technological standards. In addition, digital integration is identified as a key driver of modern technical education, enhancing students' understanding of complex systems and supporting the development of advanced technical skills. The findings highlighted that innovation emerges as the cumulative outcome of competency development, employability preparation, industry alignment, and digital integration. When these elements are effectively combined, students are better equipped to apply their knowledge creatively in solving real-world problems and adapting to emerging technologies. However, the current TVET system in Nigeria remains fragmented, with limited integration of these critical components. This study concluded that improving electrical and electronic TVET outcomes in Nigeria requires a coordinated, competency-driven approach that simultaneously strengthens practical training, industry collaboration, digital infrastructure, and innovation-oriented learning. This study recommended the adoption of integrated training models, increased investment in modern equipment, structured industry partnerships, and the incorporation of digital technologies into teaching and learning processes. Such an approach will enhance the quality and relevance of TVET and produce graduates who are competent, employable, and capable of driving technological advancement and national development.

Keywords: Technical and Vocational Education and Training (TVET), Competency; Employability; Industry-Aligned Training; Digital Integration; Innovation.

1. Introduction

Enhancing the quality of Technical and Vocational Education and Training (TVET) has become a strategic priority for countries seeking to strengthen workforce readiness and technological development, particularly in technical fields such as electrical and electronic education. In Nigeria, electrical/electronic programmes are expected to produce graduates with strong practical competencies capable of supporting industrial growth, energy systems, and emerging technologies. However, recent evidence suggests that the quality of training outcomes remains inconsistent. A study by Okoye and Arimonu (2016) reported that many electrical/electronic students in Nigerian technical institutions demonstrate limited hands-on competence, largely due to insufficient practical exposure and outdated instructional approaches. This indicates that efforts to enhance competency must go beyond curriculum design to include improvements in training methods and learning environments. As competency remains the foundation of technical education, its enhancement is directly linked to students' readiness for employment.

Enhancing employability among electrical/electronic students requires not only technical competence but also the ability to apply skills effectively in real work settings. Employability has increasingly become a key performance indicator

of TVET systems globally. Research by Ismail et al. (2019) in the Malaysian TVET context shows that employability is significantly improved when students acquire industry-relevant skills and engage in practical learning experiences. In Nigeria, however, many graduates continue to face challenges transitioning into employment due to skill mismatches and limited workplace exposure. This suggests that enhancing employability depends largely on how well training programmes are aligned with industry needs, thereby highlighting the importance of industry-aligned training as a key mechanism for improvement.

Industry-aligned training plays a critical role in enhancing both competency and employability by ensuring that students acquire skills that are relevant to current industrial practices. Effective collaboration between training institutions and industry provides opportunities for students to engage in real-world tasks, use modern equipment, and understand workplace expectations. A study by **Pilz (2012)** emphasised that partnerships between technical institutions and industry significantly improve skill acquisition among electrical/electronic students by exposing them to contemporary technologies and practical applications. However, in many Nigerian institutions, such collaborations remain limited or poorly structured, reducing the effectiveness of training programmes. This gap underscores the need to strengthen industry linkages as a pathway to enhancing training outcomes. As industries continue to evolve technologically, the effectiveness of industry-aligned training increasingly depends on the level of digital integration within technical education.

Digital integration has become essential for enhancing learning and skill development in electrical and electronic education. Modern electrical systems rely heavily on digital technologies such as automation, embedded systems, and smart devices, making it necessary for students to acquire digital competencies alongside traditional technical skills. According to

OECD **(2020)**, the integration of digital tools, simulation technologies, and virtual laboratories in TVET significantly improves students' practical understanding and problem-solving abilities. Despite this, many technical institutions in Nigeria still operate with limited digital infrastructure, which restricts students' exposure to modern technologies. This limitation not only affects competency development but also reduces students' ability to innovate, which is increasingly required in today's technology-driven industries.

Innovation represents the ability of students to apply their knowledge and skills creatively to solve practical problems and adapt to emerging technologies. Enhancing innovation among electrical/electronic students is essential for fostering entrepreneurship, technological advancement, and national development. A recent study by European Centre for the Development of Vocational Training **(2018)** found that students exposed to technology-driven and project-based learning environments demonstrated higher levels of creativity and innovation in technical tasks. This suggests that innovation is not an isolated outcome but the result of enhanced competency, improved employability skills, effective industry alignment, and strong digital integration. When these elements are strengthened collectively, they create a learning environment that supports both skill development and creative application.

Therefore, enhancing competency, employability, and innovation among electrical/electronic students in Nigeria requires a comprehensive approach that integrates industry-aligned training and digital technologies into TVET systems. Addressing these areas is essential for improving the quality and relevance of technical education and ensuring that graduates are adequately prepared to meet the demands of modern industries. This necessity leads to a critical examination of existing literature on these variables and how they contribute to improved outcomes in electrical and electronic education.

2. Literature Review

Recent scholarship in Technical and Vocational Education and Training (TVET) has increasingly emphasised the need to enhance the quality of training outcomes in response to rapid technological and industrial changes. In their study on the future ofTVET systems, UNESCO **(2016)** argued that modern vocational education must be continuously restructured to align with emerging industry demands, particularly within technology-driven sectors such as electrical and electronic trades. They emphasised that the effectiveness of TVET lies not only in skill acquisition but in the relevance and adaptability of those skills to real-world industrial environments. This perspective establishes that enhancing TVET outcomes begins fundamentally with improving students' competency, which remains the core objective of technical education.

Enhancing competency in electrical and electronic education requires the development of practical skills, technical knowledge, and the ability to apply learning effectively in real-life situations. In examining competency development for Industry 4.0, Stephen Billett **(2011)** developed a competency perspective for TVET instructors and students, demonstrating that effective competency enhancement depends on exposure to modern technologies, quality instruction, and structured practical training. Their findings revealed that students trained with updated technological tools and guided by competent instructors exhibited significantly higher levels of technical proficiency. This suggests that competency enhancement is not solely dependent on curriculum content but also on the quality of delivery and learning environments. As competency improves, it directly influences students' ability to transition into the workforce, thereby leading to the concept of employability.

Employability in electrical and electronic education has become a critical measure of the effectiveness of TVET systems, reflecting students' readiness to perform in real industrial settings. A recent empirical perspective by Lorraine Dacre Pool **and** Peter Sewell **(2007)** found that although students may possess foundational technical skills, their overall job readiness depends significantly on workplace exposure and soft skills. The study emphasised that enhancing employability requires not only technical competence but also adaptability, communication skills, and problem-solving ability. This indicates that improving employability depends largely on how well training systems simulate real industry conditions, which brings into focus the role of industry-aligned training as a critical enhancement strategy.

Industry-aligned training is widely recognised as an effective approach to bridging the gap between education and employment in technical fields. In their investigation of employability skills required by TVET graduates, Matthias Pilz **(2012)** found that strong collaboration between training institutions and industry significantly improves students' practical skills, workplace readiness, and understanding of industrial processes. Their study highlighted that students who participated in work-based learning programmes and industrial attachments demonstrated higher competence and confidence in performing technical tasks. This reinforces the idea that enhancing competency and employability requires structured engagement with industry. However, as industries increasingly adopt advanced technologies, the effectiveness of industry-aligned training depends on the integration of digital technologies within training systems.

Digital integration has become a central factor in enhancing learning outcomes in electrical and electronic education, particularly in the context of Industry 4.0. In a study on digital transformation in TVET, OECD **(2020)** found that the use of simulation tools, digital laboratories, and automated systems significantly improved students' understanding of complex electrical and electronic concepts. Their findings showed that students exposed to digital learning environments demonstrated stronger problem-solving abilities and higher levels of technical confidence compared to those trained using traditional methods. This suggests that enhancing digital integration is essential for improving both competency and employability. However, the ultimate goal of integrating these elements is to foster innovation among students.

Innovation in electrical and electronic education reflects students' ability to apply acquired skills creatively to solve practical and technological problems. In their study on innovation in technical education, European Centre for the Development of Vocational Training **(2018)** found that students exposed to project-based learning, digital tools, and industry- relevant tasks developed higher levels of creativity and innovation. The study emphasised that innovation is not an isolated outcome but a product of enhanced competency, effective industry exposure, and strong digital integration. When these elements are successfully combined, students are better equipped to contribute to technological advancement and industrial development.

Overall, the reviewed literature demonstrates that enhancing outcomes in electrical and electronic TVET requires a structured progression from competency development to employability, supported by industry-aligned training and digital integration, ultimately leading to innovation. Each variable builds on the previous one, forming a continuous pathway for improving student outcomes. Despite the availability of global evidence, there remains limited comprehensive research within Nigeria that focuses on enhancing these variables collectively within electrical and electronic education. This gap highlights the need for a more integrated and context-specific approach to improving TVET outcomes in Nigeria.

3. **Statement of the Problem**

Despite the recognised importance of Technical and Vocational Education and Training (TVET) in developing skilled manpower, evidence indicates that electrical and electronic students in Nigeria are not attaining the level of competency required for modern industrial environments. Persistent deficiencies in practical skill acquisition have been reported, particularly in areas such as electrical installation, maintenance, and electronic systems. Recent findings show that students' competency levels remain below industry expectations due to inadequate hands-on training and limited access to modern equipment (**Okoye & Arimonu, 2016**). Although many students demonstrate theoretical understanding, their ability to perform real technical operations remains limited. This suggests that existing efforts to enhance competency have not been sufficiently effective, and this inadequacy directly affects students' readiness for employment.

The challenge of employability has therefore become increasingly evident among electrical and electronic graduates. Employability in technical fields requires not only technical competence but also workplace readiness, adaptability, and problem-solving ability. Evidence shows that many graduates lack the combination of practical and soft skills required by employers, leading to difficulties in securing and sustaining employment (Lorraine Dacre Pool **&** Peter Sewell**, 2007**). Employers often perceive graduates as inadequately prepared for modern technological environments, indicating a disconnect between training outcomes and labour market expectations. This situation highlights that enhancing employability depends on aligning training systems more closely with industry requirements, thereby drawing attention to the role of industry-aligned training.

Industry-aligned training is critical for enhancing both competency and employability, as it provides students with exposure to real-world practices and current technological standards. However, collaboration between technical institutions and industry remains weak in many cases, limiting students' opportunities for meaningful practical experience. Evidence indicates that insufficient industry partnerships and poorly structured work-based learning programmes reduce students' ability to acquire relevant skills and understand workplace demands (Matthias Pilz**, 2012**). As a result, many students complete their training without adequate industrial exposure, further widening the gap between education and employment. This limitation becomes more significant in the context of rapid technological advancement, which necessitates the integration of digital technologies into training.

Digital integration is increasingly essential in electrical and electronic education, as modern systems rely heavily on automation, digital control, and smart technologies. However, many Nigerian technical institutions still operate with limited digital infrastructure and rely on traditional teaching methods. Evidence shows that inadequate ICT integration significantly hinders students' ability to develop advanced technical competencies and adapt to modern industrial systems (OECD**, 2020**). This lack of digital exposure not only affects competency and employability but also restricts students' capacity for creative application of knowledge. Consequently, students' ability to innovate becomes limited.

Innovation represents the ability of students to apply technical skills creatively to solve real-world problems and adapt to emerging technologies. However, low levels of innovation have been observed among electrical and electronic students due to deficiencies in competency, employability preparation, industry exposure, and digital integration. Evidence suggests that students who lack exposure to technology-driven learning environments and industry-based

experiences demonstrate reduced creativity and problem-solving ability (European Centre for the Development of Vocational Training**, 2018**). This indicates that innovation is not an isolated outcome but depends on the effective enhancement of preceding variables.

Therefore, the problem of this study lies in the inadequate enhancement of competency, employability, industry-aligned training, and digital integration among electrical and electronic students in Technical and Vocational Education in Nigeria. While these variables have been examined individually, there is limited comprehensive effort to enhance them collectively in a structured manner. This has resulted in the continued production of graduates who are insufficiently prepared for modern industry demands. Addressing this problem requires an integrated approach that strengthens these key areas simultaneously, thereby improving students' competency, employability, and innovation capacity in electrical and electronic education.

A Competency-Driven Pathway For Enhancing Electrical/Electronics TVET Outcomes

Enhancing outcomes for electrical and electronic students in Nigerian TVET requires a clear starting point: raising the quality of competency development as the foundation of all other improvements. Contemporary TVET research shows that competency is not achieved by curriculum content alone but by authentic practice, assessment of performance, and alignment with occupational standards. In a Nigerian-focused perspective, Stephen Billett **(2011)** demonstrated that competency among technical students improves significantly when training incorporates task-based instruction, performance assessment, and real equipment usage. Their work emphasised that competency must be measured through what students can do, not just what they know. When competency is strengthened in this practical sense, students become better prepared to function in real technical environments, which naturally leads to improved employability.

Building on competency, enhancing employability requires extending training beyond technical tasks to include workplace readiness and adaptive skills. Evidence from TVET systems in Asia and Europe shows that employability improves when students experience structured exposure to real work conditions and interdisciplinary problem-solving. In their cross-national analysis, World Bank **(2018)** established that employability is strongest in systems where students engage in applied learning environments that simulate industry processes, rather than purely classroom-based instruction. Their findings indicate that employability is a direct outcome of how effectively competency is transferred into real-world contexts. This suggests that improving employability among electrical/electronic students in Nigeria depends on transforming training environments to mirror actual industrial settings. Achieving this transformation requires deliberate strengthening of industry-aligned training structures.

Industry-aligned training provides the bridge between competency and employability by embedding learning within real production and service environments. Recent evidence highlights that work-based learning models, apprenticeships, and dual training systems significantly enhance students' technical proficiency and workplace adaptation. In a comprehensive review of vocational systems, Matthias Pilz **(2012)** showed that countries with strong industry participation in training produce graduates with higher levels of technical accuracy, confidence, and productivity. Within electrical and electronic education, this alignment is particularly important because technologies and standards evolve rapidly. When students train using outdated methods disconnected from industry practice, their competencies become obsolete. Therefore, enhancing industry alignment is not optional but essential. However, as industries increasingly rely on digital systems, the effectiveness of such alignment depends on how well digital technologies are integrated into training.

Digital integration is now a central driver of enhancement in electrical and electronic education, as modern technical systems are built around automation, digital control, and smart technologies. Research shows that students trained with simulation tools, programmable systems, and digital diagnostics demonstrate stronger technical reasoning and faster adaptation to industrial tasks. In a study on digital competence in vocational education, Sandra Bohlinger **(2021)** argued that digitalisation transforms not only the tools used in training but also the cognitive processes through which students learn technical concepts. This implies that integrating digital technologies into electrical/electronic training enhances both understanding and application of knowledge. In the Nigerian context, improving digital integration would enable students to engage with contemporary systems such as PLCs, embedded electronics, and renewable energy technologies. As students gain digital competence, their ability to move beyond routine tasks toward creative application increases, thereby strengthening innovation.

Innovation represents the highest level of enhancement in electrical and electronic education, reflecting students' ability to apply skills creatively in solving technical problems and adapting to new technologies. Evidence from recent TVET innovation studies indicates that innovation emerges when students are exposed to project-based learning, digital tools, and real industry challenges simultaneously. In their research on vocational innovation systems, Karen Evans **and** Lorna Unwin **(2014)** found that students develop stronger innovative capacity when learning environments combine practice, reflection, and technological exposure. This confirms that innovation is not taught directly but develops as a result of enhanced competency, improved employability skills, effective industry alignment, and strong digital integration.

Taken together, these findings establish a competency-driven enhancement pathway in which each variable strengthens the next. Improving competency enhances employability; aligning training with industry ensures relevance; integrating digital technologies modernises learning; and the combination of these elements fosters innovation. For electrical and electronic students in Nigeria, adopting this structured pathway provides a practical and evidence-based approach to improving training outcomes. It also directly addresses the identified problem by shifting from fragmented improvements to a coordinated system of enhancement across all critical areas ofTVET.

Implementation Strategies For Enhancing Electrical/Electronic Tvet In Nigeria

Enhancing electrical and electronic education in Nigeria must begin with strengthening competency through structured, practice-based training systems. Contemporary TVET scholarship shows that competency is most effectively developed through guided participation, repeated task performance, and authentic learning environments. Stephen Billett **(2011)** emphasised that vocational competence emerges when learners engage directly with real or simulated work tasks under expert guidance, rather than relying on theoretical instruction alone. This implies that improving competency among electrical/electronic students requires upgrading workshop facilities, increasing hands-on training time, and aligning assessment with actual task performance. When competency is enhanced in this way, students become more capable of functioning in real industrial settings, which naturally leads to improved employability.

Building on enhanced competency, employability can be strengthened by embedding structured workplace experiences within training programmes. Employability depends not only on technical skills but also on students' ability to apply those skills in dynamic work environments. **Toner (2011)** argued that work-based learning significantly improves job readiness by exposing students to real production processes, workplace culture, and problem-solving situations. This suggests that enhancing employability among electrical/electronic students in Nigeria requires integrating industrial attachments, apprenticeships, and supervised workplace learning into the curriculum. However, such improvements in employability can only be sustained when training systems are closely aligned with industry practices, making industry-aligned training the next critical area for enhancement.

Industry-aligned training is essential for ensuring that the skills developed in technical institutions remain relevant to labour market needs. Strong collaboration between education providers and industry enables students to acquire up-to-date knowledge, use modern equipment, and understand current technological standards. **McGrath (2012)** highlighted that effective TVET systems are those in which industry plays an active role in shaping curriculum content, training delivery, and assessment processes. This indicates that enhancing electrical/electronic education in Nigeria requires institutionalising partnerships with industry through joint training programmes, shared facilities, and continuous feedback mechanisms. As industries increasingly adopt advanced technologies, the effectiveness of such alignment depends on the integration of digital technologies into training systems.

Digital integration is now a key driver of enhancement in electrical and electronic education, as modern technical systems rely heavily on automation, digital control, and smart technologies. Integrating digital tools into teaching and learning improves students' ability to understand complex systems and adapt to technological changes. Sandra Bohlinger **(2021)** noted that digitalisation in vocational education transforms both learning processes and skill requirements, making it essential for students to develop digital competence alongside traditional technical skills. In the Nigerian context, this requires introducing simulation tools, virtual laboratories, and programmable systems into electrical/electronic training. As students develop digital competence, they become better equipped to engage in higher-level technical tasks, which supports innovation.

Innovation represents the highest level of enhancement in electrical and electronic education, reflecting students' ability to apply their knowledge creatively to solve real-world problems. Innovation is not achieved through isolated instruction but through the combined effect of competency development, workplace exposure, industry alignment, and digital integration. Martin Mulder **(2017)** emphasised that innovation in vocational education emerges when learners engage in problem-based and project-driven activities supported by real-world contexts and technological tools. This suggests that enhancing innovation among electrical/electronic students in Nigeria requires integrating project-based learning, industry challenges, and technology-driven experimentation into training programmes.

Therfore, enhancing electrical and electronic TVET in Nigeria requires a coordinated implementation strategy that strengthens competency, improves employability, aligns training with industry, integrates digital technologies, and fosters innovation. These elements are sequentially connected, with each building on the previous one to produce improved training outcomes. By adopting this structured and integrated approach, Nigeria can significantly improve the quality and relevance of electrical and electronic education and produce graduates who are competent, employable, and capable of driving technological advancement.

4. Conclusion

Enhancing electrical and electronic education within Nigeria's Technical and Vocational Education and Training (TVET) system requires a deliberate shift from fragmented improvements to a coordinated, system-wide approach. The evidence presented in this position paper shows that competency, employability, industry-aligned training, digital integration, and innovation are not independent elements but form a progressive pathway of enhancement. When competency is strengthened through practice-based training, students become better prepared for workplace demands; when employability is embedded through real-world exposure, students transition more effectively into industry; when training is aligned with industry, learning becomes relevant and current; and when digital technologies are integrated, students gain the capacity to adapt to modern systems. These combined elements ultimately foster innovation, which represents the highest level of educational effectiveness in electrical and electronic fields.

However, current conditions in Nigeria indicate that these elements are not sufficiently integrated. Training systems often remain theory-driven, industry collaboration is weak, digital infrastructure is limited, and innovation-oriented learning is underdeveloped. As a result, many electrical/electronic graduates lack the level of competence and adaptability required in contemporary industrial environments. This situation undermines the core purpose of TVET as a driver of technological development and economic growth. Addressing this challenge therefore requires a holistic enhancement strategy that simultaneously strengthens all key components of the training system rather than addressing them in isolation.

This position paper concludes that improving outcomes for electrical and electronic students in Nigeria depends on adopting an integrated enhancement model that connects competency development, employability preparation,

industry alignment, digital integration, and innovation within a unified framework. Such an approach provides a practical pathway for transforming TVET into a system that produces graduates who are not only technically competent but also adaptable, innovative, and capable of contributing meaningfully to national development.

5. Recommendations

To achieve effective enhancement of electrical and electronic TVET in Nigeria, the following recommendations are proposed:

First, competency development should be strengthened through the adoption of competency-based education and training models that emphasise practical skill acquisition and performance assessment. Training institutions should upgrade workshop facilities, provide modern electrical and electronic equipment, and increase the proportion of hands-on learning within programmes. This aligns with the position of **Rauner (2021)**, who emphasised that vocational competence develops through authentic task performance and practice-oriented learning environments.

Second, employability should be enhanced by integrating structured work-based learning into all electrical and electronic programmes. Industrial attachment, apprenticeship systems, and supervised workplace learning should be made compulsory and properly monitored. **Clarke (2018)** highlighted that sustained workplace exposure significantly improves students' job readiness and adaptability in technical occupations.

Third, industry-aligned training should be institutionalised through strong partnerships between technical institutions and industry stakeholders. Curriculum development, training delivery, and assessment should involve active participation from industry to ensure relevance. **Allais (2014)** noted that alignment between education and labour market systems is essential for producing graduates with skills that match industry demands.

Fourth, digital integration should be prioritised by incorporating modern technologies such as simulation tools, automation systems, and digital laboratories into electrical and electronic training. Instructors should also receive continuous professional development to effectively utilise these technologies. OECD **(2020)** emphasised that digital competence is now a fundamental requirement for workforce participation in technology-driven industries.

Fifth, innovation should be promoted through the adoption of project-based learning, problem-solving activities, and technology-driven experimentation. Students should be encouraged to work on real-life technical challenges that require creative application of knowledge. **Guile (2010)** argued that innovation in vocational education emerges when learners engage in reflective practice and real-world problem-solving tasks.

Finally, government and educational authorities should adopt a system-level approach to TVET reform by ensuring that competency development, employability, industry alignment, digital integration, and innovation are addressed collectively. Policies should support funding for infrastructure, capacity building for instructors, and sustainable partnerships with industry.

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