



Artificial Intelligence (AI), Digital Skills and Technical and Vocational Education and Training (TVET) For Modern Economy and Education in Nigeria

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ABSTRACT

The study examines Artificial Intelligence (AI), digital skills and TVET for modern economy and education in Nigeria. The 21st century has brought about unprecedented changes in the global economy, driven by technological advancements and shifting workforce demands (World Bank, 2020). Technical and Vocational Education and Training (TVET) has emerged as a crucial driver of modern economy, as it equips individuals with skills tailored to industry needs. This paper explores the integration of Artificial Intelligence (AI), Digital skills and TVET highlighting its potential to foster in modern economy and Education in the 21st century. It offers a thorough assessment of chosen materials on digital skills and artificial intelligence and TVET in modern economy and education released lately (mainly from 2010 to date), as gathered in the Web of Sciences database and selected specialized publications, from distinct educational viewpoints. In addition, the article defines both Artificial intelligence and Digital skills terminologies and some relevant sub – fields such as the Role of Digital Skills in TVET, the Impact of AI on TVET, Modern Economic Diversification through TVET Challenges and Future Directions among others. It suggests and recommended among others that, government should invest in infrastructure and resources, develop teacher training programs, promote industry partnerships and Ensure equity and access.

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INTRODUCTION

Digitalization has led to extensive changes in the skills required for work and life. For technical and vocational education and training (TVET) institutions to remain relevant and attractive, they need to identify and introduce digital skills and competencies for the changing world of work, and to better utilize the opportunities provided by digitalization, particularly distance learning. Their success in harnessing the benefits and tackling the challenges of digitalization largely depends on the digital capabilities of TVET teachers and trainers. Teachers and trainers face multiple challenges to keep up with the latest digital transformations and to upgrade their skills to apply modern technology-

aided instruction. Likewise, managers of TVET institutions are hindered by the lack of support in creating enabling digital environments and building innovative institutions (UNESCO 2022). Today digital skills and Artificial Intelligence (AI) and TVET for modern economic diversification remain under-utilization in 21st century education landscape in Nigeria.

A thorough assessment of recent studies on digital skills and AI in modern economy and education reveals the growing importance of these technologies in shaping the future of work. According to the World Economic Forum (2020), digital skills are essential for workers to remain relevant in the job market. Similarly, AI has the potential to transform TVET by enhancing the

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learning experience, improving assessment and feedback, and providing personalized learning pathways (Farias & Rochester, 2019).

The Role of TVET in Modern Economic Diversification

TVET had been defined by Ukala and Iheukwumere (2025) as all forms and aspects of education that are technical and vocational in nature, provided either in educational institutions or under their authority, by public authorities, the private sector or through other forms of organized education, formal or non-formal, aiming to ensure that all members of the community have access to lifelong learning.

The objectives of TVET according Federal Republic of Nigeria (FRN) (2014:14) are to:

1. Provide trained manpower in applied science, technology and commerce particularly at sub-professional level;
2. Provide the technical knowledge and vocational skills necessary for agricultural, industrial, commercial and economic development;
3. Provide people who can apply scientific knowledge to the improvement and solution of environmental problems for the use and convenience of man;
4. Give an introduction to professional studies in engineering and other technologies;
5. Give training and impart the necessary skills leading to the production of craftsmen, technicians and other skilled personnel who will be enterprising and self-reliant; and
6. Enable young men and women to have intelligent understanding of the increasing complexity of technology.

As the landscape of work is undergoing rapid transformation, primarily driven by digitalization and automation; Information technology is redefining essential skills for workers, emphasizing not only traditional competencies but also the increasing necessity for new, transversal skills. The relationship between

Technical and Vocational Education and Training (TVET) and Artificial Intelligence (AI) is increasingly significant as AI technologies reshape industries and labor markets in so many ways such as: enhancing skill development through adaptive learning, and intelligent tutoring systems (ITS); industry-relevant training by using AI-driven models to predict for workforce readiness; entrepreneurship and creativity; team work and collaboration.

Maseko (2024) revealed that there is a notable increase in the demand for specific technical skills, STEM skills, and training on ICT/digital and 3D technologies for TVET teachers and trainers. TVET plays a critical role in equipping individuals with the skills required to drive economic growth and diversification (UNESCO, 2019). By providing training in specific skills and competencies, TVET enables individuals to contribute to various sectors of the economy. TVET isacronyms which stand for Technical and Vocational Education and Training:

T - Technical

1. Refers to the specialized knowledge and skills required in specific technical fields such as engineering, information technology, or applied sciences (UNESCO, 2019).
2. Focuses on practical applications of scientific and technological principles (European Commission, 2020).

V - Vocational

1. Pertains to education and training that prepares individuals for specific occupations or careers, particularly in skilled trades, crafts, or technical fields (ILO, 2019).
2. Emphasizes the development of practical skills and competencies that are directly applicable to the workplace (OECD, 2019).

E - Education

1. Refers to the structured process of teaching and learning technical and vocational skills (UNESCO, 2019).
2. Involves both theoretical knowledge and practical training to ensure a well-

rounded understanding of the subject matter (World Bank, 2020).

T - Training

1. Focuses on the development of specific skills and competencies through hands-on practice and instruction (ILO, 2019).
2. Aims to equip individuals with the ability to perform tasks efficiently and effectively in a real-world work environment (European Commission, 2020).

Key Features of TVET

1. Practical Focus: TVET emphasizes hands-on learning and real-world application of skills (UNESCO, 2019).
2. Industry Relevance: Programs are often designed in collaboration with industry partners to ensure alignment with current job market needs (World Bank, 2020).
3. Career Preparation: TVET aims to prepare individuals for specific careers or occupations, enhancing their employability and potential for advancement (ILO, 2019).

Importance of TVET

1. Economic Growth: TVET contributes to economic development by providing a skilled workforce that meets the needs of various industries (World Bank, 2020).
2. Employment Opportunities: TVET programs enhance employability and provide individuals with the skills needed to secure jobs or start their own businesses (ILO, 2019).
3. Innovation and Productivity: By focusing on practical skills and industry relevance, TVET helps improve productivity and innovation in the workplace (OECD, 2019).

Digital Education/literacy

Some authors' view that digital literacy cannot be limited to certain digital skills but also is linked to a wider and, more critical view of the

given society in this era of technological revolution. Ferrari (2012) proposed the following definition of digital competence as: "the set of knowledge, skills, attitudes (thus including strategies, values and awareness) that are required when using ICT and digital media to perform tasks; solve problems; communicate; manage information; collaborate; create; share content; and build knowledge effectively, efficiently, appropriately, critically, creatively, autonomously, flexibly, ethically, reflectively for work leisure, participation, learning, socializing, consuming and empowerment(Ferrari 2012)."

In general, digital competence can also be defined as "the creative, critical and confident use of information and communication technologies to achieve the objectives related to work, employability, learning, leisure, inclusion, and participation in the society." Thus, a 'model framework', individual competences are group into five key competence areas', they are:

1. Information and data literacy,
2. Communication and collaboration,
3. Digital content creation,
4. Safety and
5. Problem solving.

Digital Education/Literacy Tools and Differential Mode of Operation

Hundreds of digital education tools (DET) have been created and identify with the purpose of giving autonomy to the student, improving the administration of academic processes encouraging collaboration and facilitating communication between the teachers and the learners (Chauhan, 2018). The following were discussed by him, thus:

1. **Edmodo**: This is educational tool that connect teachers and students, and is assimilated into a social network. In this one teacher can create online collaborative groups, administer and provide education materials, measure student performance; and communicate with parents, among other functions.
2. **Socrative**: Designed by group of entrepreneurs and engineers passionate about education, socrative is

a system that allows teachers to create exercises, or educational games which student can solve using mobile devices, whether Smartphones, laptops or tablets.

3. **Project:** Is a tool that allows you to create multimedia presentations, with dynamic slides in which you can embed interactive maps, links, online quizzes, Twitter timelines and videos among other options.
4. **TED-Ed:** Is a platform that allows creating educational lessons with the collaboration of teachers, students, animators.....generally people who want expand knowledge and good ideas. This website allows democratizing access to information, both for teachers and students.
5. **Educlipper:** This platform allows teachers and students to share and explore references and education materials. In educlipper you can collect information found on the internet and then share it with the members of previously created groups, which offers the possibility to manage more effectively the academic content found online, improve research techniques and have a digital record of what students achieved during the course.
6. **Kahoot:** Is platform that is based on games and questions. Through this tool, teachers can create questionnaires, discussion or surveys that complement academic lessons. The material is projected in the classroom and questions are answered by the students while playing and learning at the same time. It promotes game-based learning, which increases students engagement and creates a dynamic, social and fun educational environment.
7. **Room 21:** Is a 21st century social learning platform. It is a Facebook-like environment designed for peer collaboration and to create learning

communities online (Falade and Alimi 2015).

These digital tools could be of great relevance to lecturers and teachers if put in to use due to the fact that students are increasingly becoming well versed in modern communication technology and this would lead and result to economic diversification in 21st century education landscape as supported by Himmelsbach (2019), who opined that "student are digital natives."

Digital Skills in TVET

Digital skills have become essential in the modern workforce (European Commission, 2020). Digital skills are critical for TVET students to acquire, as they enable individuals to access, create, and communicate information effectively. The integration of digital skills in TVET can enhance employability, productivity, and innovation (European Commission, 2020). Some of the key digital skills that can be incorporated in TVET include:

1. Data analysis: The ability to collect, analyzes, and interprets large data sets to inform decision-making.
2. Digital literacy: The ability to use digital tools and technologies to communicate, collaborate, and access information.
3. Programming and coding: The ability to design, develop, and implement software applications and systems.
4. Cyber security: The ability to protect digital systems and networks from cyber threats.

Definition of Digital Skills

Digital skills refer to the abilities and knowledge required to effectively use digital technologies, such as computers, smartphones, and software, to access, create, and communicate information (European Commission, 2020).

Types of Digital Skills

Digital skills encompass a range of competencies, including:



Basic Digital Skills:

Digital literacy, online navigation, and communication (Van Deursen & Van Dijk, 2014).

1. Digital literacy: The ability to use digital devices and basic software applications.
2. Online navigation: The ability to effectively use the internet, search engines, and online platforms.
3. Communication: The ability to use digital tools for communication, such as email, messaging, and video conferencing.

Intermediate Digital Skills:

Data analysis, content creation, and digital collaboration (OECD, 2019).

1. Data analysis: The ability to collect, analyze, and interpret digital data.
2. Content creation: The ability to create digital content, such as writing, graphics, and multimedia.
3. Digital collaboration: The ability to work collaboratively with others using digital tools.

Advanced Digital Skills:

Programming and coding, cybersecurity, and data science (World Economic Forum, 2020).

1. Programming and coding: The ability to design, develop, and implement software applications and systems.
2. Cybersecurity: The ability to protect digital systems and networks from cyber threats.
3. Data science: The ability to extract insights and knowledge from large datasets using advanced statistical and computational techniques.

Importance of Digital Skills

Digital skills are essential in today's digital age, as they enable individuals to:

1. Access information: Digital skills allow individuals to access vast amounts of information and knowledge (Castells, 2009).

2. Communicate effectively: Digital skills enable individuals to communicate effectively with others, both personally and professionally (Katz & Krueger, 2016).
3. Participate in the digital economy: Digital skills are necessary for individuals to participate in the digital economy, including online shopping, banking, and entrepreneurship (World Bank, 2016).
4. Enhance employability: Digital skills are highly valued by employers, and having these skills can enhance an individual's employability and career prospects (Bakhshi et al., 2017).

AI in TVET

Artificial Intelligence (AI) refers to the development of computer systems that can perform tasks that typically require human intelligence, such as learning, problem-solving, reasoning, perception, and language understanding (Russell & Norvig, 2010).

Types of AI

1. Narrow AI: Designed to perform a specific task, such as facial recognition or language translation (Kurzweil, 2005).
2. General AI: Possesses human-like cognitive abilities, enabling it to understand, learn, and apply knowledge across various tasks and domains (Kurzweil, 2005).

Applications of AI

1. Healthcare: AI can analyze medical images, diagnose diseases, and develop personalized treatment plans (Esteva et al., 2019).
2. Finance: AI can detect anomalies in financial transactions, predict stock prices, and optimize investment portfolios (Dixon et al., 2020).
3. Transportation: AI can enable self-driving cars to navigate roads,



recognize obstacles, and make decisions in real-time (Ma et al., 2019).

instructors to focus on teaching and mentoring.

Benefits of AI

1. Automation: AI can automate repetitive tasks, freeing up human time for more strategic and creative work (Frey & Osborne, 2017).
2. Improved Decision-Making: AI can analyze vast amounts of data, providing insights and predictions to inform decision-making (Jordan & Mitchell, 2015).

Challenges and Limitations of AI

1. Bias and Fairness: AI systems can perpetuate biases present in the data used to train them, leading to unfair outcomes (Kluwer, 2020).
2. Explainability: AI systems can be difficult to interpret, making it challenging to understand their decision-making processes (Adadi & Berrada, 2018).

AI has the potential to revolutionize TVET by providing personalized learning support, automating assessment and feedback, and enhancing the learning experience. AI-powered systems can also help to identify skills gaps and provide recommendations for improvement (OECD, 2019). Also, AI has the potential to transform TVET (Farias & Rochester, 2019). Some of the ways AI can be integrated in TVET include:

1. Intelligent tutoring systems: AI-powered systems that provide personalized learning support and feedback to students.
2. Virtual reality and simulation: AI-powered virtual reality and simulation environments that mimic real-world scenarios, enabling students to practice and develop skills in a safe and controlled environment.
3. Automated assessment and feedback: AI-powered systems that automate assessment and feedback, freeing up

Modern Economic Diversification through TVET

Modern Economic diversification refers to the process of shifting an economy's focus from a single industry or sector to a variety of industries or sectors. This strategy aims to reduce dependence on one particular source of income, enhance economic resilience, and promote sustainable growth (World Bank, 2020).

Key Aspects of Modern Economic Diversification

1. Reducing Dependency: Decreasing reliance on a single industry to mitigate risks associated with market fluctuations (Auty, 1993).
2. Promoting Innovation: Encouraging the development of new industries and sectors through innovation and entrepreneurship (Schumpeter, 1942).
3. Creating Employment: Generating job opportunities in diverse sectors to reduce unemployment and improve livelihoods (ILO, 2019).
4. Enhancing Competitiveness: Building a more competitive economy by fostering a variety of industries that can adapt to global market demands (Porter, 1990).

TVET plays a critical role in driving economic diversification by equipping individuals with skills tailored to industry needs. The integration of digital skills and AI in TVET can enhance the employability of graduates, improve productivity, and drive innovation (World Bank, 2020).

Benefits of Modern Economic Diversification

1. Increased Resilience: Diversified economies are better equipped to handle economic shocks and external pressures (World Bank, 2020).
2. Job Creation: New industries and sectors create employment

- opportunities, reducing unemployment rates (ILO, 2019).
3. Sustainable Growth: Diversification promotes long-term economic stability and growth by reducing reliance on volatile sectors (IMF, 2019).
 4. Innovation and Competitiveness: Encourages innovation and enhances the economy's ability to compete globally (OECD, 2019).

Challenges in Achieving Modern Economic Diversification

1. Infrastructure Development: Requires investment in infrastructure, such as transportation, energy, and digital networks (World Bank, 2019).
2. Workforce Skills: Developing a skilled workforce capable of adapting to new industries and technologies (OECD, 2019).
3. Policy and Regulation: Effective policies and regulations are needed to support new industries and attract investment (World Bank, 2020).
4. Market Access: Access to domestic and international markets is crucial for the success of diversified industries (WTO, 2020).

Benefits of Digital Skills and AI in TVET

If government can engage and implement action plan on the integration of digital skills and AI in TVET, they can lead to numerous benefits, including improved employability, increased productivity, and innovation (OECD, 2020).

Challenges and Future Directions/ Opportunities

Despite the potential benefits of digital skills and AI in TVET, there are several challenges that need to be addressed, including:

1. Infrastructure and access: Ensuring that TVET institutions have the necessary infrastructure and access to digital technologies.

2. Teacher training: Providing instructors with the necessary training and capacity building opportunities to develop their digital skills and AI competencies.
3. Industry partnerships: Fostering partnerships between industry and TVET institutions to ensure that graduates are equipped with the skills required by industry (World Economic Forum, 2020).
4. Future research should focus on exploring the impact of digital skills and AI on TVET outcomes and identifying effective strategies for implementation.

CONCLUSION

The utilization/integration of digital skills and AI in TVET has the potential to drive economic diversification and growth. By investing in infrastructure and resources, developing teacher training programs, promoting industry partnerships, ensuring equity and access, collaboration between policymakers, educators, and industry stakeholders is crucial to harnessing this potential. Governments can support the effective implementation of digital skills and AI in TVET.

RECOMMENDATIONS

Based on this paper, the following recommendations are made:

1. Integrate digital skills and AI in TVET curricula: TVET programs should be revised to include digital skills and AI competencies.
2. Provide training and capacity building for instructors/teachers: Instructors should be provided with training and capacity building opportunities by the concern authorities.
3. Foster and promote collaboration between industry and TVET institutions: Industry and TVET institutions should collaborate to develop curricula and provide work-based learning opportunities.
4. Ensure equity and access: Efforts should be made by the Nigerian



government to ensure that all students have access to digital skills and AI training, regardless of their background or location.

5. Government should invest in infrastructure and resources development.

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