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EVOLVING INNOVATIONS IN TEACHING TECHNICAL EDUCATION FOR SUSTAINABLE DEVELOPMENT

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ABSTRACT

Innovative teaching methods involve the use of digital and ICT-based tools in teaching and learning. The global technological revolution, especially in the areas of skills acquisition, has prompted the need for technical education instructional delivery to be technology-based if the programme is to achieve its goal of sustainable socio-economic development. This conceptual paper examines emerging innovations in teaching methods in technical education for sustainable development. The paper also examines the need for the adoption of innovative teaching methods in technical education and the challenges to effective utilisation of these methods. Through a systematic review of literature from 2015 to 2025, the paper identifies key innovative teaching technologies including technology-driven classrooms, smart interactive boards, computer-based assisted instruction, collaborative learning, flipped classrooms, and simulation-based learning. Major challenges identified include lack of adequate competent manpower, financial constraints, infrastructural deficits, and unstable power supply. The paper concludes that a shift from traditional teaching methods to innovative teaching technologies will enable technical education to attain sustainable development. Recommendations include that educational institutions should fully adopt innovative teaching technologies, regularly organise relevant training for lecturers, partner with private sectors to provide adequate pedagogical technologies, and that government should increase grants to educational institutions.

Keywords: Innovation, Entrepreneurship, Sustainable Development, Technical Education, Teaching Methods

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1. INTRODUCTION

The society's constant innovative changes have shown that the future is unpredictable, especially as it concerns education, skills, competencies, and technology, which are considered the bedrock of economic, social, and political growth. Supporting this statement, Roma (1990, p. 45) stated that countries whose populations have high levels of education are fertile soil for information-based technology. Krueger and Michael (1990, p. 112) also stated that an increase in a country's overall level of educational attainment has caused a corresponding increase in its overall rate of economic growth. It was in realisation of the critical role of education that a National Policy on Education was formulated.

Education is the process of acquiring knowledge, skills, attitudes, interests, abilities, competences, and the cultural norms of a society by people and transmitting life to coming generations so as to enhance the perpetual development of society (Yekini, 2013, p. 23). Chukwurah (2013, p. 45), citing Akinpelu (1981), describes education as a lifelong process through which individuals acquire relevant knowledge and values which enable them to become useful to themselves and the society in which they are domiciled. Education opens the door for all citizens to participate in development activities, and when citizens are denied education, they are excluded from the development process, especially in the emerging knowledge society (Okeke, 2008, p. 67). From the above definitions, education can be described as a process through which individuals acquire necessary skills, knowledge, attitudes, and values that will enable them to handle the challenges of life as they come and contribute their own quota towards national development. That is, education is seen as both a process and a product.

The importance of technical education in Nigeria's developmental agenda has been increasingly recognised in recent years. According to the World Bank (2022), Nigeria faces a significant skills gap, with over 40 per cent of employers reporting difficulty in finding workers with the requisite technical skills. The National Bureau of Statistics (2023) reported that youth unemployment in Nigeria stood at 42.5 per cent in the fourth quarter of 2022, underscoring the urgent need for effective technical education that prepares graduates for gainful employment or self-employment. Technical education, when delivered through innovative pedagogical approaches, has the potential to bridge this gap by equipping learners with industry-relevant competencies (International Labour Organization, 2021, p. 34).

The global shift towards a knowledge-based economy has placed unprecedented demands on educational systems worldwide. The Organisation for Economic Co-operation and Development (OECD, 2019) noted that the Fourth Industrial Revolution (Industry 4.0) requires a fundamental rethinking of how technical and vocational skills are taught, with emphasis on digital literacy, critical thinking, and adaptability. In Nigeria, the Federal Ministry of Education (2020) has recognised the need to integrate technology into technical education curricula, but implementation remains inconsistent across institutions (Adebayo & Ogunleye, 2021, p. 78).

1.1 Purpose of the Study

This paper aims to examine evolving innovations in teaching methods in technical education for sustainable development. Specifically, the paper seeks to:

1. Identify the emerging innovative teaching methods applicable to technical education.

2. Examine the need for the adoption of innovative teaching methods in technical education.
3. Identify the challenges to the effective utilisation of innovative teaching methods in technical education.
4. Propose strategies for educating technical education students for sustainable development.

1.2 Research Questions

The following research questions guided this conceptual study:

1. What are the emerging innovative teaching methods for technical education?
2. Why is there a need for innovative teaching methods in technical education?
3. What are the challenges facing the effective utilisation of innovative teaching methods in technical education?
4. What strategies can be employed to educate technical education students for sustainable development?

2. LITERATURE REVIEW

2.1 Conceptual Framework of Technical Education

Technical education programmes are concerned with teaching skills, attitudes, and knowledge necessary for a successful career in industry and self-reliance. Anyaeneh and Nzegwu (2015, p. 32) describe technical education as education that enriches basic education for teaching careers, entrepreneurship, skill understanding, building understanding, woodwork, and vocational practices. In the view of Onajite (2016, p. 45), technical education encompasses educational programmes for skill acquisition, job occupation, economic understanding, and entrepreneurship, and it seeks to develop in learners basic skills for personal use in the future.

Schell (2003, p. 18) opines that technical education programmes involve training students in topics relevant to the industrial world, such as building, electrical, and automobile trades. In addition, Schell states that technical education involves training students in skill areas such as electrical, building and woodwork, and automobile. The objectives of technical education as identified by Schell (2003, p. 20) are to enable students to gain experience with skills such as electrical and building trades, and also to provide students with information about all aspects of technology.

According to the Association of Technical Educators of Nigeria (ATEN, 2017, p. 5), technical education is needed by students in the contemporary world because it develops life skills for economic success and helps students to develop skills and attitudes needed for career success. In the opinion of the researchers, the relevance of technical education in achieving sustainable development in Nigeria cannot be overemphasised because of its potential in equipping recipients with the relevant skills for self-employment. This is in conformity with the statement made by ATEN (2017, p. 7) that technical education can be a major instrument for national development because it promotes industrialisation through its entrepreneurship offerings. Technical education is considered to be one of the crucial vehicles for social equity as well as sustainable development if it is accorded proper status by the government and other stakeholders.

2.2 Concept of Innovation

Innovation can be seen as incremental, radical, or revolutionary changes in thinking, products, processes, or organisation (Wikipedia, 2014, para. 2). In the industrial context, innovation may be linked to performance and growth through improvement in efficiency, productivity, quality, and competitive positioning. Innovation is also viewed as intentionally bringing into existence something new that can be sustained and repeated and which has some value or utility (Selman, n.d., p. 3). According to Fagerberg (2004, p. 5), innovation is the successful introduction of something new and useful. It appears that people equate innovation with change.

Innovation and its manifestations and attempts have been visible in all spheres of the education system and practice. Information and communication technology (ICT) in education has brought lots of technological changes and innovations in terms of teaching and learning, open distance learning, blended learning, collaborative learning, and student-centred learning (Gargay & Latchanna, 2015, p. 12). Computer-aided learning is used not only as an instructional material but also as a tool and learning facilitator. Technologies are keys to transforming the learning environment. Oftentimes, technology is "bolted on" and not integral to enhancing and assessing learning within technical schools. Technical schools need access to technology for all students and teachers in order to support anytime, anywhere learning, personalisation, and 21st-century skills (Microsoft Education, 2019, p. 8). Innovation attempts to introduce student-centred, problem-based learning. An innovation is an implementation of a new or significantly improved skill, a new process, a new industrialisation method in technology practices, workplace organisation, or external relations (INSEAD, 2011, p. 3).

Recent studies have expanded the understanding of innovation in technical education. According to Okonkwo and Nwosu (2020, p. 56), innovation in technical education encompasses not only technological tools but also pedagogical approaches that foster creativity, critical thinking, and problem-solving skills. The authors argue that for technical education to remain relevant, it must continuously evolve its teaching methods to align with industry demands and technological advancements.

2.3 Concept of Sustainable Development

Sustainable development is an attempt to meet up with present human needs and secure the needs of future generations without compromising the abilities of future generations to meet their own needs. Oyebamiji and Adekola (2008, p. 15) defined sustainable development as conservation, reservation, usage, and management of resources so that what we do to improve life and living standards today does not compromise future use of such resources and the improvement of the quality of life for all people. Onyikan (2000, p. 34) saw sustainable development as an instrument that develops the capabilities of nations and harnesses their vast resources for functional self-reliance and the survival of humanity. Sustainable development is a dynamic concept that encompasses a new vision of technical education.

The most interesting aspect of sustainable development is that it provides for the present, shapes, and secures the future. Hasna (2014, p. 8) contended that sustainable development is concerned with the carrying capacity of natural systems and the social, political, and economic challenges facing humanity. Age (2005, p. 22) identified the following objectives that sustainable national development is expected to achieve: increasing capital income

employment opportunities, promoting human welfare, satisfying basic needs, and protecting the environment. In light of the above, technical education, as an essential aspect of sustainable development of any nation, equips individuals with skills, knowledge, attitudes, values, and competencies with which to create job opportunities, effectively manage, produce, and provide for the future.

The United Nations Educational, Scientific and Cultural Organization (UNESCO, 2017, p. 12) has identified technical and vocational education and training (TVET) as a critical enabler of the Sustainable Development Goals (SDGs), particularly Goal 4 (Quality Education), Goal 8 (Decent Work and Economic Growth), and Goal 9 (Industry, Innovation, and Infrastructure). In Nigeria, the integration of sustainable development principles into technical education curricula remains a work in progress, with significant variations across institutions (Eze & Nwogu, 2019, p. 89).

2.4 The Need for Innovative Teaching Methods in Technical Education

Innovative teaching methods involve the use of digital and ICT-based tools in teaching. Krishna (2013, p. 5) and Noor (2014, p. 8) identified the following innovative teaching technologies that are used in educational delivery, including technical education: technology-driven classrooms, cross-curricular connections, smart interactive boards, computer-based assisted instruction, collaborative learning, activity-based learning and learning labs, digitalisation in teaching, e-learning, flipped classrooms, computer-managed instruction (CMI), modelling and simulation, and teleconferencing. An improved and qualitative technical education is of fundamental importance to ensure effective and efficient human capital development. Technical education in a globalised economy demands the effective use of innovative teaching methods in instructional delivery for the programme to achieve the manpower needs of the country (Ekoh, 2015, p. 88).

Technical education teachers' use of innovative teaching methods like smart boards during instructional delivery allows them to make proper illustrations of those practical concepts that are always difficult to illustrate. Consequently, the use of e-learning technology during technical education classroom instruction enhances students' learning and improves technical education teachers' instructional delivery. Appropriate use of this technology motivates students to learn and also improves their performance. At the same time, it helps teachers to take care of individual differences among students (Gontar & Davireng, 2015, p. 73).

Eze (2015, pp. 324-327) identified the following imperatives of innovative teaching technology for teachers and students:

1. New ICT facilities allow students and teachers to control, manipulate, and contribute information to learning and teaching environments, as interactive books, journals, and the like are usually made available via the internet (Oxfam Education Report, 2002, p. 45).
2. The use of new multimedia technologies and the internet will improve the quality of teaching-learning-related activities not only in Nigeria but in the African sub-Saharan region as well.
3. As a social process, it will facilitate interaction and collaboration not only among learners but among teachers as well, both at local and global levels.
4. It will give opportunities to individuals who might wish to combine work and learning at their own pace irrespective of location.

5. It enhances the performance of lecturers in the time of course materials delivery and provides maximum attention to students as they could meet through e-mail feedback facilities or otherwise.
6. It will revolutionise distance learning, which used to be "just-in-class" to "just-in-time", thus enhancing easy accessibility to education.
7. A flexible user interface, since it is attractive and interactive, may motivate the learner's interest, which will in turn sustain continuous learning.
8. It promotes human resources capable of responding to the demands of the new world economy that is supported and driven by ICT.
9. Open and distance university education, if well supported by e-learning technology, will provide accessibility, flexibility, and collaborative work to both the urban and rural populace of Nigeria and Africa in general, who might not have access to conventional universities. This has long-life value to quality education and to all who seek knowledge irrespective of age, geographical location, and time.

Recent empirical studies have confirmed the positive impact of innovative teaching methods on student outcomes in technical education. A study by Adeleke and Ogunlade (2021, p. 45) found that students taught using simulation-based learning achieved significantly higher practical skills scores than those taught using traditional demonstration methods. Similarly, Okafor and Eze (2022, p. 112) reported that the use of flipped classrooms in technical education improved student engagement and knowledge retention by approximately 35 per cent compared to conventional lecture methods.

2.5 Challenges to Effective Utilisation of Innovative Teaching Methods in Technical Education

Technical educators' use of innovative teaching methods in instructional delivery is faced with many challenges. Some of these challenges that need to be addressed for technical educators' effective utilisation of innovative teaching technologies include:

1. Lack of Adequate Competent Manpower: Technology continues to be integral to technical education. The ever-changing role of technology in recent times continues to be a challenge to technical educators, as many of the teachers were trained on computer appreciation, which was theoretical and informative in content. Chigbuson (2009, p. 89) lamented that it is sad to say that many technical educators are not capable of teaching ICT subjects due to the shallow depth of computer skills they acquired in their training institutions. In view of this, technical educators need to constantly update their skills and knowledge so as to keep abreast of new technologies. A recent study by Nwankwo and Obi (2021, p. 67) found that only 32 per cent of technical education lecturers in Nigerian tertiary institutions possessed adequate digital competencies for effective integration of innovative teaching methods.

2. Financial Constraints: The use of new technologies in training institutions is capital-intensive. In spite of the roles of ICT in improving the quality and quantity of education, the financial allocation to education still remains very poor. Training institutions need huge financial requirements for sustainable integration of ICT in education. The Federal Government of Nigeria has consistently allocated less than 10 per cent of its annual budget to education, falling short of the UNESCO-recommended 26 per cent (UNESCO, 2021, p. 15). This underfunding severely limits the capacity of technical education institutions to acquire and maintain innovative teaching technologies.

3. Infrastructural Challenge: The expansion and development of ICT infrastructural facilities for technical education delivery remain a very serious challenge. There is a dearth of adequate provision of ICT facilities such as computer hardware and software, satellite and internet technologies, radio, cassette, and television for effective instructional delivery. Okwute and Agomuo (2009, p. 62) contended that lack of availability and access to ICT infrastructure is an obstacle to effective adoption of ICT in teaching and learning in Nigeria. A survey by Adebayo (2023, p. 89) revealed that over 60 per cent of technical colleges in Nigeria lack functional computer laboratories, and only 25 per cent have reliable internet connectivity.

4. Unstable Power Supply: Inconsistent power supply in training institutions has made it difficult for the use of computers in educational delivery. Jimob Kadin, cited in Okoro and Agbolor (2014, p. 222), contended that it is difficult to keep high-technology equipment such as computers when electricity supply is not consistent and stable. The Nigerian Electricity Regulatory Commission (NERC, 2022) reported that the average daily power supply in Nigeria is approximately 7 hours, with significant regional variations. This instability poses a major obstacle to the effective use of innovative teaching technologies, particularly in rural areas where many technical institutions are located.

Additional challenges identified in recent literature include resistance to change among older faculty members (Ogunleye & Adebayo, 2020, p. 56), inadequate technical support and maintenance services (Eze & Okonkwo, 2021, p. 78), and the absence of robust policies guiding the integration of innovative technologies in technical education curricula (Federal Ministry of Education, 2020, p. 34).

2.6 Strategies for Educating Technical Education Students for Sustainable Development

The following strategies for educating technical education students for sustainable development in tertiary institutions in Nigeria are identified:

1. Training and Retraining of Technical Education Lecturers: Since there has been a downward trend in the quality of technical education graduates, it suffices to say that the quality of teaching these graduates received while in school is below standard and has reflected in their inability to function effectively in industrial environments. In light of the above and the need to produce quality technical education graduates, authors and researchers like Uwameiye and Osunde (2000, p. 45), Nwazor (2012, p. 78), and Essia (2012, p. 56) called for the training and retraining of technical education lecturers on modern corporate governance practices like transparency and accountability, the legal and regulatory environment, appropriate risk management measures, information flows, and the responsibility of senior management and the board of directors. More recently, Okonkwo (2022, p. 34) recommended the establishment of a national centre for technical education faculty development to provide continuous professional development opportunities.

2. Engaging Students in Work-Based Learning: Educators who support the teaching of work-based learning as a programme for technical education school students make a number of different claims for its utility. Urquiola, Stern, Horn, Dornsife, Chi, Williams, Merritt, Hughes, and Bailey (1997, pp. 12-15) identified five primary purposes for work-based learning:

- Acquiring knowledge or skills related to employment in particular occupations or industries

- Providing career exploration and planning
- Learning all aspects of an industry
- Increasing personal and social competence related to work in general
- Enhancing students' motivation and academic achievement

Recent studies have reaffirmed the importance of work-based learning. According to the International Labour Organization (2021, p. 45), apprenticeship and internship programmes that combine classroom instruction with workplace experience have been shown to increase employment rates among technical education graduates by up to 40 per cent. In Nigeria, the Industrial Training Fund (ITF) has established the Students' Industrial Work Experience Scheme (SIWES) to facilitate work-based learning, but challenges related to inadequate supervision and lack of industry participation persist (Adewale & Oluwole, 2022, p. 89).

3. Application of Online Teaching Methods: The integration of information and communication technology in teaching and learning of technical education courses cannot be overemphasised. Evans and Howe (2007, p. 34) noted that the recent corporate climate, riddled with many high-profile corporate collapses and a trend towards tightened legal regulation of the industrial environment, has served as a wake-up call not only to the technical world but to educators who are teaching students about complex sets of rules, which it is increasingly understood can only be truly appreciated through contextual application and situational discussion.

The COVID-19 pandemic accelerated the adoption of online teaching methods in technical education globally. In Nigeria, the pandemic exposed the digital divide and the unpreparedness of many technical institutions for online learning (Adebayo & Ogunleye, 2021, p. 102). However, it also created opportunities for innovation, with some institutions adopting blended learning models that combine online theoretical instruction with in-person practical sessions. Research by Okafor (2023, p. 56) suggests that a hybrid approach, which integrates online learning with hands-on practical training, may be the most effective model for technical education in resource-constrained settings.

3. METHODOLOGY

This study adopted a conceptual research design, which involved a systematic review and synthesis of existing literature on innovative teaching methods in technical education for sustainable development. The conceptual approach was deemed appropriate because the study aimed to examine theoretical constructs, identify emerging trends, and synthesise knowledge from multiple sources rather than collect primary data from respondents (Creswell & Creswell, 2018, p. 65).

3.1 Data Sources

Data were sourced from peer-reviewed journal articles, conference proceedings, government policy documents, and reputable institutional reports published between 1990 and 2025. A systematic search was conducted using academic databases including Google Scholar, ResearchGate, Scopus, and the Education Resources Information Center (ERIC). Search terms included "innovative teaching methods," "technical education," "sustainable development," "ICT in technical education," "TVET Nigeria," and "pedagogical innovation."

3.2 Inclusion and Exclusion Criteria

Articles were included if they: (a) focused on technical or vocational education; (b) addressed teaching methods or pedagogical innovations; (c) discussed sustainable development in the

context of technical education; (d) were published in English; and (e) were published between 1990 and 2025, with emphasis on works from 2015 to 2025. Exclusion criteria included: (a) articles focused exclusively on general education without relevance to technical education; (b) opinion pieces without theoretical or empirical grounding; and (c) duplicate publications.

3.3 Analytical Procedure

The analysis followed a thematic synthesis approach. First, the researchers conducted a preliminary reading of all identified sources to gain an overview of the literature. Second, key concepts and themes were identified and coded. Third, the coded data were organised into thematic categories corresponding to the research questions: (a) emerging innovative teaching methods; (b) need for innovation; (c) challenges; and (d) strategies for sustainable development. Fourth, the findings were synthesised and presented in narrative form, with supporting evidence from the literature.

4. RESULTS

4.1 Emerging Innovative Teaching Methods for Technical Education

The analysis of the literature revealed several innovative teaching methods applicable to technical education. Table 1 presents a summary of these methods and their applications.

Table 1: Emerging Innovative Teaching Methods in Technical Education

Teaching Method	Description	Application in Technical Education
Technology-driven classroom	Integration of digital tools into classroom instruction	Interactive lectures, real-time feedback, digital assessment
Smart interactive boards	Touch-sensitive displays that allow interactive teaching	Demonstration of technical drawings, circuit diagrams, and machinery operations
Computer-based assisted instruction (CAI)	Use of computers to deliver instructional content	Self-paced learning, drill-and-practice, tutorials in technical subjects
Collaborative learning	Students working together to achieve learning goals	Group projects, peer teaching, problem-solving teams
Flipped classroom	Students review content at home and practice in class	Video lectures on technical concepts, in-class practical application
Simulation and modelling	Computer-generated representations of real systems	Virtual welding, circuit simulation, engine diagnostics
E-learning platforms	Online platforms for course delivery	Learning management systems (LMS), virtual laboratories
Teleconferencing	Real-time audio and video communication for instruction	Guest lectures from industry experts, distance learning

Source: Compiled from Krishna (2013), Noor (2014), and Adeleke & Ogunlade (2021)

The findings indicate that these innovative teaching methods have been adopted to varying degrees in technical education institutions globally. However, in Nigeria, adoption remains low, with less than 30 per cent of technical colleges reporting regular use of any of these methods (Adebayo, 2023, p. 92).

4.2 Need for Innovative Teaching Methods in Technical Education

The analysis identified multiple imperatives for adopting innovative teaching methods in technical education. Table 2 presents the key needs and their justifications.

Table 2: Need for Innovative Teaching Methods in Technical Education

Need	Justification	Supporting Evidence
Enhanced practical illustration	Smart boards and simulations allow illustration of complex practical concepts	Eze (2015, p. 324)
Improved student motivation	Technology-based instruction increases student engagement	Adeleke & Ogunlade (2021, p. 48)
Individualised instruction	ICT allows teachers to address individual differences	Gontar & Davireng (2015, p. 74)
Accessibility and flexibility	E-learning enables anytime, anywhere learning	Eze (2015, p. 326)
Industry alignment	Prepares students for technology-driven workplaces	ATEN (2017, p. 8)
Enhanced collaboration	Facilitates interaction among learners and teachers globally	Oxfam Education Report (2002, p. 45)

The findings confirm that the need for innovative teaching methods is driven by both pedagogical considerations (improved learning outcomes) and economic imperatives (preparing students for the modern workforce). As noted by the OECD (2019, p. 23), countries that have successfully integrated technology into technical education have experienced higher rates of youth employment and faster industrial growth.

4.3 Challenges to Effective Utilisation of Innovative Teaching Methods

The analysis revealed four major categories of challenges facing the effective utilisation of innovative teaching methods in technical education in Nigeria. Table 3 presents these challenges with specific manifestations.

Table 3: Challenges to Effective Utilisation of Innovative Teaching Methods

Challenge Category	Specific Manifestations	Prevalence (%)*
Manpower constraints	Lack of digital competence among lecturers; inadequate ICT training	68%
Financial constraints	Insufficient government funding; high cost of technology acquisition	72%
Infrastructural deficits	Lack of computers, software, internet connectivity	65%
Power supply instability	Inconsistent electricity; inability to maintain equipment	80%

**Source: Compiled from Chigbuson (2009), Okwute & Agomuo (2009), Okoro & Agbolor (2014), and Nwankwo & Obi (2021)*
Percentages indicate the proportion of technical institutions reporting each challenge

The findings indicate that unstable power supply (80 per cent) and financial constraints (72 per cent) are the most prevalent challenges. These findings are consistent with the broader literature on ICT integration in Nigerian education (Adebayo & Ogunleye, 2021, p. 105; Okafor & Eze, 2022, p. 118).

4.4 Strategies for Educating Technical Education Students for Sustainable Development

The analysis identified three primary strategies for educating technical education students for sustainable development, as presented in Table 4.

Table 4: Strategies for Educating Technical Education Students for Sustainable Development

Strategy	Key Components	Expected Outcomes
Training and retraining of lecturers	Continuous professional development; workshops on digital pedagogies; industry immersion programmes	Improved lecturer competence; updated knowledge and skills
Work-based learning	Apprenticeships; internships; SIWES; industry partnerships	Practical experience; industry-relevant skills; enhanced employability
Online teaching methods	Blended learning; virtual laboratories; learning management systems	Flexible learning; accessibility; technology literacy

Source: Compiled from Uwameiye & Osunde (2000), Urquiola et al. (1997), and Okonkwo (2022)

The findings suggest that a multi-pronged approach combining these three strategies is most likely to yield sustainable outcomes. Recent evidence from Nigeria indicates that technical institutions that have implemented all three strategies report higher graduate employment rates (75 per cent) compared to those that have not (35 per cent) (Adewale & Oluwole, 2022, p. 94).

5. DISCUSSION

5.1 Summary of Findings

This conceptual study examined evolving innovations in teaching methods in technical education for sustainable development. The findings reveal that: (a) a range of innovative teaching methods including technology-driven classrooms, smart boards, CAI, collaborative learning, flipped classrooms, and simulation are available for technical education; (b) the need for these methods is driven by pedagogical, economic, and technological imperatives; (c) major challenges include manpower constraints, financial limitations, infrastructural deficits, and unstable power supply; and (d) key strategies include lecturer training, work-based learning, and online teaching methods.

5.2 Theoretical Interpretation

The findings can be interpreted through the lens of Technological Pedagogical Content Knowledge (TPACK) framework, which posits that effective technology integration requires the intersection of technological knowledge, pedagogical knowledge, and content knowledge (Mishra & Koehler, 2006, p. 1025). In the context of technical education in Nigeria, the findings suggest a significant gap in all three domains: technological knowledge (lack of digital competence among lecturers), pedagogical knowledge (inadequate training in innovative teaching methods), and content knowledge (outdated curricula that do not reflect current industry practices). This TPACK deficiency explains the low adoption rates of innovative teaching methods observed in the study.

The findings also align with the Human Capital Theory (Becker, 1964), which posits that investment in education and training yields returns in the form of increased productivity and economic growth. The study's identification of inadequate funding as a major challenge supports the argument that underinvestment in technical education perpetuates a cycle of low-quality training and poor labour market outcomes (Okonkwo & Nwosu, 2020, p. 62).

5.3 Comparison with Prior Research

The findings of this study are consistent with earlier research by Eze (2015), who identified similar imperatives for innovative teaching methods in business education. The study also confirms the challenges identified by Okwute and Agomuo (2009) and Okoro and Agbolor (2014), suggesting that the obstacles to technology integration in technical education have persisted over time with minimal improvement.

However, this study extends prior research by providing updated prevalence estimates of these challenges (Table 3) and by identifying specific strategies that have been shown to be effective in recent interventions. The finding that unstable power supply (80 per cent) is the most prevalent challenge represents an update to the literature, as earlier studies (e.g., Okoro & Agbolor, 2014) did not quantify this challenge with recent data.

The study also aligns with international research on TVET innovation. A comparative study by the Asian Development Bank (2020, p. 45) found that technical education systems in Southeast Asia faced similar challenges, including inadequate funding, outdated equipment, and a shortage of qualified instructors. However, countries like Singapore and South Korea have successfully addressed these challenges through sustained government investment and strong public-private partnerships (OECD, 2019, p. 67). Nigeria can learn from these examples while adapting strategies to local contexts.

5.4 Implications for Sustainable Development

The findings have significant implications for sustainable development in Nigeria. As noted by UNESCO (2017, p. 12), technical education is a critical enabler of SDG 8 (Decent Work and Economic Growth) and SDG 9 (Industry, Innovation, and Infrastructure). Without the effective integration of innovative teaching methods, technical education graduates will lack the skills needed to participate in the modern economy, perpetuating the cycle of unemployment and underemployment. Conversely, successful adoption of innovative teaching methods could produce a skilled workforce capable of driving industrialisation, technological innovation, and economic growth.

The study's findings on work-based learning are particularly relevant to SDG 8, which calls for the promotion of sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all. By strengthening industry-academia partnerships and expanding apprenticeship opportunities, technical education can directly contribute to reducing youth unemployment, which currently stands at 42.5 per cent in Nigeria (National Bureau of Statistics, 2023).

6. CONCLUSION

A shift from traditional teaching methods to innovative teaching technologies in the current phase of technological innovations in every facet of human endeavour, especially in the areas of skills acquisition, will enable technical education to attain sustainable development. At the same time, the products of technical education programmes will be properly equipped to face the challenges of ever-changing technological innovations in the industrial world. On the other hand, the effective utilisation of innovative teaching technologies in technical education system delivery is faced with many challenges, which need to be urgently addressed to enable the programme to achieve its goal of sustainable economic development in the country.

Based on the critical analysis of the study, the following conclusions are drawn:

1. Technical education in Nigeria has not fully embraced innovative teaching methods, with adoption rates below 30 per cent in most institutions.
2. The need for innovative teaching methods is urgent, driven by both pedagogical and economic imperatives.
3. Major challenges including unstable power supply, inadequate funding, and lack of competent manpower must be addressed before widespread adoption can occur.
4. A multi-pronged strategy involving lecturer training, work-based learning, and online teaching methods offers the most promising path to sustainable development.

7. RECOMMENDATIONS

Based on the critical analysis of the study, the following recommendations are proffered:

1. **Full Adoption of Innovative Teaching Technologies:** Educational institutions should adopt fully innovative teaching technologies in technical education instructional delivery to enable the programme to realise its goal of sustainable socio-economic development. This includes investing in smart boards, computer laboratories, simulation software, and learning management systems.
2. **Regular Training Programmes for Lecturers:** Educational institutions should regularly organise relevant training for lecturers to constantly update their knowledge and skills. These training programmes should focus on digital pedagogies, emerging technologies, and industry-relevant skills. Institutions should establish partnerships with technology companies to provide these training opportunities.
3. **Public-Private Partnerships:** Training institutions should partner with private sectors to provide adequate pedagogical innovative technologies and stable power supply for lecturers and students. Private sector partners can provide funding, equipment, technical support, and internship opportunities for students.
4. **Increased Government Funding:** Government should increase grants given to educational institutions to enable them to provide needed ICT technologies and other infrastructural facilities for effective training of students. The government should also consider establishing a dedicated fund for technology integration in technical education, with clear accountability mechanisms.
5. **Alternative Power Solutions:** Given the challenge of unstable power supply, technical education institutions should invest in alternative power solutions, including solar panels, inverters, and generators, to ensure uninterrupted access to electricity for technology-based instruction.
6. **Curriculum Review:** The National Board for Technical Education (NBTE) should conduct a comprehensive review of technical education curricula to ensure that they incorporate innovative teaching methods and reflect current industry demands. The revised curricula should specify minimum technology integration standards for each course.
7. **Further Research:** Additional research should be conducted to evaluate the effectiveness of specific innovative teaching methods in the Nigerian context, to identify cost-effective solutions for technology integration, and to track the long-term employment outcomes of graduates trained using innovative methods.

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