Theme: INNOVATIONS FOR EDUCATIONAL RESILIENCE

Sub theme: Inspiring innovations

ARTIFICIAL INTELLIGENCE (AI) DRIVEN INTERVENTIONS IN TECHNICAL AND VOCATIONAL EDUCATION AND TRAINING

ABSTRACT

In the last decade the world has witnessed major advancement in science and technology, an industrial revolution of some sort, a truly massive shift that has birthed industry 4.0. This gigantic shift has given rise to a demand for uniquely transformative technical skills, a demand that can only be quenched by a properly developed and correctly implemented quality, industry focused, demand-driven Competency Based Technical and Vocational Training (CBET) program. To ensure immediate and sustainable employability of these Technical and Vocational Education and Training (TVET) graduates, the training curricula must take cognizance of the latest trends in science and technology, such as Artificial Intelligence (AI) that are responsible for the prominent shifts in the labour market and the requisite skill demanded. In education AI has been used to improve administration and to augment teaching and learning. The objective of this study was to identify, analyze and categorize Artificial intelligence (AI) driven interventions currently used in TVET institutions and to determine their effectiveness and cost of implementation. The research was conducted using scoping review methodology, selected since it enabled the researcher to address the broad research question, assess the extent of the available evidence, define eligibility criteria, search the literature, organize it into groups, screen the results and select evidence for inclusion. The JBI manual for evidence synthesis was used in the data extraction and synthesis. And a descriptive summary of the evidence created (charting). A literature search was conducted on the Web of Science for English language peer-reviewed articles related to AI application to TVET institutions. Out of the 380 eligible studies retrieved only 75 were considered based on the inclusion criteria. These articles had been published in **17** different journals. The result identified the most commonly employed AI-driven interventions and gave recommendations necessary to realize the full potential AI in TVET.

Keywords: TVET, artificial intelligence, deep learning, machine learning

1.0 INTRODUCTION

The rapid advancements in science and technology being witnessed globally is largely responsible for the seismic shift in the job landscape. This change is not only disruptive but also non-linear, unpredictable and inevitable (Phelps, Hase, and Ellis,2005). Industry 4.0 is truly transformative and has revolutionized the way companies undertake their processes. It has integrated new technologies such as Internet of Things (IoT), cloud computing, Artificial Intelligence (IA) and machine learning into companies' production facilities and operations.

According to The International Labor Organization (2010) this rapid change is responsible for the prominent shift into the 'modern labor market' with unique technical skills requirement that cannot be imparted using the Traditional Technical and Vocational Education and Training (TVET) models. Hence the need to invest more in the design, development and implementation of quality, industry focused, demand-driven Competency Based Technical and Vocational Training (CBET) programs. The programs must be robust and dynamic enough to infuse the latest trends in science and technology, such as Artificial Intelligence (AI) and Augmented Reality (AR).

1.1 STATEMENT OF PROBLEM

To address the huge and unique technical skill gap created by industry 4.0 revolution, artificial intelligence (AI) has been deployed at various levels of the Competency Based Technical and Vocational Training (CBET) curricula implementation. Whereas, AI offers enormous potential benefits, it also inevitably brings multiple risks and challenges. We therefore conducted a review of AI driven interventions in Technical, Vocational Education and Training (TVET) institutions to deliver industry focused, demand-driven CBET programs.

1.2 OBJECTIVES OF THE STUDY

The objectives of this study were;

- To identify and categorize Artificial intelligence (AI) driven interventions currently used in TVET institutions

- To analyze and to determine the effectiveness of Artificial intelligence (AI) driven interventions currently used in TVET institutions.

1.3 SCOPE OF THE STUDY

The study adopted a scoping review methodology and it was confined to undertaking a literature search on the Web of Science database for English language peer-reviewed articles related to AI application to TVET training and institutions published between January 1, 2018, and December 31, 2021. The database search was supplemented with reference list checks. A thematic analysis and narrative review of AI applications of TVET was conducted.

2.0 LITERATURE REVIEW

Artificial intelligence (AI) has a provides a two-faceted definition and description, as a field and a theory. (Chassignol, 2018). As a field of study, AI is defined as a study area in computer science whose pursuits are aimed at solving different cognitive problems commonly associated with the human intelligence, such as learning, problem solving, and pattern recognition, and subsequently adapting. As a theory, Chassignol (2018) defined AI as a theoretical framework guiding the development and use of computer systems with the capabilities of human beings, more particularly, intelligence and the ability to perform tasks that require human intelligence, including visual perception, speech recognition, decision-making, and translation between languages.

Whereas computers may have formed the basis the development of artificial intelligence, there is a gravitation away from the computer alone, as a matter-of-fact AI is currently platform and software, independent. Embedded computers, sensors, and other emerging technologies have facilitated the transfer of artificial intelligence to machines and other items, such as buildings and robots.

3.0 METHODOLOGY

3.1 Overview

Review of the Artificial intelligence (AI) driven interventions used in TVET programs was explored using a scoping review as guided by the methodology of Arksey and O'Malley (2005) and the researchers created a scoping review protocol to guide the process. The JBI manual for evidence synthesis was used in the data extraction and synthesis. This study adhered to the

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) extension for scoping reviews.

3.2 Search Strategy

The researchers developed a comprehensive search strategy for 3 electronic citation databases: ERIC (ProQuest), Web of Science Core Collection (Clarivate Analytics) and VOCED (research database for technical and vocational education and training, TVET) for publications made between January 1, 2018, and December 31, 2021

The search strategy sought to balance both comprehensiveness with precision. The utilization of both general index terms and free text terms ensured comprehensiveness while precision was achieved by applying adjacency (or proximity) operators to the text word terms so as to restricts results to those where a relational association exists in the title or abstract text. The searches were thereafter checked for sensitivity and relevance and peer reviewed for accuracy and consistency.

3.3 Inclusion and Exclusion Criteria

Articles were determined eligible for inclusion if they discussed the use of Artificial intelligence (AI) in TVET training, including but not limited to use of Artificial intelligence in TVET training, administration and to augment teaching and learning. Articles were included if authors studied or commented on the uses, benefits, challenges or limitations of AI in Education.

All articles published since 2017, including dissertations, conference abstracts, and opinion pieces were included in the study.

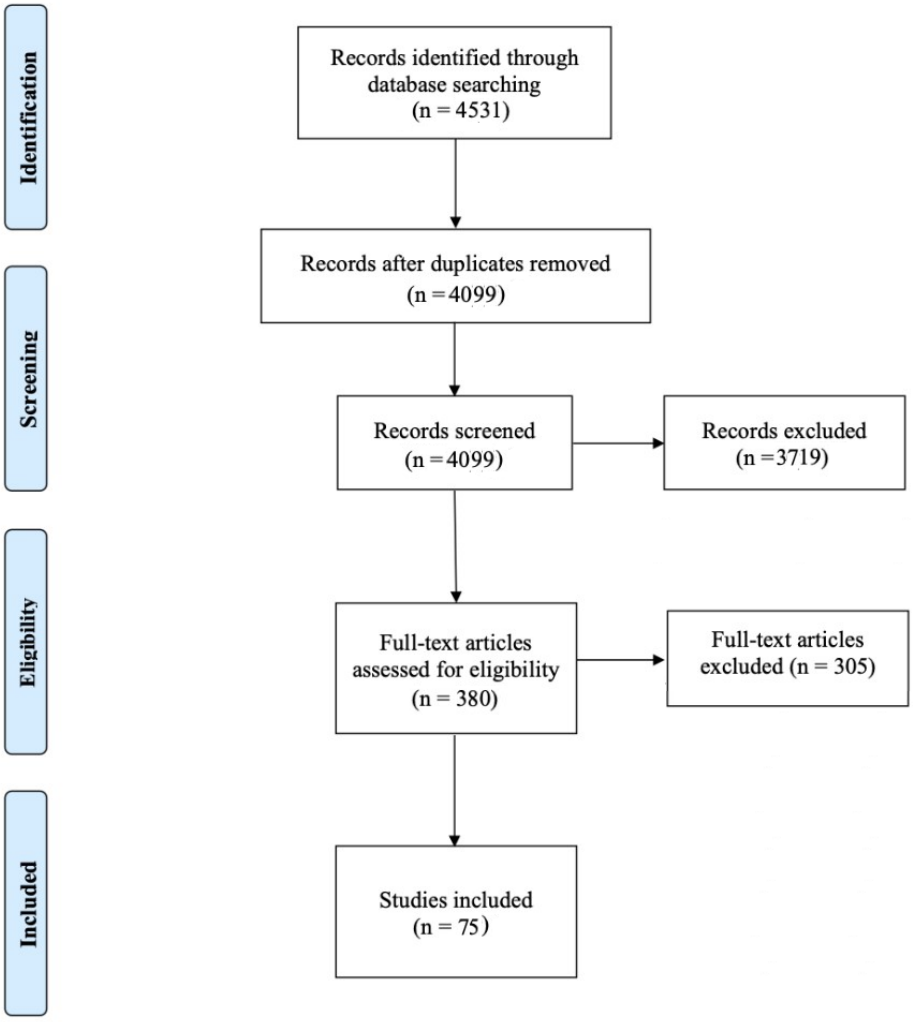
Articles were excluded if they were not written English language or if they focused on the use of Artificial intelligence outside of Education, Training, TVET and research. Systematic reviews, scoping reviews, books, and book chapters were also excluded.

3.4 Data Extraction

The screening process was conducted using the PRISMA extension for scoping reviews. Using Covidence (a web-based software platform that streamlines the production of systematic reviews and other research reviews that require screening citations and full text, assessing risk of bias, or extracting study characteristics and outcomes) the two researchers (KC and EO) screened the titles

and abstracts. All significant data such as year of publication, journal, country of first author, article type, discipline, academic affiliation, area of application and predetermined categories were extracted using a google form specially designed for the extraction purpose.

4.0 RESULTS AND FINDINGS



4.1 Study Selection

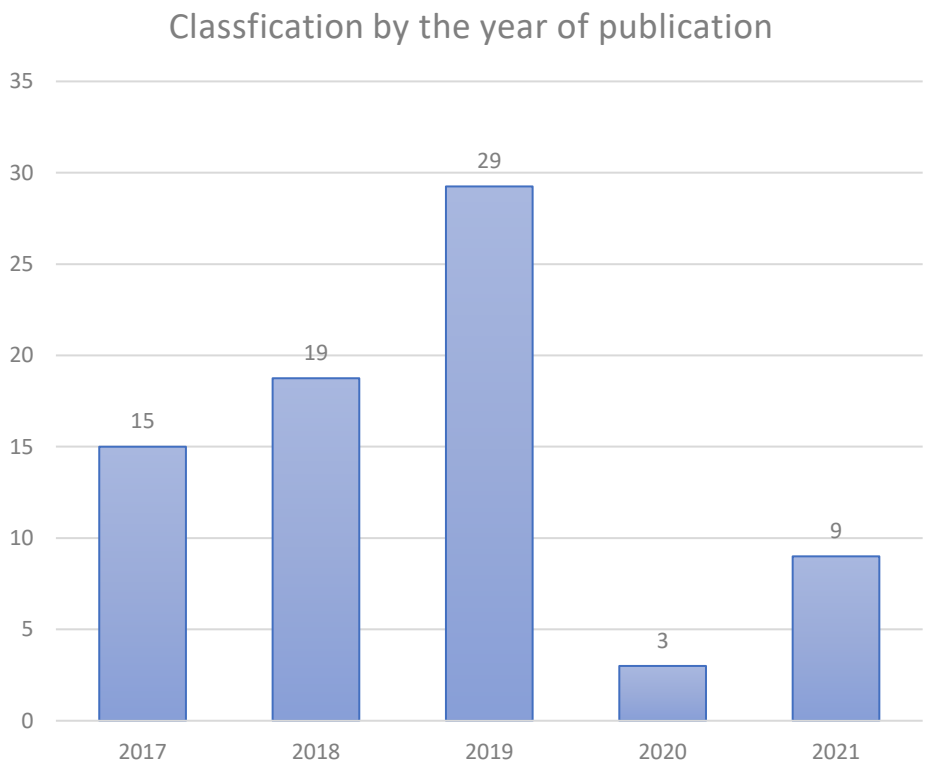
On the initial database search 4531 articles were identified, 4099 were identified after the duplicates were removed. At the title and abstract screening stage, 3719 articles were excluded. A total of 380 articles were screened as full text, and a further 305 articles were excluded based

on the inclusion/exclusion criteria. The researchers then extracted all data from the 75 identified articles.

4.2 Article Characteristics

The study identified 75 unique articles across 17 different journals with most of the articles authored from the United States (41.47%), Britain (24.01%),(India 15.12%), and Australia (7.13%).

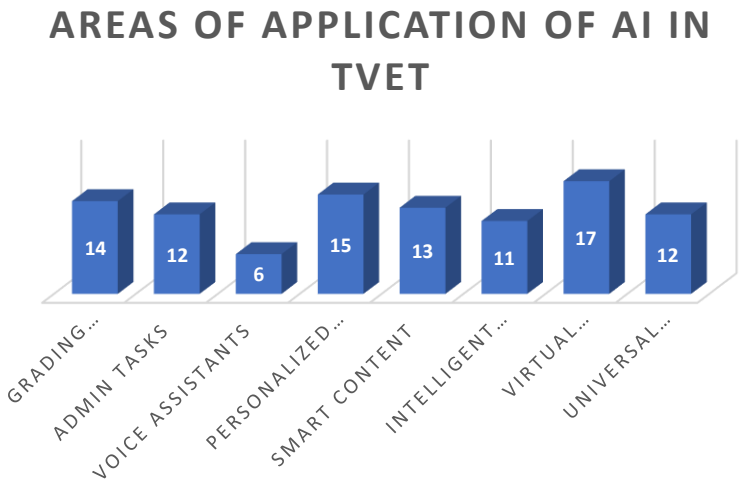
4.3 Year of publication



Of the 75 identified most (39%), of the articles were published in the year 2019, 25% were published in 2018, 20% published in 2017, 4% in 2020 and 12% in 2021.

4.4 Areas of application of AI

Eight areas of application for AI in TVET were identified.



The study identified the most common uses of AI in education. They were identified as Voice assistants (6%), Grading software (14%), Admin tasks (12%), Personalized learning (15%), Smart content (13%), Intelligent tutoring (11%), Virtual learning environment (17%) and Universal access to education (12%)

5.0 DISCUSSION

Results of this scoping review identified the areas of application for AI in TVET training in the 75 articles that met inclusionary criteria and were published between 2017 and 2022.

The vast majority of publications originate from scholars in high-income countries with most of the authors based in the United States, Britain, Australia, or Canada. The possible reason for this publication bias could be the fact that the 1st world countries had a higher percentage of allocation for research and also their English proficiency, this twin factors are associated with a greater likelihood of having publication output in high-ranking peer reviewed journals

5.1 Areas of application for AI in TVET

Grading software

AI-powered grading applications employ algorithms that incorporates machine learning. The algorithm enables the tools to 'learn', understand and replicate the teacher's human grading process by collecting important data on metrics for grading assignments from papers that have been graded by trainer/professors.

The trainer's input plus the AI combination can grade essays, papers and tests in seconds, even in different languages hence are very handy in situations where the number of scripts to be marked is significant.

The systems can also be easily integrated into existing virtual environment or cloud based TVET training platform.

Administration tasks

AI has been extensively employed to automate most of the administration work in training institutions such as schools, colleges and universities. AI tools are capable of performing various functions in an accurate and timely manner. The functions most commonly automated include scheduling, rescheduling classes, marking attendance, grading papers, automation of routine student forms, enrollments, and other paperwork to finance and accounting and record keeping.

This streamline and automation of tasks enables trainers and teachers to focus primarily on improving educational quality instead of manual paperwork and reducing work pressure.

Personalized learning

Through the use of AI tools, trainers are able design tailor-made study schedules and customize learning based on the specific needs of individual learners. It assists the trainers to identify the gaps in knowledge, create instructions, testing and feedback systems for learners from preschool to college. It enables customization of individual lesson plans based on students' individual needs and go a long way in differentiated and adaptive learning that can build a solid foundation for all kinds of learners.

AI-powered software, games and tools enables the trainers to setup a machine-assisted classroom environment with an individualized strategy for the trainees to learn at their speed, time and requirements for repeated practice.

AI based Monitoring and Evaluation tools can streamline the operations of the institution to ensure that its objectives are achieved.

Smart content

AI tool enables the creation of 'smart content' and customized environments for the educational organization based on strategies and specific goals. AI tools has made 'personalization' of training program possible. Augmented Reality (AR) and Virtual reality (VR) based learning environments as well as web-based lessons are the future global trend in TVET training. AI also assist in the development of Resources such as digital textbooks, guides, instructional snippets, videos to accompany learning.

AI powered algorithms can identify the areas that can be improved in the curriculum to fill in the gaps in defective or ineffective content and help teachers correct.

Intelligent tutoring

Intelligent tutoring systems (ITS) based on artificial intelligence are equipped to handle personalized feedback and instructions for one-on-one teaching. This can be a very effective tool in e-learning platforms and could easily solve the major problem that has hindered the successful roll out of e-learning for engineering and technical content. They can be designed to factor in engagement, metrics for grading and comprehension.

Virtual learning environment

AI tools enables the design and implementation of Virtual learning environments that are effective in offering group educational experiences and facilitate an immersive learning experience. VR headsets can further improve the experience by blocking out distractions and increasing attention spans. Additionally, learners can also aid learners in soft skill coaching, life skills, self-development with interactive virtual simulations.

Universal access to education

AI technologies can significantly bridge the boundaries and scale geographical barriers between trainees, trainers and educational administrators. Smart data gathering, individualized schedules, custom tasks, 24/7 access to education can be made possible with AI tools.

AI tool are capable of creating subtitles and language translation hence breaking up the language barrier in training. Most of AI tools and software are plug and play cross-platform system that can be distributed globally to ensure a truly global and universal learning, breaking down silos between traditional educational approaches that are outdated or inadequate.

AI-powered tools paired with the power of cloud integration provide robust training platforms capable of handling large number of trainees and data in real-time, enabling institutions to expad their capacities globally.

Voice assistants

These AI-powered voice assistants can be used in apps and they provide the following benefits in education:

- Efficient saving of time for students and teachers
- Providing community learning opportunities
- Providing personalized education within seconds

5.2 LIMITATIONS OF AI

Whereas, AI offers enormous potential benefits, it also inevitably brings multiple risks and challenges.

Difficult Data Collection

AI needs large amounts of training data to generate accurate predictive algorithms (Santosh, 2019) the acquisition of the required amount of data has both if financial and logistical

implications. Even in cases where the amount of data is sufficiently available the quality of the data may not be high enough hence AI is not infallible

Lack of Multimodal AI Assessments

Many studies used singular data types to perform AI-driven tasks, however decision based on a single data type may be skewed, thus highlighting the need for a multimodal AI framework capable of analyzing different data types.

Inability to Be Used by Laypersons

While the use of AI technology may appear to be simple, the underlying theory and operating mechanisms of these algorithms are often opaque to the untrained layperson for instance a trainer developing some curriculum. Hence to avoid hindering AI's uptake, implementation frameworks need to be designed in a way that make AI easily operable.

Resource requirement

The benefits of AI-based approaches may not be realized in resource-poor settings. Effort is needed to shift the reliance of AI from expensive technologies to cheaper and more readily accessible alternatives

Ethical issues

The use of AI may require access to personal information to generate trends, make predictions, and conduct assessments. The sharing of such information may lead to the infringement of privacy and personal rights. Confidentiality of the data obtained from the public must be assured

5.3 CONCLUSION

AI is no longer new in the field of education; however, it hasn't been fully exploited in the field of TVET. In the face of growing pressure on limited resources and the rapidly changing industrial environment, the use of AI-driven techniques to aid in the design, development and implementation of quality, industry focused, demand-driven Competency Based Technical and Vocational Training (CBET) programs is long overdue. We must to infuse the latest trends in

science and technology, such as Artificial Intelligence (AI) and Augmented Reality (AR) in the delivery of TVET curricula. We hope that our rapid review can help highlight additional areas for more robust AI applications and further studies to overcome the highlighted limitations.

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