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KJ-TVET

The Kenya Journal of Technical and Vocational Education and Training (KJ-TVET), ISSN 2227–5088 is a peer reviewed Journal published by TVET Authority. Technical and Vocational Education and Training Authority is a state corporation established by TVET Act No. 29 of 2013 to regulate and coordinate TVET in Kenya. The Authority was established to address emerging trends and reforms in the TVET sector and provide overall regulatory framework for all TVET providers and promote access, equity, quality and relevance. The mandate of the Authority includes *inter alia,* Advising and making recommendations to the Cabinet Secretary on all matters related to training; Promoting access and relevance of training programmes within the framework of overall national socio-economic development plans and policies; Establishing training system which meets the needs of formal and informal sectors; Collecting, examining and publishing information relating to training; Assuring quality and relevance in programmes of training; and Liaising with the National and County Governments, public and private sector on matters relating to training. In order to effectively achieve these mandates, the Authority requires reliable information for making informed decisions and recommendations. The Authority is committed to promoting TVET research and dissemination of findings through regular knowledge sharing of research findings and annual publication of KJ-TVET.

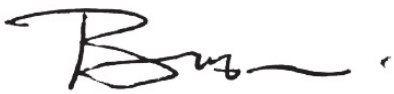
EDITORIAL TEAM

MESSAGE FROM THE CHIEF EDITOR

I take this opportunity on behalf of the KJ-TVET Editorial Board and Secretariat to convey my gratitude to all authors whose manuscripts satisfied the requirements for publication in Vol. 7 of this Journal. I also express my appreciation to all reviewers for meticulously going through the papers and providing appropriate recommendations as well as expert and thought provoking advise to authors on areas of improvement in their papers.

The theme of Vol. 7 of the KJ-TVET was **Global Perspectives of TVET,** while the sub-themes were Greening and digitalization of TVET and lifelong learning; Enablers of a responsive TVET and training subsector; TVET and industrial revolution: Integration of modern technologies in TVET; TVET reforms in Kenya: Impact on sustainable development; TVET funding models; The impact of artificial intelligence on TVET. Although the advert on call for abstracts and papers initially attracted 45 abstracts, only thirteen papers were eventually recommended for publication.

It is envisaged that the findings, conclusions and recommendations presented in the papers published in this Journal shall continually help in building new knowledge or validating existing knowledge and previous research data. The Editorial Board also hopes that the information from this journal will provide a reliable basis for further research, decision making, problem solving and policy formulation in TVET. I hereby invite all researchers in TVET to read the journal and submit their studies to be considered for publication in the subsequent volumes of the journal.



PROF. BONAVENTURE W. KERRE, PhD

CHIEF EDITOR, KENYA JOURNAL OF TVET

1

THE IMPACT OF ARTIFICIAL INTELLIGENCE ON TVET

Adoption of Artificial Intelligence in Technical and Vocational Education and Training Institutions in Kenya.

***Okumu, G. J., & Kenei, J. K.**
Public Service Commission of Kenya

Abstract

The application of Artificial Intelligence (AI) in education and training has attracted many stakeholders, including scholars, government and non-governmental organizations. The main objective of this study was to examine the adoption of AI in Technical and Vocational Education and Training (TVET) institutions in Kenya. The specific objectives were to establish the education level of trainers; determine the status of Information and Communication Technology (ICT) equipment and infrastructure TVET institutions and determine the relationship between availability of ICT infrastructure, staffing levels, and academic qualifications of teaching staff in supporting the adoption of AI in TVET institutions in Kenya. A survey targeting 204 TVET institutions was conducted in all the 47 County Governments between September and December 2023. An online questionnaire was used to collect data from the 204 TVET institutions through the Sogolytics platform. The institutions were given predefined Excel templates to upload data regarding the functionality of ICT equipment and infrastructural tools. A total of 187 institutions responded, representing a response rate of 91.7%. The study further analyzed secondary data and studies on the various applications of AI and their impact on TVET in various jurisdictions. The data collected was analyzed using SPSS Version 27 to calculate descriptive and inferential statistics. The results were presented in frequency tables and percentages. Additionally, bivariate correlation analysis was conducted using Pearson Product Moment Correlation (PPMC) to examine the relationship between the variables, providing valuable insights into the readiness of TVET institutions to embrace AI technology in their training programmes. The study established that the readiness of TVET institutions in adopting AI technology was influenced by factors such as the availability of computer devices, software licenses, network security, and academic qualifications of trainers. Institutions with better technological infrastructure and qualified teaching staff were more likely to succeed in adoption and integration of AI technologies. However, challenges such as lack of a legal policy framework, low investment in AI research, low or poor internet connectivity hindered realization of full potential of AI adoption in TVET institutions. The study proposed recommendations for effective adoption of AI in TVET institutions.

Keywords: Artificial intelligence, machine learning, algorithms, revolutionize TVET.

Introduction

Artificial Intelligence (AI) has been defined by various scholars. Akello (2022) defined AI as the ability of machines to replicate human intelligence and capabilities through learning and automation. The AI technology enables machines to perceive their environment, learn, reason, and, in some instances, take action in response to the environment and the underlying circumstances. The ICT and Digital Policy defines AI as a group of technologies and systems that are linked to deep learning, Natural Language Processing (NLP), and signal recognition that allows computers to interact and learn like human beings (Akello, 2022). The AI readiness index 2021 of the Sub-Saharan Africa region was the lowest globally, with Kenya ranked 78th, after Mauritius, South Africa, and Seychelles

Technical and Vocational Education and Training (TVET) institutions play a significant role in technology diffusion through transfer of knowledge and skills needed for the labour market (Marope, Chakroun & Holmes, 2015). They noted that the integration of AI in TVET has the potential of transforming teaching and learning processes. They concluded that rapid technological progress continues to have significant implications for TVET. Globalization and the Fourth Industrial Revolution have intensified the need for TVET to integrate changing skills requirements in the labour market into the curricula. The future job market is expected to be more machine-powered and data-driven, emphasizing the need for reorganization of the skills ecosystems (Marope *et al*., 2015). The four technological developments that have compelled these changes include AI, High speed mobile internet and automation, the use of Big Data analytics and cloud computing.

The Future of Jobs Report by the World Economic Forum predicted that 75 million jobs worldwide were to be lost by 2020. The report also foresaw the creation of 133 million new jobs that would require new sets of skills in Science Technology Engineering and Mathematics (STEM), data analytics, engineering and computer science. The report further predicted that 52% of jobs in Kenya would be automated. The report concluded that the future jobs would be more power and data driven, hence the need for reorganization and re-orientation of the entire skills eco-system (World Economic Forum, 2020).

In developed countries new ICT approaches have been introduced to modernize administration and finance, including learner records in institutions. However, in developing countries, the access to the internet remains uneven. The percentage of population who have regular access to internet is still relatively low, especially women and people in rural areas (International Telecommunication Union, 2020). In Kenya, AI technology is transforming key sectors such as agriculture, education, health care and government services. The 2021 edition of the Government AI readiness Index ranked Kenya among the top five African countries.

Previous Studies on Impact of AI in Education and Training

Studies by Chen *et al*. (2020), and Bullock (2019) reported valuable insights on the use of AI in various fields such as public administration, healthcare, education, and vocational training. The studies further highlighted the benefits of AI-powered adaptive learning platforms in personalizing instruction and improving learning outcomes in TVET. By tailoring instruction to individual needs, these platforms enhance engagement, motivation, and knowledge acquisition, leading to more effective vocational education and training experiences. A study by Walkington, (2013) on Intelligent Tutoring System (ITS) for secondary mathematics found that personalized instruction based on personal interests led to improved performance and learning outcomes. Additional studies by Weng *et al.,* (2018) and Jantjies *et al.,* (2018) demonstrated the potential of AI technologies, specifically virtual reality and augmented reality, in enhancing learning experiences in TVET.

Studies by Dietzmann and Duan (2022), demonstrated the potential of AI technologies in analyzing large volumes of data and providing insights for informed decision-making in TVET. Further, studies by Razak *et al.,* (2022) demonstrated the role of AI in customizing and optimizing learning content, providing personalized feedback, supporting collaborative learning and enhancing the overall effectiveness of teaching and learning in TVET institutions. Smith and Johnson (2018), Brown and Williams (2020), and Johnson *et al.,* (2019) reported positive effects of assistive technology in education and training. They noted that assistive technology contributes significantly to talent development since it enhances accessibility, learning, and participation in AI-related activities that ultimately lead to improved talent development.

Benefits of adoption of AI

Kibet and Wanyama (2019) established that AI can enhance curriculum delivery by providing customized knowledge and skills to learners. Through analysis of individual student data, AI algorithms can detect the specific needs and learning preferences of each student, allowing for tailored instruction and support, leading to improved student engagement, motivation, and overall learning outcomes. Studies by Mutahi and Wanyama (2020) and Mutahi *et al*., (2018) found that AI-powered tools can collect and analyze data on labour market needs, hence assist curriculum developers to align vocational education programmes with the skills required by industries. They further explained that AI can be used in software such as plagiarism detectors, real-time translation services, and 'smart classrooms', which offer support to students and enable lecturers to monitor trainees' behaviour, leading to improved learning outcomes. They concluded that AI can reduce trainers' administrative workload by assisting with grading and providing feedback on individual tasks.

Kibet and Komen (2020) noted that AI can automate routine tasks, streamline administrative processes like student registration and grading, saving time and reducing errors. A study by Smith *et al.,* (2019) noted that AI can automate repetitive tasks in training, providing immediate feedback to trainees and offering personalized career guidance. These findings demonstrate the significant impact of AI on improving efficiency and enhancing the learning experience. Additionally, Mwenda *et al.,* (2019) demonstrated that AI can help trainers in creating customized instructional materials using NLP algorithms.

Research Objectives

The main objective of this study was to examine the adoption of AI in TVET institutions in Kenya. The specific objectives were to:

i. Establish the education level of teaching staff in TVET institutions in Kenya.
ii. Determine the status of ICT equipment and infrastructure in supporting the adoption of AI in TVET institutions in Kenya.
iii. Determine the relationship between computer devices, network devices and internet connectivity in supporting implementation of AI technology in TVET institutions in Kenya.
iv. Establish the relationship between computer devices, and Software Licenses and Network Security Devices in Implementation of AI Technology in TVET institutions in Kenya.
v. Establish the relationship between computer devices, staffing levels, and academic qualifications of teaching staff in supporting the adoption of AI in TVET Institutions in Kenya.

Methodology

A survey of 204 public TVET institutions was undertaken across all the 47 County Governments. An online questionnaire was used to collect data from the targeted institutions through the Sogolytics platform. Predefined Excel templates were provided for institutions to submit data on functional ICT equipment and infrastructural tools as uploads. The collected data was analyzed using SPSS Version 27. Descriptive and inferential statistics were calculated, and the results were presented in the form of frequency tables and percentages. Bivariate correlation analysis was conducted using Pearson Product Moment Correlation (PPMC) to determine the relationship between the variables, providing insights into the readiness of TVET institutions in adopting AI technology. The study further analyzed secondary data and studies on the various applications of AI and their impact on TVETs in various countries. The studies considered were those that considered the identification, analysis, understanding, and synthesis of the adoption of AI in TVET institutions

Results and Discussions

Response Rate

Out of the 204 institutions that were targeted in this study, 187 responded, representing a response rate of 91.7%. Table 1 shows the distribution of TVET Institutions by category and the response rate.

Table 1

Response Rate

Category	Targeted	Responses	%
National Polytechnics (NPs)	11	10	90.9
Technical & Vocational Colleges	193	177	91.7
Total	**204**	**187**	**91.7**

Distribution of TVET Institutions by Category

The TVET institutions in Kenya are grouped into three categories namely; National Polytechnics (NPs), Technical and Vocational Colleges (TVCs) and Vocational Training Centres (VTCs). This study considered the NPs and TVCs. Table 2 presents the distribution of respondents by category of TVET institutions and Gender.

Table 2

Distribution of Teaching Staff in TVET Institutions by Gender

Category (N=187)	Total No. of Staff	Female	%	Male	%
National Polytechnics (NPs)	1,587	572	36.0	1,015	64.0
Technical & Vocational Colleges (TVCs)	7,859	3,040	38.7	4,819	61.3
Total	**9,446**	**3,612**	**38.2**	**5,834**	**61.8**

It was observed that a total of 9,446 tutors from 187 institutions responded. Among them, 3,612 were female, accounting for 38.2%, while 5,834 were males constituting 61.8% of the total respondents.

Education Level of the Respondents

The study sought to establish the level of education of tutors in TVET Institutions. Table 3 presents the distribution of tutors by category and highest level of education.

Table 3

Level of Education of Respondents by Category of Institutions

	Level of Highest Qualification														
Category (N=187)	Total No. of Teaching Staff	No. of PhD	%	No. of Masters	%	No. of Bachelors	%	Higher Diploma	%	No. of Diploma	%	No. of Certificate	%	No. of Not Stated	%
National Polytechnics	1,587	13	0.8	203	12.8	1,055	66.5	41	2.6	211	13.3	52	3.3	12	0.8
Technical Vocational Colleges (TVCs)	7,859	45	0.6	685	8.7	4,613	58.7	475	6.0	1,753	22.3	250	3.2	38	0.5
Total	9,446	58	0.6	888	9.4	5,668	60.0	516	5.5	1,964	20.8	302	3.2	50	0.5

It was established that 58 (0.6%) tutors held PhDs, 888 (9.4%) had Master's degrees, 5,668 (60.0%) possessed Bachelor's degrees, 516 (5.5%) had Higher Diplomas, 1,964 (20.8%) held Diplomas, 302 (3.2%) possessed Craft Certificates, while 50 (0.5%) did not disclose their qualification. The trainers' education level is a crucial factor in determining adoption of in training. Trainers with higher education qualifications readily appreciate and embrace technology more quickly than those with lower levels of education. Trainers with higher qualifications easily adopt and embrace AI technology due to their better understanding and ability to implement AI technologies.

The fact that over 70% of the tutors possessed a Bachelor's degree and above showed that majority of them could readily adopt and embrace AI technology. A study by Smith *et al*., (2018) established that the ability of teaching staff to comprehend and apply AI technologies in the classroom was positively influenced by a higher level of education. Similarly, Jones and Brown (2019) demonstrated that AI was more likely to be embraced as a tool for enhancing student learning outcomes by trainers with advanced degrees.

ICT Equipment and Infrastructure in TVET Institutions

The study assessed the state of ICT equipment and infrastructure to determine the readiness of the institutions to integrate AI in training. The preparedness of the institutions was assessed by collecting data on the availability and functionality of existing ICT equipment. This included the number of computers, servers, networking devices, and other essential hardware. The study also investigated the availability of internet connectivity devices and the capacity of ICT infrastructure to support AI technology. This involved evaluating the availability of software and applications, as well as necessary software licenses. Table 4 presents the distribution of functional ICT equipment and infrastructure in the institutions.

Table 4

Status of ICT Equipment and Infrastructure in TVET Institutions

Category (N=187)	No. of Institutions	No. of Computer Devices	%	No. of Network & Internet Connectivity Devices	%	No. of Software Licenses & Network Security Devices	%	No. of Teaching Staff	%
National Polytechnics (NPs)	10	4,244	20.1	2,114	34.3	764	33.3	1,587	16.8
Technical Vocational Colleges (TVCs)	177	16,904	79.9	4,045	65.7	1,535	66.7	7,859	83.2
Total	187	21,148	100	6,159	100	2,299	100	9,446	100

The findings revealed that there were 21,148 functional computer devices within the 187 institutions. These devices included 19,005 desktops, 325 iPads/Tablets, and 1,818 laptops. Additionally, there were a total of 2,299 software licenses and network security devices, 6,159 network and internet connectivity devices, and 9,446 teaching staff.

The high number of computing devices, software licenses, network security devices, and network and internet connectivity devices indicated that the institutions had the essential infrastructure to support successful implementation and operation of AI technologies. Furthermore, the high number of qualified trainers showed that there were adequate professionals to effectively implement and manage AI technologies. Generally, the analysis revealed that the TVET institutions were well equipped to integrate AI into their curriculum and provide students with the requisite skills and knowledge. The findings from this study were consistent with that of Smith *et al*., (2019), which established that there was a significant correlation between the quality of technological infrastructure in educational institutions and student performance. The findings suggested that institutions with better technological infrastructure tend to achieve higher student outcomes.

Readiness of TVET Institutions in Adoption of AI Technology

The parameters that were considered in assessing the readiness of institutions to embrace AI technology included availability of functional computer devices, presence of network and internet connectivity devices, accessibility of network security and software licenses, staffing levels of tutors and the educational qualifications of tutors.

Relationship between Computer Devices and Level of Network & Internet Connectivity Devices in TVET Institutions

The Pearson Correlation Analysis was used to establish the relationship between existence of functional computer devices and internet connectivity devices. The results are presented in Table 5.

Table 5

Correlation analysis between Computer Devices and Network & Internet Connectivity Devices in TVET institutions

Correlations			
		Computer Devices	Network & Internet Connectivity Devices
Computer Devices	Pearson Correlation	1	0.574**
	Sig. *(2-tailed)*		0.000
	N	187	187
Network & Internet Connectivity Devices	Pearson Correlation	0.574**	1
	Sig. *(2-tailed)*	0.000	
	N	187	187

***. Correlation is significant at the 0.01 level (2-tailed).*

The Pearson Correlation Analysis revealed a moderate positive relationship between computer devices and internet connectivity devices ($r = 0.574$, $n=187$, $p < 0.01$). The p-value < 0.001 was less than 0.05, and thus statistically significant at 95% confidence level. This showed that TVET institutions with more functional computer devices are likely to have better network and internet connectivity. This relationship is important for the adoption of AI technology since AI relies heavily on access to computer networks and the internet for data processing, analysis, and communication.

A study conducted by Smith *et al.,* (2018) on the influence of technology infrastructure on the integration of AI in educational institutions established that institutions with improved access to computer devices were more likely to embrace AI technologies in their classrooms. Additionally, schools that integrated AI into their curriculum witnessed increased student engagement and academic success. This highlights the positive impact of improving computer devices in schools and adoption and efficacy of AI technologies in education. Similarly, a study conducted by Jones and Brown (2019) to explore the impact of computer and network resources on the integration of AI into the TVET curriculum revealed a significant correlation between the availability of the resources and the integration of AI. Institutions with greater access to computer and network resources were more inclined to incorporate AI into their curriculum.

Relationship between Computer Devices, Software Licenses and Network Security Devices in TVET Institutions

The study investigated the relationship between the availability of computer devices, software licenses and network security devices in TVET institutions. This was achieved by conducting a correlation analysis between the variables. Table 6 presents the correlation results between the variables.

Table 6

Correlation analysis between Computer Devices, Software Licenses and Network Security Devices in TVET Institutions

Correlations			
		Computer Devices	Software Licenses & Network Security Devices
Computer Devices	Pearson Correlation	1	0.531**
	Sig. *(2-tailed)*		0.000
	N	187	187
Software Licenses & Network Security Devices	Pearson Correlation	0.531**	1
	Sig. *(2-tailed)*	0.000	
	N	187	187

***. Correlation is significant at the 0.01 level (2-tailed).*

The analysis revealed that there was a moderate positive correlation between Computer Devices, Software Licenses and Network Security Devices ($r = 0.531$, $=187$, $p < 0.01$). The p-value < .001 was less than .05, and hence statistically significant at 95% confidence level. This finding showed that having adequate computer devices was associated with the availability of necessary software and security measures, which were essential for the successful implementation of AI. Acquisition of software licenses was essential for TVET institutions since it allowed them to legally utilize AI software applications. Non-availability of software licenses would limit the institutions from fully exploiting AI technology. Further, Network security devices safeguard the data and information stored and processed by AI systems. These security devices also protect against cyber threats and ensure the privacy and security of sensitive data. A secure network infrastructure is therefore essential for successful implementation of AI technology in training.

A study by Smith *et al*., (2019), established that the level of software licenses and network security devices in organizations significantly affect the successful adoption of AI technology. Institutions with valid software licenses and robust network security measures can effectively implement and utilize AI technology, while those lacking in these areas faced challenges and security risks.

Another study by Wang *et al*., (2019) emphasized the significance of having essential computer devices, software licenses, and network security devices to facilitate the integration of AI technology. Additionally, Smith *et al*., (2020) established that institutions with strong network security systems were more successful in implementing AI technology.

Relationship between Computer Devices and level of Teaching Staff in TVET Institutions

The study examined the correlation between the availability of computer devices and staffing levels of tutors and the extent to which it could support the adoption of AI in TVET institutions. A correlation analysis was done to establish the relationships between the variables of interest and results obtained were as presented in Table 7.

Table 7

Correlation analysis between Computer Devices and Tutors Staffing Levels in TVET institutions

Correlations			
		Computer Devices	No. of Teaching Staff
Computer Devices	Pearson Correlation	1	.835**
	Sig. (2-tailed)		.000
	N	187	187
No. of Teaching Staff	Pearson Correlation	.835**	1
	Sig. (2-tailed)	.000	
	N	187	187

***. Correlation is significant at the 0.01 level (2-tailed).*

The results indicated a strong positive correlation between computer devices and the number of trainers, ($r = 0.835$, $n=187$, $p < 0.01$). The p-value < 0.001 was less than 0.05, and therefore statistically significant at 95% confidence level. This revealed a significant relationship between the availability of computer devices and the number of trainers in TVET institutions. The availability of adequate computer devices and trainers plays a crucial role in accelerating the adoption of AI in TVET institutions. With sufficient computer devices, students could access and utilize AI technologies for their learning. Additionally, having an adequate number of knowledgeable and skilled trainers in AI would enable effective instruction and guidance to students. The findings were consistent with that from a study by Johnson *et al.,* (2019) who established that a combination of sufficient computer devices and teaching staff improved the outcomes of AI interventions in education. This study therefore reinforced the importance of both variables in enhancing the integration of AI in TVET institutions.

Relationship between Computer Devices and Academic Qualifications of Trainers in TVET institutions

The study sought to establish the linkage between computer devices and trainers' academic qualifications on adoption of AI technology in TVET institutions. A correlational analysis was performed to establish the relationship and results are presented in Table 8.

Table 8

Correlation analysis between Computer Devices and Academic Qualifications of Tutors in TVET Institutions

Correlations				
N=187		Computer Devices	Masters, PhDs & Bachelors	Certificates & Diplomas
Computer Devices	Pearson Correlation	1	.814**	.677**
	Sig. (2-tailed)		.000	.000
	N	187	187	187
Masters, PhDs & Bachelors	Pearson Correlation	.814**	1	.664**
	Sig. (2-tailed)	.000		.000
	N	187	187	187
Certificates & Diplomas	Pearson Correlation	.677**	.664**	1
	Sig. (2-tailed)	.000	.000	
	N	187	187	187

***. Correlation is significant at the 0.01 level (2-tailed).*

The analysis revealed a strong positive correlation between availability of computer devices and academic qualifications of teaching staff; Masters, PhDs and Bachelors ($r = 0.978$, $p < 0.01$), and Certificates & Diplomas ($r = 0.804$, $p < 0.01$). The computed p-values < 0.001 was less than 0.05, and thus statistically significant at 95% confidence level. The finding showed that TVET institutions with a higher number of teaching staff were more likely to be prepared and adopt AI. The presence of qualified teaching staff, with higher academic qualifications is therefore crucial for effective integration of AI into the curriculum and training programmes. This finding was consistent with the study conducted by Johnson and Brown (2019) which noted that institutions with higher numbers of teaching staff with advanced degrees were more likely to embrace AI technologies. Another study by Smith *et al.,* (2018) established that teaching staff with higher levels of academic qualifications in technology-related fields were more likely to incorporate AI technology into their teaching practices. Similarly, a study by Koc & Liu (2019) established a positive correlation between the academic qualification of teaching staff and their willingness to adopt AI technology in education.

The research also revealed that teaching staff with higher academic qualifications were more inclined to accept and proficiently utilize AI technology in their teaching methods. The analysis of secondary data on the readiness of a country to adopt AI revealed that development of AI was derailed by lack of legal framework governing AI and low investment by the respective government in AI research. Low investment in AI research reduced the opportunity to design AI solutions that meet the most pressing needs. Additionally, the benefits of AI could be fully realized through improved broadband internet connectivity which still remained a major setback in many parts of the country. According to the Global System for Mobile Communications Association (GSMA) state of mobile internet connectivity 2021 report, only 37% of Kenya's population was connected to the internet, with a major gap seen in rural and urban areas.

The number of people and TVET institutions not connected to the internet remained high. Connectivity gap was caused by several factors including high cost of the internet and mobile devices, low levels of digital literacy and lack of infrastructure. Further, Akello, (2022) explained that AI applications depends on the existence of massive databases of coded material for training machines, hence limiting its applicability in sectors that do not have access to such data sources. She observed that Kenya lacks data that could be used to train AI algorithms that makes AI systems ineffective and useless in some cases.

Conclusions and Recommendations

Conclusions

Globalization and the Fourth Industrial Revolution has intensified the need for TVET to adapt to changing skills requirements and reorganization of the skills ecosystems. The integration of AI in TVET institutions has the potential of revolutionizing teaching and learning processes. The study established that the readiness of TVET institutions in adopting AI technology was influenced by factors such as availability of computer devices, software licenses, network security, teaching staff levels, and academic qualifications of tutors. Institutions with better technological infrastructure and qualified teaching staff were more likely to successfully adopt and integrate AI technologies. However, challenges such as lack of a legal policy framework, low investment in AI research, low internet connectivity, and data availability hindered the full potential of AI adoption in TVET institutions in Kenya.

Recommendations

Based on the findings from this study, the integration of AI in TVET can be greatly enhanced through implementation of the following recommendations:

i. The Ministry of ICT and key stakeholders in TVET to develop a legal framework for adoption and mainstreaming of AI in training;

ii. All approved TVET trainer colleges to review their curriculum and incorporate competences for AI;

iii. The Ministry of ICT to enhance internet connectivity and access to technology in all TVET institutions to facilitate the adoption and use of AI;

iv. The Ministry of Education to develop policy framework for collaboration between TVET institutions and various stakeholders to develop/review the curricula to include the use of AI in different occupations and support integration of AI technologies in training;

v. The Ministry of ICT and Education to invest in AI research to enhance innovation and development of AI solutions that meet societal needs;

vi. The TVET Authority to enforce regular continuous professional development for retooling all trainers on AI;

vii. The TVET institutions to digitize all records kept in hard copy and create relevant data for development of AI systems.

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The Impact of Artificial Intelligence on the Future of Technical and Vocational Education and Training (TVET) in Bungoma County: A Stakeholder Analysis

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Abstract

Technical and vocational education and training (TVET) is crucial in Kenya's training and education system since it equips trainees with essential skills for employment. The advent of Artificial Intelligence (AI) holds the promise of revolutionizing TVET in Kenya by enabling personalized learning experiences, improving outcomes, and aligning training with industry needs. However, integrating AI in TVET raises concerns about job displacement, data privacy, and equity. This study aimed at evaluating the impact of AI on the future of TVET in Bungoma County, Kenya. It focused on trainers' and trainees' perceptions, AI implementation levels, and its effect on quality of skill development. A descriptive research design was employed that involved collection of data through questionnaires and interviews from 400 students, 100 trainers, Deputy Principals, and Human Resource Managers. The findings indicated the existence of gaps in trainers' confidence and proficiency in effectively utilizing AI technologies, leading to suboptimal implementation levels due to challenges such as inadequate infrastructure and unprepared trainers. The study also noted the importance of intensifying efforts to promote and integrate AI technology into training programs to enhance training quality. The study recommended implementation of targeted training programs to enhance understanding of AI, provision of continuous professional development on digital skills, and raising awareness on the significance of AI in TVET, adequate budgetary allocation for digital resources, strategic AI integration planning, ongoing support for trainers, and collaboration with industry stakeholders in order to harness AI's potential in TVET and align it with industry demands.

Keywords: Artificial intelligence, stakeholders' analysis, TVET

Introduction

Technical and Vocational Education and Training (TVET) plays a crucial role in the education system in many countries, such as Kenya (Billett, 2009). The TVET programs offer numerous benefits, such as emphasizing practical skills, aligning with industry needs, and taking shorter duration, providing flexibility, addressing skills shortages, promoting entrepreneurship, highlighting lifelong learning (Sharma, 2017). Technical and Vocational Education and Training contributes to sustainable development by fostering employment, decent work, and lifelong learning (Shiohira, 2021). The effectiveness of a TVET system depends on its connections and relevance to the labour market. By ensuring that TVET institutions are closely linked to industry needs, individuals can be equipped with the necessary skills to enhance employability and meet the evolving demands of the job market. According to Preckler, Galguera, & Preckler (2018), TVET is an integral part of a lifelong learning pathway that encompasses secondary, post-secondary, and tertiary levels, including work-based education and professional development.

Despite the great benefits of TVET, the rapid technological advancements pose a challenge to the relevance of TVET programs. The rapid shift in technology makes it harder to predict future skills needed in the workforce (Autor, 2015). However, the integration of Artificial Intelligence (AI) into TVET has proven to be beneficial in embracing these changes. Countries like Singapore, Germany, China, and Canada have successfully integrated AI into their TVET programs, improving education quality, offering personalized learning, and aligning training with industry requirements (Pedro *et al*, 2019). This adaptation is crucial for TVET institutions to stay relevant and meet the evolving skill demands of the job market.

The impact of Artificial Intelligence (AI) on education and the labour market is profound. It is not only revolutionizing teaching and learning methods but also transforming various sectors such as labour markets, industrial services, agriculture, value chains, and workplace organization (Li, 2022). The labour market is experiencing a shift towards high-skilled and low-skilled jobs, leading to a divide in skills. There is a growing demand for new skills among workers with intermediate skills, while routine tasks are being automated, especially in middle-skill jobs where machines can replicate predictable tasks (Smith, 2016). The transformation of mid-level workforce skills will involve incorporating digital and transversal skills. Automation poses a significant risk in developed countries, but it is even more pronounced in some developing regions where routine tasks are prevalent. Currently, 82% of middle-skill jobs require digital skills that are associated with higher pay and better career opportunities (Egana del Sol & Joyce, 2020).

Digital competence is a multifaceted issue, as demonstrated by the UNESCO definition of digital literacy (Bravo *et al.,* 2021). It encompasses the ability to safely and appropriately access, manage, understand, integrate, communicate, evaluate, and create information through digital devices and networked technologies for active participation in economic and social life (Ala-Mutka, 2011). In light of this, countries with emerging economies like Kenya are encouraged to respond rapidly to digital proliferation and uncertain environmental and social changes by reforming their TVET systems. One crucial reform is providing TVET staff with access to professional development opportunities to enhance their competencies and incorporate modern teaching methods and assistive technologies in the classroom. To remain relevant and attractive to learners, TVET trainers need to understand the application of digital technologies, including AI, robotics, 3D technologies, and augmented and virtual reality (Grech & Camilleri, 2020).

A review, conducted by various authors, highlights the transformative potential of AI in TVET, including personalized learning experiences, enhanced teaching effectiveness, and improved student engagement. Several studies, such as those by Zhang *et al.,* (2021), Topolovec-Vranic *et al.,* (2018), Lee *et al.,* (2019), and Johnson *et al.,* (2021), demonstrated the positive impact of AI integration in various fields, such as automotive engineering, healthcare education, language learning, and STEM education.

According to Egana del Sol and Joyce (2020), digital skills serve three main functions for middle-skill job seekers; providing access to the job market, offering opportunities for career progression without advanced education, and advancement in sectors like retail, construction, production, and maintenance by defining domain-specific competencies for specialized roles, such as healthcare jobs that rely on specific digital knowledge. It is on this basis that digital skills have become a basic requirement for middle-skill jobs across various sectors, where AI is expected to further integrate AI-related skills in occupations. Therefore, TVET systems worldwide should adapt to the changing landscape by equipping the workforce with digital and transversal skills, which are essential for adapting to changes, identifying career pathways, and exploiting opportunities.

In response to the changing demands of work, TVET systems should reassess the structure and scheduling of vocational education programs to enhance flexibility and prioritize the acquisition of new skills needed for emerging forms of work. Incorporating AI can boost agility by analyzing the external landscape and utilizing real-time data on job openings, skill demands, and evolving employment patterns to make informed decisions and develop training content effectively.

However, challenges such as limited infrastructure, lack of expertise among instructors and administrators, and resistance to change need to be addressed (Liu *et al.,* 2023). Overcoming these barriers requires careful planning, investment in resources and training programs, and fostering a culture of innovation. Stakeholder readiness is also crucial for successful AI integration in TVET.

As a significant driver of change, it is crucial to deepen our understanding of the impact of AI on labour markets and, consequently, on TVET systems (Chanda, 2023). In some middle- and higher-income societies, artificial intelligence is already deeply ingrained in legislation, governance, policies, state expenditures, the private sector, and national economies (Casares, 2018). In these instances, TVET institutions are observing the decline of intermediate-level skills and the direct integration of AI into education and training. On the other hand, many TVET institutions have yet to develop meaningful or robust responses to technological advancements. Irrespective of the context, all TVET institutions should foster an awareness of the present and future importance of AI and start integrating its use into their strategic planning. Proactive and forward-thinking measures will position TVET institutions and their graduates to excel in the era of AI and contribute positively to economic, social, and individual development.

Statement of the Problem

The integration of AI into TVET holds significant promise for transforming skills training by enabling personalized learning experiences, adaptive curriculum design, real-time feedback mechanisms, and innovative teaching methodologies tailored to learners' specific needs. However, the successful integration of AI in training programs like TVET requires a thorough understanding of stakeholders' awareness and comprehension levels regarding AI. Educators, administrators, industry partners, and students must be well-informed and prepared to embrace the potential benefits and challenges associated with AI integration to ensure its effective adoption in enhancing the quality of the training process.

The high youth unemployment rate and heavy reliance on agriculture in Bungoma County, combined with a lack of information on the current level of AI implementation in the training process, provided a strong rationale for exploring AI's potential in addressing these critical issues. The unique socio-economic context of the region made it an ideal setting for investigating the impact of AI on the future of TVET, with potential implications for local and broader educational and economic development initiatives. This study sought to determine the impact of Artificial Intelligence on the future of TVET in Bungoma County and how it was impacting on quality of TVET by undertaking a stakeholder analysis.

Objectives of the Study

The study sought to address the following specific objectives:

i. To establish trainers' ratings on the importance of AI in TVET in Bungoma County;

ii. Examine the extent of implementation of AI in TVET institutions in Bungoma County;

iii. To evaluate the effect of integration of AI in TVET on quality of skill development in Bungoma County.

Methodology

The study adopted a descriptive research design and targeted a total of 17,125 respondents. This included 16,553 trainees, 566 trainers, and 4 Deputy Principals in Charge of Academics (DPAC) from four TVET institutions in Bungoma County. Additionally, three Human Resource Managers (HRM) from major industries that offer practicum or employment opportunities to TVET trainees and graduates were included. The actual sample of respondents consisted of 400 trainees, 100 trainers (17% of the total), 4 DPAC, and 3 HRM, making a total of 509 respondents. The institutions, DPAC, and HRM were selected using purposive sampling; while trainees and trainers were selected using proportionate and simple random sampling techniques. Data collection involved the use of questionnaires and interviews. The trainees' respondents were chosen using the formula by Chepkoech, Khatete, & Wanjala (2021) at 95% confidence level p= 0.05 as follows:

$n= (N/ (1+N (\varepsilon)^2)$

Where; n = the sample size, ε= the acceptance sampling error

Both the initial goal, which aimed at determining the importance of AI in training according to trainers and assessing the level of AI implementation at educational institutions, were analyzed descriptively using mean and standard deviation. This analysis was based on the positive statements rated on a Likert scale. The final objective, which aimed at evaluating the impact of AI implementation in TVET institutions on the quality of skill development, was analyzed through inferential methods. This included conducting correlations among variables based on the positive statements rated by trainees in the second objective to determine the influence of AI implementation in TVET institutions on the quality of skill development.

Results and Discussions

This section presents the analyzed outcomes of the study in relation to the research questions and/or objectives. It provides interpretation of the data, discusses the significance of the results and compares them with existing literature.

Response Rate

A total of 500 questionnaires were dispersed to 400 Trainees and 100 trainers out of which 352 Trainees and 77 trainers returned. The responses were as shown in Table 1.

Table 1

Questionnaire Return Rate

Respondent Category	No Dispatched	No Returned	Percentage Response
Trainees	400	352	88
Trainers	100	77	77
Total	500	429	85.8

As revealed in table 3.1, the response rate stood at 88% for trainees and 77% for trainers. The overall response rate stood 85.8 percent. Chepkoech, Khatete, & Wanjala (2021) stated that a response rate of 70 percent or above is deemed excellent for conducting a thorough and detailed survey analysis.

Demographic Characteristics of the Respondents

Demographic information was sought from the Trainees and trainers in terms of their gender. This segmentation offered the researcher useful insights on the disaggregated data. The reason for seeking the gender of the respondents was to evaluate whether gender parity was achieved among the respondents. The findings are presented in Table 2.

Table 2

Gender of Respondents

	DPAC		Trainers		Trainees	
Gender		**Percentage**		**Percentage**		**Percentage**
Male	3	75	45	58.4	198	56.25
Female	1	25	32	41.56	154	43.75
Total	**10**	**100**	**77**	**100**	**352**	**100**

The findings in Table 2 revealed that the government's gender mainstreaming requirements had been achieved in the institutions for both the trainers and trainees, since the gender representation met the required minimum of 30 percent (RoK, 2010). However, the appointment of DPAC did not adhere to the gender mainstreaming rule. This could be attributed to the fact that the DPAC were mainly selected based on academic qualifications and experience, rather than consideration of gender factor.

Data analysis

This section analysed the data of the three variables examined to determine the Impact of Artificial Intelligence on the Future of Technical and Vocational Education and Training (TVET) in Bungoma County: A Stakeholder Analysis. The analysis is structured around the study objectives focusing on trainers' perceptions of the importance of AI in TVET in Bungoma, the level of AI implementation in TVET institutions, and the impact of AI implementation on the quality of skill development.

Table 3

Descriptive Statistics of Trainers Response on Importance of AI in Training

Variable Statement	N	Mean	Std
I understand what AI is and how it works.	77	2.4545	1.27264
I believe that AI can improve the quality of training in my field of study.	77	2.3896	1.16026
I am aware of the potential applications of AI in various industries.	77	2.2987	1.14782
I am interested in learning more about AI and its applications.	77	2.0909	1.26888
I believe that AI will have a significant impact on the job market in the future.	77	1.9740	.98641
I think that it is important for students to learn about AI as part of their education.	77	2.2857	1.15687
I feel confident in my ability to work with AI technologies.	77	3.2727	1.22083
I think that AI will change the way we live and work in the future.	77	2.0130	1.05747
I am excited about the possibilities that AI can bring to my field of study	77	2.3636	1.22377

The findings in Table 3 provide descriptive statistics for the scores of positive statements related to AI and TVET, as rated by trainers on a Likert scale. The results showed that the mean scores for all statements, except for trainers' confidence in working with AI technologies, were below 2.5. The variable measuring trainers' confidence had a mean score of 3.2727.

Based on these findings, it can be reasonably concluded that trainers generally agreed on the importance of AI in TVET. However, their confidence in working with AI technologies was relatively low. This suggests that the majority of trainers lacked confidence and preparedness in terms of their digital competen-

cies, especially in working with AI technologies. The findings are similar to qualitative data captured from HRM as industry players who affirmed that TVET graduates had low confidence in working with AI technology and meeting industrial demands.

These results highlight the need for targeted interventions to enhance trainers' digital skills and build their confidence in utilizing AI technologies in TVET. Providing training programs and continuous professional development opportunities focused on AI integration can help trainers develop the necessary competencies and improve their confidence in utilizing AI in training.

Table 4

Extent of Implementation of AI at Study Institutions

Variable Statement	N	Mean	Std. Dev.
I believe that AI can improve the quality of training in my field of study.	352	2.4396	1.2126
Majority of trainers have developed AI-based assessment tools which have been used to evaluate trainees' progress or performance	352	4.3263	.61201
Chatbots or virtual assistants have been implemented to provide support or answer trainees' questions as part of training	352	3.5385	1.18264
Majority of trainers have used AI to personalize or adapt the training content based on individual trainee needs	352	3.6434	1.06827
AI has improved the training experience for majority trainees	352	3.2448	1.43170
Our institution has AI-powered tools or software that used that used in learning	352	4.0956	1.03115
Majority of Trainers have integrated AI into the curriculum or training materials	352	3.8019	1.06578

Based on the data presented in Table 4, there is a shared perspective between trainers and trainees that the integration of AI in TVET training could improve the quality of training. The average agreement level for this notion was 2.4396, with a standard deviation of 1.2126, indicating some variation in responses. These quantitative results align with qualitative insights from interviews, which highlighted the positive impact of AI on TVET training quality.However, when evaluating the actual implementation of AI based on training indicators, the average agreement scores were below 3.2.

This observation was consistent across all DPAC respondents. The concerns regarding the challenges hindering effective AI integration in TVET institutions were best captured by one DPA who had this to say:

-----though AI can play a key role in the training process, the state in TVET institutions cannot allow effective institutions of the same, a situation that is linked to the state of digital infrastructure, inadequacy, and ill-prepared trainers and over-reliance on government funding whose flow can be termed as "epileptic". As an institution, we majorly rely on trainers engaged by Bog. With such a high number of BoG trainers, investing in the same in terms of capacity building may be uneconomical due to the high level of turnover. The situation is worsened in view of the fact that of lack of policy and strategic plan on AI integration in training.

These findings collectively suggested low level of AI implementation in TVET within the institutions. The disparity between the perceived potential benefits of AI in training and the actual implementation challenges underscores the need to address key issues such as infrastructure development, trainer readiness, and sustainable funding mechanisms to realize the full potential of AI in enhancing quality of training in TVET.

Table 5

Correlation between Implementation of AI and Quality of Training

Variable Statement		X1	X2	X3	X4	X5	X6
Majority of trainers have developed AI-based assessment tools which have been used to evaluate trainees' progress or performance (X1)	Pearson Correlation	1					
	Sig. (2-tailed)						
	N	429					
Chatbots or virtual assistants have been implemented to provide support or answer trainees' questions as part of training (X2)	Pearson Correlation	.086	1				
	Sig. (2-tailed)	.075					
	N	429	429				
Majority of trainers have AI used to personalize or adapt the training content based on individual trainee needs (X3)	Pearson Correlation	.035	.041	1			
	Sig. (2-tailed)	.463	.392				
	N	429	429	429			

Variable Statement		X1	X2	X3	X4	X5	X6
AI has improved the training experience for majority trainees (X4)	Pearson Correlation	-.065	.032	.205**	1		
	Sig. (2-tailed)	.181	.504	.000			
	N	429	429	429	429		
Our institution has AI-powered tools or software that used that used in learning (X4)	Pearson Correlation	.099*	.032	-.024	.467**	1	
	Sig. (2-tailed)	.041	.503	.618	.000		
	N	429	429	429	429	429	
Majority of Trainers have integrated AI into the curriculum or training materials (X5	Pearson Correlation	-.033	.063	.268**	.715**	.455**	1
	Sig. (2-tailed)	.493	.196	.000	.000	.000	
	N	429	429	429	429	429	429
AI can improve the quality of training in my field of study (X6)	Pearson Correlation	.351**	-.148	.262*	.132	.369**	.215
	Sig. (2-tailed)	.002	.200	.021	.251	.001	.060
	N	429	429	429	429	429	

Based on the correlation results presented in Table 5, there is a weak to moderate relationship between the variables representing AI influencers in the training process (X1, X2, X3, X4, and X5) and quality training (X6). The correlation coefficients range from 0.132 to a maximum of 0.369. The findings indicated that while both trainers and trainees recognize the potential benefits of AI in improving training quality, a significant gap still exist in the actual implementation of AI in TVET programs. This highlights the need to increase efforts in promoting and integrating AI technology in training schemes to improve training quality and leverage the benefits that accrue from the effective utilization of AI.

Conclusions and Recommendations

Conclusion

The study findings revealed the perceptions and realities surrounding integration of Artificial Intelligence (AI) in Technical and Vocational Education and Training (TVET) programs. It was noted that although trainers recognize the significance of AI in TVET, they demonstrate lower confidence levels in utilizing AI technologies. This underscores a critical gap in their digital skills and hence the need for targeted interventions to boost their proficiency and confidence in effectively applying AI in vocational training.Moreover, while there is a shared agreement among trainers and trainees regarding the potential advantages of AI in enhancing training quality, the actual implementation of AI in TVET institutions falls below optimal levels.

Challenges such as inadequate infrastructure, unprepared trainers, and inconsistent government funding highlight the need to address key issues to fully harness AI's potential in improving the quality of TVET training.

The correlation findings indicated a weak to moderate relationship between various AI elements in the training process and training quality. Despite recognizing AI's benefits, there is a significant gap in AI implementation in TVET programs. This underscores the need to intensify efforts in promoting and integrating AI technology into training programs to bridge this implementation gap and fully exploit AI's advantages in enhancing training quality-considering the above conclusion and the following objectives.

Recommendations

Targeted training programs and workshops should be undertaken to enhance trainers' understanding and confidence in utilizing AI technologies as well as continuous professional development opportunities focusing on AI integration as a way of bridging digital skills among trainers and increasing their awareness of the importance of AI in TVET. There is a need to ensure adequate budgetary allocation to promote the acquisition of digital resources to support effective implementation of AI in addition to supporting trainers. This should be guided by a strategic plan for AI integration, in vocational training programs. As a way of enhancing the challenge of quality, there is a need to address the identified gaps in AI implementation by providing ongoing support for trainers, updating the curriculum to include AI-related skills, and collaborating with industry players to fully harness AI's potential in TVET in alignment with industry demands as well continuous monitoring and evaluation of the AI implementation programs.

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Embedding Artificial Intelligence in Skills Development in Kenyan TVET Institutions

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Abstract

In the new era of Artificial Intelligence (AI), intermediate-skill jobs are disappearing as tasks become more systematically automated, and individuals are increasingly more likely to encounter AI technology in their day-to-day activities. Approximately 50% of organisations worldwide already use some form of AI in their operations. It has become imperative for education and training institutions, including Technical and Vocational Education and Training (TVET), to provide learners with the appropriate lifelong skills to navigate the workplace and society with AI. Kenya's education systems, particularly TVET, have not yet embedded AI into their training and skills development programs. This has resulted in graduates with limited digital skills, which limits their success in the labour market. Kenyan TVET institutions should rise to the challenge and develop personalised and adaptive learning, which AI can advance. This study was guided by three main objectives; First, the study investigated how AI can be embedded into TVET institutions and how this can impact skills development. Second, the report analysed the opportunities and challenges of embedding AI in TVET institutions. Finally, the paper determined channels through which TVET institutions can embed AI in empowering teaching and learning. The study adopted a qualitative research approach by carrying out a desk review on integration of AI in TVETs, with content analysis as the primary data analysis method. This enabled a review of existing evidence on embedding AI into TVET institutions with secondary data analysed from credible sources, including reports, journal articles, and books on the research phenomena. The results from the study indicated that AI can be embedded into TVET institutions by leveraging AI tools, AI-powered adaptive learning systems, Chatbots and virtual assistants, AI-powered simulations, and virtual laboratories, resulting in improved technical and practical training. The paper concluded that TVET institutions across the country must establish a structured framework to embed AI into training systems through the existing AI tools in their curriculum and programs. The paper recommended development of comprehensive digitalisation strategy to provide guidance on how to embed the development of digital skills for learners, heavy investment on teachers' digital competence as well as research to enhance understanding on ways of optimizing AI and other digital technologies.

Keywords: Artificial intelligence, skills development, technology

Introduction

The current environment is becoming increasingly digitalised, with Artificial Intelligence (AI) changing how people work, communicate, live, play, and learn. Due to its close integration into our lives, individuals are increasingly engaging and interacting with AI in their everyday lives (Karani & Waiganjo, 2022). The interaction has been integrated in diverse settings such as borrowing loans, engaging in social media, visiting buildings, and using transportation systems. In particular, AI is increasingly transforming the labour markets and according to Tuenpusa *et al.,* (2022), half of the work carried out by people is likely to be automated through advanced technology by 2055. As a result, there is a need to move towards higher-skill jobs or have skills aligned to the use of advanced technologies. TVET institutions play a critical role in ensuring that their graduates have the necessary skills to transition smoothly into the labour market by equipping them with employability skills such as digital skills.

TVET institutions in developed countries are playing the role of integrating flexible learning pathways with AI directly used by education and training institutions. According to Adams (2023), some TVET institutions in developed countries have already succeeded in embedding AI in various contexts, including legislation, policy, and sectors such as education and the national economy. As a result, TVET institutions in developed countries is playing a role in integrating flexible learning pathways with AI directly used by education and training institutions. On the other hand, most TVET institutions in developing countries have not been successful in embedding AI in their training systems. According to Okumu & Kenei (2023), such countries may need to hire experts in AI and service providers to embed AI in the TVET institutions. Hong *et al.,* (2023) noted that institutions which are not proactive in integrating technological advancement, including AI in their curricula and training programs, run the risk of becoming obsolete and irrelevant.

To optimize the digital era, training institutions need to develop appropriate structures to adapt to the changes brought about by AI. However, evidence reveals that many countries have yet to respond meaningfully to the changes brought by digitalization (Adams, 2023; Musau, 2023). As a result of the high rate of advancement in technology and automation, rapid skills obsolescence is a critical emerging challenge in many countries. According to Nyakundi (2023) and Muriuki & Dominic (2022) the rapid skills obsolescence has increased the significance of lifelong learning opportunities in Kenya for learners and employees to ensure that they are prepared for the frequent transition from one stage to another. Adams (2023) further indicated that the demands of employability has increased the interconnection between education and work.

The TVET institutions must therefore urgently address the challenges that come with enhanced flexibility and the reduced learning pathways due to technological advancement while still maintaining quality (Adams, 2023). TVET institutions should also ensure that they are adequately prepared to establish approaches for embedding digitalization in their programs and curriculum, and ensuring that the graduates have the appropriate digital skills to work in the digital era.

Problem Statement

The digital era is marked by advanced technology, with various digital technologies disrupting different fields with innovations, including medicine, science, and education (Becker *et al.,* 2022). While digitalisation has been linked with potential to drive economic growth, there is a need to develop approaches and models on how digitalisation can be optimised to improve economic growth while being part of society. AI, automation, and other digital technologies also have the risk of increasing inequalities existing in society whereby innovations are increasingly replacing people in the labour market (Adams, 2023). In agreement, Tuenpusa *et al.,* (2022) indicate that certain occupations are becoming obsolete and developing new occupations. However, these occupations driven by technological innovations require individuals to have different skills than those traditionally taught in the education system (Musau, 2023). According to Becker *et al.,* (2022), the era of digitalisation is likely to amplify the economic development of developing countries that successfully establish appropriate measures to promote the development of the necessary digital era skills. However, developing countries that cannot optimize technological advancement are likely to be left behind and face lagging economic development.

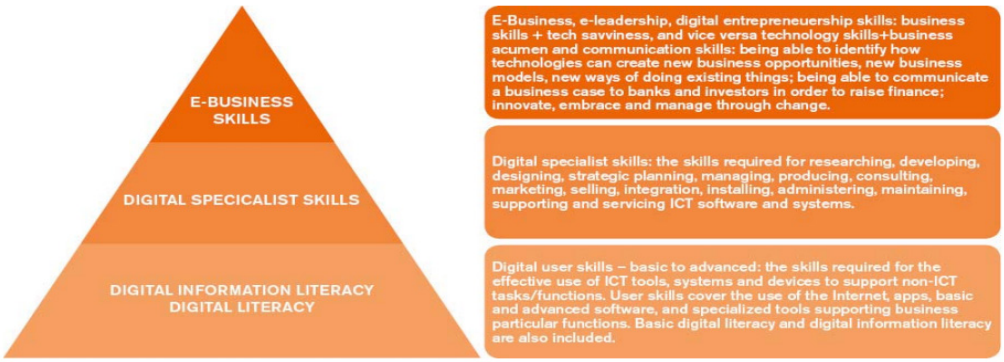
Existing evidence reveals that most TVET institutions in Kenya have no meaningful or structured responses to AI changes (Nyakundi, 2023; Wahungu *et al.,* 2023). This results in TVET graduates who are unprepared for the highly digitalized labour market, calling for the optimisation of digital technologies. It is critical that national politics, as well as the various TVET institutions have a comprehensive understanding of the current and future link of AI to the labour market and lay appropriate foundations to incorporate AI into their skills development (Karani & Waiganjo, 2022; Munene *et al.,* 2023). As Ridzuan & Junaidi (2023) recommended, forward-thinking and planning for sustainable curricula and programmes which will ensure that the TVET graduates thrive in the AI era and make positive contributions to the economic, social and individuals' goals. Failure to effectively optimize AI in their skills development will result in poorly prepared graduates for the competitive labour market, eliminating the need for TVET institutions (Ngware *et al.,* 2022; Okumu & Kenei, 2023). As such, embedding AI into the skills development in TVET institutions in Kenya is critical.

Theoretical Background

Digital skills are a critical part of the current education system as students are prepared to enter the highly digitised society both personally and professionally. According to UNCTAD (2017), three skills are necessary for both advanced and developing countries to optimize the existing digital technologies: e-business skills, digital specialist skills, and digital information literacy. Figure 1 summarises the three necessary skills recorded.

Figure 1

Digital Skills to Thrive in the Digital Era (Source: UNCTAD, 2017)



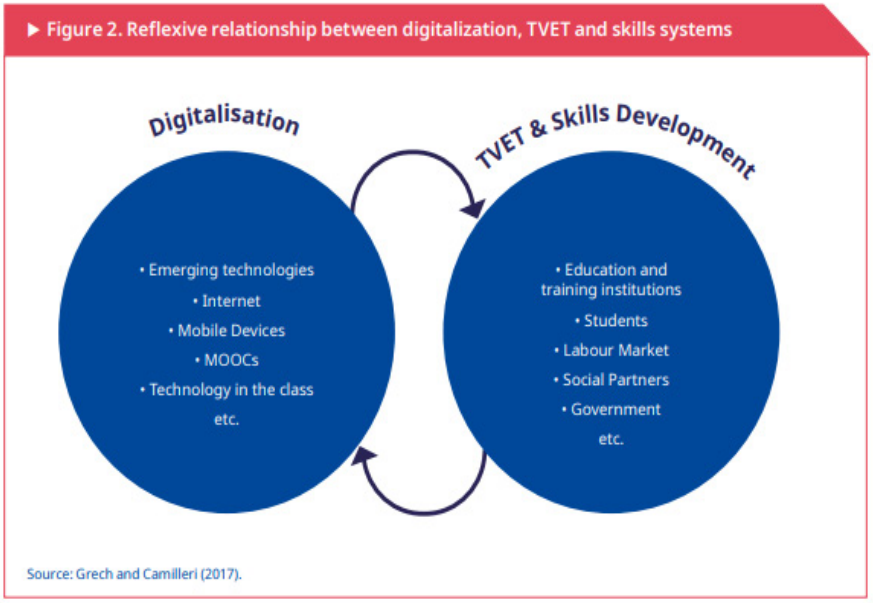
Source: UNCTAD 2017: 66

Basic digital skills will be useful in the future labour markets, allowing developing countries to avoid the digital gap which will further exclude a significant proportion of the population from formal employment (Hong *et al.,* 2023). However, Becker *et al.,* (2022) indicate that in preparing for a highly digitalized society, individuals should not be limited to basic digital user skills but also inclusive digital information skills that include searching for information and reviewing sources.

Islam & Banerjee (2022) further indicate that basic digital skills should incorporate analytical skills such as coding, not limited to user and information literacy. Scholars and practitioners agree that while digital technologies have numerous opportunities for learners, it is critical to align learning to future skills needs by promoting their economic employability and securing broader human development and well-being (Umaimah *et al.,* 2022; Chandrasekar, 2022). For instance, an employability-focused education may fail to equip learners with the skills necessary to acquire social and political agency and ensure they can act as responsible citizens in the digitalized society.

Recently, many developing countries have identified digitalization as a priority, with some like Rwanda, developing specific digitalization strategies for their education systems while others, like Kenya, have integrated digitalization in their education sector strategies as priority actions (Hong *et al.,* 2023). However, specific digitalization strategies for TVET do not exist and rather, TVET is placed as a sub-sector and not given specific focus (Abd & Mustapha, 2022). Establishing a particular digitalization strategy for TVETs is critical, allowing for the optimization of digital technologies for TVET graduates. The paper applies a new media theory to understand how AI can be embedded in skills development. The theory argues that a reflexive relationship exists between digitalization and the social world (Grech & Camilleri, 2017; Siapera, 2018). This is summarized in Figure 2.

***Figure 2**:*
Disruptive Link between Digitalization, TVET, and Skills Development Systems (Source; Grech and Camilleri, 2017)



Digitalization is a disruptor in society whereby it is marked by emerging technologies, use of internet, mobile devices and other digital technologies and TVET institutions must engage with the existing education networks and community to promote skills development for its learners. As Becker *et al.,* (2022) indicated, the TVET institutions must engage with other education and training institutions, students, the labour market, government, and social partners to establish a skills development framework to prepare their graduates for the labour market.

TVETs are increasingly faced with the challenge of preparing learners for skills needed as the labour transitions from the Industrial age to the information age, with the information age skills requirements and flexibility in the changing world of work (Ridzuan & Junaidi, 2023). As such, it is important to identify appropriate approaches and best practices for embedding AI into the skills development within the TVET systems.

Objectives of the Study

The main objective of the study was to determine the effect of embedding AI in the TVET curricula. The specific objectives of the study were to:

i. Determine the effects of leveraging AI tools in skill development
ii. Identify the link between digitalization and TVET skills development systems;
iii. Identify the opportunities of skills development using AI

Methodology

To meet these objectives, a qualitative research approach was adopted by carrying out a desk review on integrating AI in skills development at TVET institutions in Kenya. As evidenced by the literature review above, there is limited evidence on embedding AI into the skills development in Kenyan TVET institutions. Based on this, desk review was chosen as it provides a foundation for reviewing existing evidence and establishing a knowledge base upon which future research can be carried out. As indicated by Pandey & Pandey (2021), a desk review not only identifies gaps in knowledge but also contributes to scholarly conversations. A desk review also allowed for a cost-effective method of acquiring insights about the use of AI in skills development of TVET learners. In carrying out the current research, the desk review involves an analysis of credible sources including research reports from international organisations such as the UN, peer reviewed journal articles, and books.

Journal articles were identified from credible databases such as ERIC, JSTOR, Education Full Text and Science Direct. The search terms utilised included digitalisation, TVETs, AI, digital technologies, and skills development. After collection the data from the diverse sources was analysed using thematic analysis. After collecting the data from the diverse sources were analysed using thematic analysis. As Sileyew (2019) recommended, the researcher familiarised with the data, developed codes, and searched and identified the themes. In reviewing the results, two major themes were identified; leveraging AI tools in skills development and opportunities and challenges of embedding AI into the skills development of learners in TVET institutions in Kenya.

Results and Discussion

Leveraging AI tools in Skills Development

Leveraging AI tools in the skills development of TVET students has been proposed as one of the best ways of ensuring that the labour force is prepared for a highly digitized market. According to Legusov *et al.,* (2022), AI tools can help establish personalised learning paths for TVET students, allowing them to take optimal career paths based on their learning styles, strengths, and weaknesses. In agreement, Umaimah *et al.,* (2022) indicate that AI tools such as Intelligent-Tutoring Systems can be employed also to adapt the learning materials to the student's needs. As proposed by Odondi *et al.,* (2022), personalized learning is critical; ensuring that learners' specific needs are met includes allowing for feedback. Through AI tools, TVET students can improve their learning outcomes. Secondly, AI tools can enable simulations and virtual reality whereby TVET instructions are able to secure practical; training for their students. As Chen *et al.,* (2020) illustrated, AI tools can allow for enhanced realistic simulations where creative, engaging and adaptive learning scenarios can be established. Further machine learning can be undertaken with algorithms employed to simulate real world challenges that students can tackle.

AI-powered adaptive learning systems, Chatbots and virtual assistants, AI-powered simulations, and virtual laboratories, result in technical and practical training. According to Qadir (2023), through simulations, instructors can promote realistic simulations and real-world training for their students. This can have positive impacts on their training including practical training exercises where students engage with concepts within a virtual environment to help hone their technical skills (Williamson, 2023). In agreement, Holmes *et al.*, (2021) indicate that the confidence and experience of the learners can be enhanced even before applying them in real-world situations. Additionally, AI driven simulations enable instructors to establish safe and controlled spaces which allow for hands-on learning with risks reduced in certain vocational training practices.

Institutions can leverage AI by employing data driven curriculum development. According to Perrotta & Selwyn (2020), AI tools can aid in carrying out analysis of the different industries, job market trends and inform on emerging technologies which can be enhanced to inform the development and modification of the curricula. Further, predictive analytical models using AI can identify relevant skills and competencies required in the different sectors (Huang *et al.,*2021). This would allow instructors to keep up to date with the skills required for the different sectors and ensure that the students develop them.

As indicated by the skills pyramid, 21st-century employees must have e-business skills promoting digital entrepreneurship and e-leadership, digital specialist skills necessary for employing digital technologies to enhance productivity, and digital user skills that ensure one can use various ICT tools (UNCTAD, 2017). Based on this framework, instructors and curriculum developers can ensure that AI is adequately embedded into the curricula resulting to the development of critical skills for the learners.

In leveraging skills development for learners, it is important for the instructors to have an in-depth understanding of the market's current needs. The findings by Nemorin *et al.,* (2023) indicate that instructors can develop curricula that can easily adapt to the changing needs of the market by carrying out adequate research and forecasting using AI. Existing evidence aligns with this contention, arguing that the skills development should be aligned to the market's future needs (Chandrasekar, 2022; Ummaimah, *et al.*, 2022). As such, instructors and curricula developers can optimize AI tools to develop a curriculum well versed in adapting to the labour force's changing needs. However, in using AI, Williamson (2023) cautions the need to educate staff as well as students on ethical use of AI. This should be done by establishing a structured value and ethical framework on how AI will be used. This includes how to utilise and safeguard student data as well as ensuring that students understand the ethical issues which can arise in the use of AI.

Opportunities and Challenges of Skills Development using AI

Foundations skills which have traditionally been the 3Rs; reading, writing and arithmetic have evolved to require digital literacy, occupational skills and soft skills. According to Chen *et al.,* (2020), one of the major challenges faced by TVET institutions is to teach and assess on the additional skills particularly the digital skills. Many developing countries like Kenya are faced with a learning crisis whereby despite the increased literacy levels, students are still not optimizing learning in schools due to a number of challenges including irrelevant curriculum, incompetent teachers, a weak assessment system and poor adaptability and flexibility of the advanced technologies. As a result, many students joining TVET programs are unprepared and have inadequate foundation skills which are required to better understand and apply learning (Zhang & Aslan, 2021). This is particularly so for learning using AI tools with many of the TVET students having no prior engagement with digital tools. As such, it is important for TVET institutions to incorporate foundation skills for digital tools such as use of AI to enable learners to have a better basis for learning (Nemorin *et al.,* 2023).

From the strong foundation, TVET institutions will be able to offer opportunities to advance their digital skills including investment in lifelong learning and improvement of skills based on a continuous process. Employers also have the opportunities to invest in the reskilling and improving the skills of their workforce to optimize innovation in the digital era. The use of AI tools can further enhance online blended and simulated learning. As indicated by Qadir (2023), online blended and simulated learning is a cost-effective approach to learning whereby quality is promoted. However, to be established, the Kenyan government in collaboration with the TVET institutions must work together in establishing a large-scale online education ecosystem that will help to further leverage the existing AI tools (Nyakundi, 2023). As indicated, one of the challenges in the labour force is that some jobs are becoming obsolete.

However, with the use of AI tools, curriculum can be established to help workers to take online courses that add to what they traditionally learned and embed it with relevant digital skills and knowledge. The TVET institutions can draw from world class courses which ensure that relevant elements in AI and related digital technologies such as Big data analytics are incorporated. The use of AI in TVET requires a broad range of professionals to be involved in the process of creating and embedding it into the curricula as well as its provision. According to Nemorin *et al.,* (2023), a key limiting element in embedding and integrating AI and other digital technologies is lack of teachers and instructors who have the necessary digital competence.

In agreement, Okumu & Kenei (2023), indicate that the TVET domain is marketed by lone professionals who have the competence to provide high quality instructions and direction. However, a few professionals' efforts are not enough to carry out a fully drawn and comprehensive embedding of AI into TVETs, with their efforts likely to be ineffective and unsustainable (Becker *et al.,* 2022). In embedding AI into skills developments in TVET institutions in Kenya, diverse professionals including instructional designers, teachers who have digital competence, assessment and skills experts among others are some of the professionals required. To match these professionals will require investing into the TVET staff to expand their range of skills as well as hire professionals who are experts in digital technologies.

Conclusions and Recommendations

Conclusions

The paper concludes that TVET institutions must proactively engage in developing appropriate responses on the challenges and opportunities brought about by the AI in their systems. First, TVET institutions must leverage AI tools in developing the skills of their graduates.

This involves the use of various tools including chatbots and virtual assistants, AI powered simulations, AI powered learning and virtual laboratories to name a few. This should include continually researching on emerging technologies to ensure that they keep up with the technology. Further, TVET institutions must optimize AI and manage the challenges that arise such as having digitally incompetent teachers and staff. This should be done by TVET institutions across the country establishing a structured framework to embed AI into their learning through embedding existing AI tools in their curriculum and programs.

Recommendations

Based on the review of existing evidence, there are a number of recommendations that institutions within the TVET system in Kenya should adopt in order to optimize AI and adequately prepare their graduates for a highly digitised work environment.

These include the following:

- The Kenyan government through the appropriate organizations and government departments should establish a comprehensive digitalization strategy that TVET institutions should follow in developing digital skills to their learners. As revealed in the review, the TVET system in Kenya lacks a specific digitalization strategy that would provide guidance on how to optimize digital technologies. As such, there lacks a direction on how AI as a major digital technology can be embedded and integrated within the TVET sector. Through a well-structured digitalization strategy and action plan, AI can be successfully embedded in the skills development of the learners.
- TVET institutions to invest heavily in their staff to ensure that they have the necessary digital competence of effectively embedding AI into their system. Trainers to be equipped with the necessary digital competencies and institutions to carry out baseline survey on training needs and develop specialized training programs and professionals development aligned with the needs of the institutions and also promote experiential learning. In developing professional development strategy for its staff, it is important to establish continuous learning opportunities with staff encouraged to attend webinars, trainings, and conferences related to embedding AI into skills development of learners. For example, instructors and teachers in TVET institutions should attend training on use of AI tools such as AI-powered chatbots, AI based grading systems and AI driven skills assessment to name a few.
- Research should be improved and increased particularly on how best to optimize AI and other digital technologies for TVET graduates. This should include the economic, political and social impacts of digitalization in TVET and in the Kenyan education system at large. It is important to carry out extensive research both from practitioners, policy makers, and academicians to better the best practices in embedding AI and other digital technologies in the TVET curricula and in skills development of the learners.
- In adopting the above recommendations, the Kenyan government and TVET institutions will be able to effectively embed AI into the skills development of their learners and prepare them adequately for the digitised era.

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A Review of Kenya Medical Training Colleges' Teaching and Learning as a Response to Artificial Intelligence Integration

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Abstract

Artificial intelligence (AI) is rapidly transforming learning in Technical and Vocational Education and Training (TVET) institutions. With AI technology advancement and its adoption into routine learning activities, the use of AI in the field of medical training and education is rapidly evolving. The review paper assesses the association between AI, and teaching and learning in medical training colleges. The objective of the review was to explore evidence-based literature on the impact of AI on teaching and learning in medical colleges. The paper utilized a secondary qualitative method to build on the knowledge- with the help of extant researches that are of importance and peer-reviewed. Thematic analysis was established by conducting a review of the extant research to determine the impact of AI on teaching and learning in medical colleges. The review noted that AI is already widely used in the medical training and education sector and its implementation crucial factor in educational development. Artificial Intelligence is increasingly being employed as a digital assistant since it assists students and teachers in various ways, such as offering access to a wider range of learning materials as per their specific learning needs and approved subjects. Nevertheless, there exist some risks linked to AI advancements, such as security, safety, and privacy concerns. Consequently, AI technologies both positively and negatively impact quality of learning in the education sector. The review concluded that by leveraging on AI for curriculum- development and assessment, educators may offer tailor made and effective educational experiences which enhances students' skills and knowledge, thus, influencing the learning objectives of the studies in medical colleges. The review recommended that more work need to be done in facilitating conditions and the perceived risks to enhance learning.

Keywords: Artificial Intelligence, Learning Quality, Medical Colleges, Review

Introduction

The field of artificial intelligence (AI) as has witnessed significant growth over the recent years, with progressions in many fields like natural language processing, machine and medical learning, leading to the development of widespread and sophisticated AI systems (Bewersdorff *et al.,* 2023). By design, AI is a method that uses intelligent technology knowledge to accomplish concrete purposes in efficiency. Presently, the following classification of AI are available: Reactive Machines, Self-aware, Limited Memory, Artificial Narrow Intelligence, Theory of Mind, Artificial General Intelligence and Artificial Superintelligence (ASI). The prompt advances in these fields have brought about considerable changes in education, opening up new opportunities and challenges to teaching and learning anytime and anywhere by providing new approaches as well as systems that aim to stimulate innovative teaching and ultimately bolster learning outcomes (Owoc, Sawicka & Weichbroth, 2019).

Artificial intelligence (AI) is the process of programming different software applications to 'think' like human beings and manipulate human actions (Hussain *et al.,* 2022). Artificial intelligence is linked to the way human mind think and analyse the issues to solve challenge encountered (Holmes, Bialik, & Fadel, 2023). The AI has ability to think and act in a particular job that it handles (Anyim, 2021). Therefore, AI in medical education may provide new exciting opportunities to adopt to learning contents based on trainee's individual learning styles and characteristics.

Teaching and learning entail the lessons and learning procedure offered to learners by educational institutions (Anyim, 2021). AI learning provides the student's different types of hi-tech learning methods for a better understanding of the topics they are studying (Chen, Chen & Lin, 2020). Therefore, using cutting-edge technology, medical students can be given learning tools with advanced technology to encourage personalized learning, contact with peers and instructors, and access a wealth of information (Hussain *et al.*, 2022).

According to Dave & Patel (2023) the application of AI in medical virtual simulation and training allows learners to understand and take part in complex processes on virtual patients. This type of training is tailor made, hence enabling learners to work at their own pace and repeat procedures until mastery. Artificial intelligence (AI) algorithms are capable of analyzing learners' data to generate intelligent tutoring systems, grade assignments, and offer individualized learning experiences. AI can also be used to produce simulations and virtual reality experiences, thereby giving students hands-on practice in a safe setting. Furthermore, the majority of AI apps nowadays concentrate on machine learning, which uses inferences rather than code to learn from and adjust to user behaviour. In this case, data becomes the most important resource for implementing and maintaining AI (Tahiru, 2021).

The utilization of AI in the medical field, including the use of generative language models, is often accompanied by challenges and contentions. Some common challenges include privacy, data security, algorithmic transparency and explainability, errors and liability, as well as regulatory issues associated with AI medicine (Wong, Ming & Ali, 2023). Based on its performance in a parasitology examination, a Korean study reported that ChatGPT showed lower knowledge and interpretation ability when compared to medical students (Huh, 2023). In addition, the uncertainty on how ChatGPT and other AI applications derive their information and the black box problem has always been a big challenge in AI medicine. This further raises concerns about transparency and trust, which are two crucial elements in medicine (Wong, Ming & Ali, 2023).

According to Bandura (1969) social-learning theory of identificatory processes, various studies on "neural-like elements" and "multidimensional neural-like growing networks" are included in the field of artificial intelligence. When it comes to problem-solving, the artificial intelligence system functions as a human system's brain (Vrontis *et al*., 2022). This study applies this notion to show how artificial intelligence can be used to enhance teaching and learning. Since skill development is a prerequisite for artificial intelligence, the contextual learning theory of education discusses how an individual might acquire cognitive and professional abilities. This hypothesis has been applied to higher education to associate artificial intelligence with improved learning strategies. Consequently, it is imperative for trainers to continually improve their talents because doing so enables pupils to learn that they may do better (Hussain *et al*., 2022).

The Kenya Medical Training College (KMTC) is a State Corporation established through an Act of Parliament under the Ministry of Health. The college is mandated to train various disciplines in the field of health to serve interest of the citizens of Kenya, East Africa and even beyond. The KMTC has 72 campuses situated strategically in different parts of the country. The Graduates of the College account for more than 85% of the local middle-level workforce in Kenya's health facilities. In line with its transformative expansion agenda aimed at consciously increasing training opportunities, the College has 72 campuses spread across the country with over 51,000 students (https://kmtc.ac.ke/).

Objectives of the Study

The objective of the review was to explore evidence-based literature on the impact of Artificial Intelligence on teaching and learning in medical colleges. The review addressed the following specific objectives:

(i) To explore the incorporation of AI to teaching and learning in Kenya medical colleges

(ii) To analyze the advantages and disadvantages of the integration of AI in teaching and learning in Kenya medical training colleges

Methodology

The paper is descriptive desk-top review of the literature. The purpose was to gain a deeper understanding of the current development in the incorporation of AI to teaching and learning in Kenya medical colleges. Data from the secondary source was obtained from various sources such as publications, journal articles, research papers and websites. The review was based on the objectives of the study to fill the evidence gap by identifying success stories on incorporation of AI to teaching and learning in medical training colleges.

Results and Discussions

Incorporation of AI to teaching and learning in KMTCs

Bewersdorff *et al*., (2013) review on myths, mis-and preconceptions of AI. Examined 25 related studies on original empirical research on education and AI, as well as reports on AI concepts in a formal learning environment. The review was mostly undertaken in Europe and North America, and mostly focused on school and university levels. The results dispelled a number of myths, misconceptions, and prejudices regarding AI. For example, learners often ascribe human-like traits or qualities to AI systems and may have limited perspectives on the extent, potential, and constraints of AI. The review also demonstrated that students frequently held polarized and vague opinions regarding the risks and advantages of artificial intelligence. Since the context of the review was school and university level of learning, it may not be appropriate to generalize the findings to medical colleges.

Li & Qin (2023) undertook a study on medical students' perceptions of AI in education, curricular recommendations, and design suggestions. Out of the 1,243 undergraduate and graduate students from 33 hospitals and 13 universities, 54.3% stated that they had used medical AI. The results showed that medical postgraduate students were more aware of the use of medical AI than their undergraduate counterparts. As a result, modern medical undergraduate and graduate students are not receiving a structured education in medical AI from medical education. While trust, hedonic motivation, habit, performance expectancy, and habit are favourably correlated with the intention to utilize medical AI, learning quality and practices are not improved.

Wong, Ming & Ali (2023) reviewed the intersection of Clinical Medicine, ChatGPT, and Medical Education. The purpose of the review was to unveil the perspective on the integration of AI models such as ChatGPT in clinical medicine and medical education. Through a comprehensive review as well as the authors' personal experiences, the article elucidated the cons, pros, and ethical considerations of using ChatGPT within clinical medicine and notably, its implications for medical education. The findings of the review showed that it enhanced student learning experience and increased accessibility to learning resources due to the intersection of ChatGPT, Clinical Medicine, and Medical training.

Since only one type of AI was used in the review it could; therefore; be difficult to generalize the findings to all other AI applications, raising questions about the impact of the review on the quality of medical relationships. Integrating AI into the learning process in medical education has been explored from the teaching and learning viewpoint. AI based teaching and learning implementation framework which contains AI backend layer, data processing layer and User interface layer form the basis of integration of AI algorithm and applications in the teaching and learning process. Medical education focused on the integration of artificial intelligence to improve the teaching and learning process and to produce man power with expected skill and knowledge.

Advantages and disadvantages of integrating AI in teaching and learning in KMTCs

Hussain *et al.,* (2022) reviewed the effects of AI on teaching and learning in higher education. In this study, a secondary qualitative method was employed to expand knowledge through the utilization of significant, peer-reviewed literature already in existence. The development of thematic analysis involved examining the features of the article that were part of the investigation into the significance of AI in higher education. The findings demonstrated that AI contributes to the professional and interpersonal skill development necessary for an organization's growth. Using AI, learning systems help students to become more productive and efficient by improving their mental health and problem-solving abilities. The study examined the effect of AI on teaching and learning, however, the advantages and disadvantages of AI integration in education were not examined.

Tesfay, Deng & Shao (2023) explored the importance of AI in Teaching Vocational Education and Training Case study at Ethiopia Federal TVET Institute. The main objective of the study was to unveil the relevance of AI integration in vocational education and training at Ethiopia Federal TVET Institute. A descriptive research design was employed in carrying out the investigation. The study investigated the relevance of AI in the key areas: curriculum development, personalized learning, adaptive tests, practical application, and teacher training and professional development. The case study showed the positive impact of AI in TVET as indicated by increased student engagement, improved learning outcomes, and enhanced employability prospects. The context of the review was, however, TVET institute used primary data.

Al Saad *et al.,* (2022) undertook an online survey on medical students' knowledge and attitude toward artificial intelligence. This study explored Jordanian medical students' perspectives on machine learning (ML) and artificial intelligence (AI). Additionally, the study gauged the degree of awareness and comprehension regarding AI's impact on medical students. In this survey, nine hundred medical students from six Jordanian universities took part. Data was gathered via an electronic pre-validated questionnaire published via social media and created using Google Forms.

Majority of the students (89%) state that AI was important for the medical field, 71% that teaching AI would be beneficial for those in the medical field. A significant proportion (47%) of the students had understood the basic principles of AI, while 68.4% of the students believed that medical students should have knowledge on AI. This study did not examine the impact of learning and teaching on medical education as one of the measures that make up the dependent variable.

Tolsgaard *et al.,* (2006) did a study on fundamentals of AI in medical education research. The objective of the study was to describe practical considerations considered in reading and conducting studies among medical education using AI. The utilization of AI in medical training was revealed to facilitate understanding of complicated tasks and improve efficiency. The use of AI could help automate the assessment of written responses or give feedback on medical image interpretations with excellent reliability. This study however failed to examine the impact of learning and teaching on medical education as one of the measures that make up the dependent variable.

While AI has the capacity to make a significant positive impact on education, it is important to keep in mind the negative impact of AI. There are a number of promising opportunities like simulation of learning environment and lecturers, intelligent tutoring system, accumulation of smart content and automation. There are several concerns related to the deployment of AI; these include data privacy, security, bias, and teacher-student relationships, and they must be addressed to ensure the responsible and ethical implementation of AI in education. By leveraging these advancements, educators and policymakers can work towards creating inclusive, equitable, and effective learning environments that cater to the diverse needs of learners.

Table 1

Summary of Empirical Literature Review and Research Gaps

Author(s) and year	Research Objectives	Methodology	Key findings	Research Gaps
Bewersdorff *et al.,* 2023)	Identify and consolidate common- mis- and preconceptions about AI among learners.	Systematic review	A substantial amount of misunderstanding and confusion surrounding AI. Learners more often have binary and unspecific views about the dangers, threats, and benefits of AI.	School and university level of learning was the focus of the study thus may not be easier to generalize its findings to medical colleges.
Li & Qin (2023).	Identify key factors that influence the acceptance and intention to use medical AI.	Survey design	Intention to utilize medical AI is positively associated with factors such as hedonic motivation, performance expectancy, habit, and trust.	Factors including performance expectancy, habit, hedonic motivation, and trust was the main intention to use medical AI but not impact of AI on teaching and learning.

Author(s) and year	Research Objectives	Methodology	Key findings	Research Gaps
Tesfay, Deng & Shao (2023)	Examine the relevance of AI integration in vocational education and training at the Ethiopia Federal TVET Institute.	Descriptive research design	The positive impact of AI in VET with learners reported improved learning outcomes, increased engagement, and enhanced employability prospects.	The context of the review was TVET Institute and used primary data as data.
Wong, Ming & Ali (2023)	Present the authors' perspective on the integration of AI models such as ChatGPT in clinical medicine and medical education.	Peer-reviewed literature	Enhance student learning experience and increase accessibility to learning resources.	Only one type of AI was used in the review and could, therefore, be difficult to generalize to all other AI applications, raising questions about the impact of the review on the teaching and learning of medical relationships.
Hussain *et al.,* (2022)	Importance of artificial intelligence in higher education.	A systematic review of "peer-reviewed resources	AI is adopted to develop professional and personal skills that are required for the development of an organization.	Both merits and demerits of the integration of AI in education were not examined.
Al Saad *et al.,* (2022)	Investigate the attitudes and estimate the level of knowledge and understanding of Jordanian medical students regarding AI and ML.	Simple descriptive statistics	Medical students have a clear level of understanding and knowledge of the effects of AI on medical advancements.	This study however failed to examine the impact of learning and teaching on medical education as one of the measures that make up the dependent variable.
Tolsgaard *et al.,* (2006)	Describe practical considerations involved in reading and conducting studies in medical education using AI.	Quantitative methods	AI has ability to facilitate complicated tasks as well as improve efficiency, automate the assessment of written responses or provide feedback on medical image interpretations with excellent reliability.	This study however failed to examine the impact of learning and teaching on medical education as one of the measures that make up the dependent variable.

Conclusions and Recommendations

Conclusion

Results from this study showed that Artificial intelligence (AI) imitates human brain and also try to give solution to challenges by understanding the problem and trying to find out the solution. The relevance and importance of AI in medical colleges cannot be understated. This is because AI has ability to influence directly the teaching and learning techniques as well as the learning objectives in medical colleges.

Maintaining the teaching and learning objectives is directly proportional to knowledge and skills acquisition of the learners. For instances the case study undertaken at the Ethiopia Federal TVET Institute reveal how AI technologies can revolutionize traditional teaching methods much applicable in medical colleges.

By leveraging AI for curriculum development, personalized learning, and assessment, educators can provide tailored as well as effective educational experiences that boosts students' skills and knowledge. This review adds to the literature that investigates the incorporation of AI for improving the learning quality and practices in institutions of higher learning, medical colleges not an exception. The current the results obtained by other researchers in terms of the positive and negative consequences of implementing AI in institutions of higher learning.

Recommendations

Based on the findings and from this study, the authors recommend that the KMTCs should:

(a) Develop and update tools and mechanisms to anticipate and identify both current and future curricula needs in regards to AI development, to bolster the relevance of teaching and learning.

(b) Determine the role of AI in teaching and learning needs, a future-oriented strategy guided by clear pedagogical principles and foresight.

(c) Conduct regular studies to ensure effective adoption of AI for quality learning and teaching, accessibility and equity.

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Impact of Artificial Intelligence on Technical and Vocational Education and Training: A Case study of The Kisumu National Polytechnic, Kenya

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Abstract

Technical and Vocational Education and Training (TVET) plays an important role in providing students with the skills needed in the world of work. The world has witnessed massive technological revolutions that often-put old-style teaching to the test in delivering innovative and flexible learning to diverse groups of trainees. To ensure rapid and sustainable employment of TVET graduates, training curricula should incorporate emerging technology, such as Artificial Intelligence (AI), which can predict market changes and the skills needed. Artificial intelligence in education is already being used to improve management and support teaching. The aim of this study was to determine the impact of AI on the learning and teaching, assessment and grading process in TVETs and the future careers of graduates. The research also explored the potential for AI in transforming TVET and helping graduates gain new skills. The sample size was determined using the Taro Yamani model, which selected 377 students from a population of 6,431 with a 5% margin of error. Additionally, 110 academic staff, 10 administrators, 45 technical staff and 32 former students participated in the research. This study used descriptive and explanatory design; in addition, desktop library research was also used to collect secondary data. Data were analyzed using the chi-square statistical tool at the 5% significance level presented in frequency tables and percentage. Random sampling was used to identify participants. Research findings showed that AI supports personalized learning by tailoring learning content to students' individual needs and learning styles. There was also a positive relationship between AI and learning-teaching in TVET. The results of this study will help TVETs and other higher education institutions to integrate self-learning with AI into their curricula to improve learning and performance. The findings also suggest that AI could influence the learning process by making it easier to acquire new skills.

Keywords: TVET, artificial Intelligence, curriculum, personalized learning

Introduction

Artificial intelligence relates to the human mind by using the way people think and learn about problems and finds ways to solve them (Holmes *et al.,* 2019). Artificial intelligence can also do all the work as the human brain reacts and responds to all problems. The main distinguishing factor of artificial intelligence is the ability to take action to achieve the goals set for a particular task (Anyim, 2021). Different industries use AI in different ways, including "financial and medical Sectors" (Chen *et al.,* 2020).

Artificial intelligence is a new trend in the world because it has proven to be useful in many fields, especially during the global pandemic COVID-19 (Vaishya *et al.,* 2020). Artificial intelligence has helped prevent diseases and often saved jobs and education (UNESCO, 2020). Therefore, it is important to know how artificial intelligence affects higher education. This research article examined how AI may impact higher education based on past research as well as participants' experiences, perceptions, and predictions. There is no doubt that artificial intelligence plays an important role in general education and higher education (Edtech, 2020), for instance, the effective use of filtering of emails, advertisements, YouTube and virtual assistants (such as Google, digital libraries, Google Scholar and other digital research) in a higher institution in the world (García-Vélez *et al.,* 2021).

Incredible changes have occurred in education with the impact of artificial intelligence on education. Teaching and learning are being transformed by new technologies. The impact of educational knowledge is increasing with the idea of changing learning, assessment and interaction through online platforms to achieve blended learning. Artificial Intelligence (AI) has the ability to solve some of the biggest problems in education today, developing new teaching methods and ultimately improving learning outcomes. However, it is certain that this rapid technological development will also lead to many risks and problems, as well as discussions regarding the law and regulatory process. The connection between AI and education involves three areas; learning with AI (such as using AI-powered tools in the classroom), understanding AI (its methods and processes), and preparing for AI (including reporting on public impact), Neven, (2015).

The aim of integrating AI is to try to popularize the human and technical aspects of intellectual skills in education and training. The first process involves building the capacity of the development process and supporting trainers and trainees in selected institutions. Artificial intelligence can provide instant access to instructors and courses anytime anywhere. Artificial intelligence can be used as a guiding tool for trainees to achieve their goals by providing assignments and test answers based on AI algorithms.

Education and training play an important role in the development of human progress. Since ancient times, education and training has been constantly evolving, thanks to new technologies. We are all familiar with the conventional school system where learning is delivered to students within the classroom. With the influence of the internet and digital technologies, online platforms are gradually changing direction. Therefore, today's education removes all the limitations of the classroom and encourages participation of a large number of students from all over the world. Today's education can attract more students and teachers to technology education by providing information through online platforms. Online education, which has no time, place or student limitations, has become popular. According to Nilsson (2009), online education has many advantages; flexibility, low cost and breadth of content. As Perrotta and Selwyn (2020) suggest that the integration of AI is useful for anticipating future problems and improving trainee and employee performance.

Due to its effective teaching methods, AI is used as a substitute for teachers; especially for weak students boosting training strategies according to Williamson and Eynon (2020) findings. Therefore, measuring trainee performance using AI is very fast and effective.

Statement of the Problem

The integration of artificial intelligence has caused great transformation and resulted to radical changes in the field of education and training. Measurements and evaluations are discussed through online platforms where various topics are presented. For the last two decades, there have been no educational standard models leading to the inclusion of artificial intelligence in education. Since AI is still in its infancy in education, only a few institutions have tried to use AI in learning and teaching. Neven, H. (2015). A country's future economy, productivity and economic growth depend on the knowledge and technical skills of young people (Bartel, Figas and Hagel, 2015).

The industrial revolution has allowed industries to embrace smart, digital manufacturing and industrial processes. To address the vast and distinctive technical skill gap spawned by industry 4.0 revolution, artificial intelligence (AI) has been positioned at various levels of the Technical and Vocational Education and Training curricula implementation. Whereas, AI offers enormous potential benefits there are few studies on its impact. Therefore, this study was conducted to determine the impact of the AI learning skills in TVET institutions for students to acquire skills that prepare them for the job market based on the knowledge they acquire and apply on the use of AI in education and how it should continue to change economies and the labour market.

Research Objectives

The main aim of this study was to determine the impact of Artificial Intelligence on TVET. The specific objectives of the study were:

i. To determine the impact of AI on the learning and teaching process
ii. To determine the impact of AI on the assessments and grading process
iii. To determine the impact of AI on future careers of graduates

Hypotheses

Based on the purpose of the study, the researcher formulated the following research hypotheses:

i. H_0: There is no relationship between artificial intelligence on learning and teaching process in TVETs.
ii. H_1: There is relationship between artificial intelligence on learning and teaching process in TVETs
iii. H_0^2: There is no impact of integrating artificial intelligence on assessment and grading processes in TVETs.
iv. H_2: There is an impact of integrating artificial intelligence on assessment and grading processes in TVETs.

Methodology

The researcher applied explanatory and descriptive research design. Qualitative inquiry was used to ensure the quality and accuracy of the data collected. Three questionnaires, one for trainers, another for the trainees, and the trainee alumni composed of both structured and open-ended questions, coupled with interview schedules for administrators and technical staffs were used to collect data. The study targeted students categorized by departments to give every department an equal opportunity to be sampled. Data was presented in frequency tables, charts and pie charts. Random sampling was employed to obtain a sample of respondents. A self-interview survey was prepared too and applied to 574 respondents. Responses were rated on a five (5) point Likert scale with 5 points for strongly Agree (SA), 4 points for Agree (A), 3 points for Neutral (N), 2 points for Disagree (D), and 2 points for strongly Disagree (SD) 1 point. Data were analyzed using the chi-square statistical tool at a 5% significance level and hypotheses were evaluated using the equality test of proportion.

Results and Discussions

Response rate

A total of 574 participants answered and responded to the survey, with an overall response rate of 100% with the majority of the participants being students (65.7%), academic staff (19.2%), technical staff (7.8%), administrators 1.7% and graduate students 5.6%.

Sample Distribution

Sample population distribution by gender was as shown in Table 1.

Table 1

Gender distribution of the respondents

Response	frequency	Percent	Valid Percent	Cumulative Percent
Valid Male	377	65.7	65.7	65.7
Female	197	34.3	34.3	100.0
Total	574	100.0	100.0	

From the table 1 above, it shows that 65.7% of the respondents were male and 34.3% of the respondents were female.

Table 2

The Distribution and Sample Size of Respondents

Response	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Administrators	10	1.7	1.7	1.7
Trainers	110	19.2	19.2	20.9
Technical staffs	45	7.8	7.8	28.7
Students	377	65.7	65.7	94.4
Alumni students	32	5.6	5.6	100.0
Total	574	100.0	100.0	

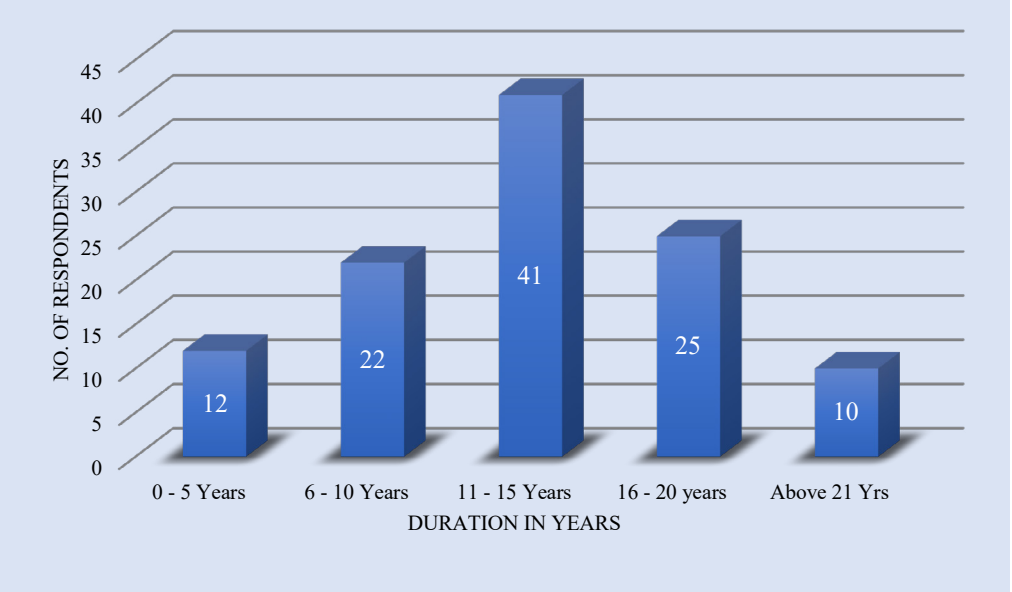
Table 2 shows that there were 10 administrators, accounting for 1.7%; 110 trainers making up 19.2%, 45 technical staff making up 7.8%, 377 students making up 65.7% and 32 former students making up 5.6% with the data from the office of the career services.

Trainer's teaching experience

Teachers were asked how many years they had trained in TVET schools to determine their experience in incorporating AI into student teaching – learning process.

Figure 1

Trainers/academic staff teaching experience



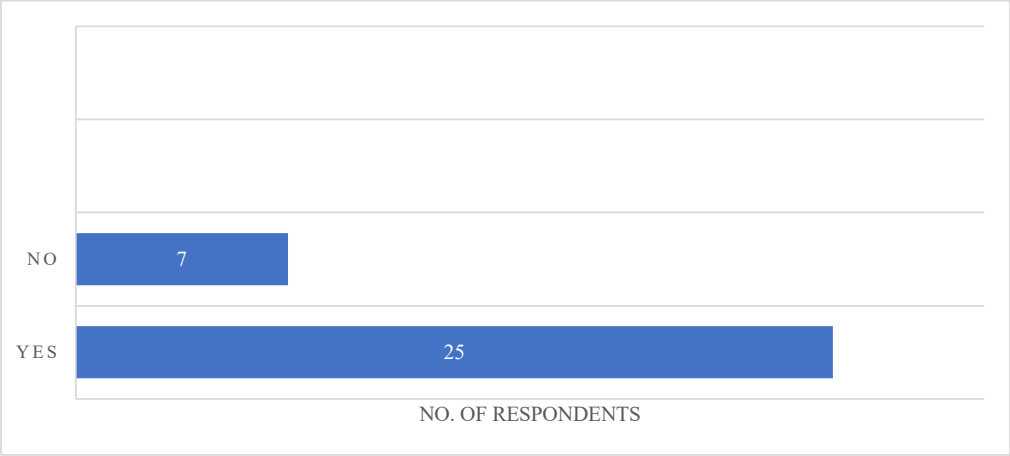
These results represent the length of time academic staff has worked at the school. The data above shows that most teachers had six or more years of experience. This shows that they are well conversant with the activities in the institution and were therefore able to teach students efficiently and effectively by integrating content-based intellectual skills by use of AI.

Impact of AI on Future Careers of TVET Graduates

Artificial intelligence has an impact on learning and follows students long after they graduate. Wang and Siau (2017) believe that artificial intelligence will influence the skills needed in the future market. The study also determined whether student graduates acquired the necessary job market-related skills, as the knowledge and skills gained while undergoing AI integrated training. The findings of this study showed that AI has a greater impact on the careers of graduate trainees since it provides the necessary skills required in the future job market.

Figure 2

Impact of AI on Future Careers of TVET Graduates



The survey results show that most graduates (78.1%) agreed that artificial intelligence helped them acquire practical skills during their education. This proves that TVET students have knowledge of modern technology used in the teaching process.

Test of Hypotheses

There is no relationship between AI and Learning-Teaching process in TVETs

Table 3

There is a relationship between AI and Learning-Teaching process in TVETs

Response	Observed Frequency, O	Expected Frequency, E	Residual, (O - E)	$(O - E)^2$	
Strongly Agreed	391	114.8	277.2	76839.84	669.34
Agreed	113	114.8	-1.8	3.24	0.03
Neutral	25	114.8	-89.8	8064.04	70.24
Disagreed	33	114.8	-81.8	6691.24	58.29
Strongly disagreed	12	114.8	-102.8	10567.84	92.05
Total	574				889.95

Table 4

Test statistic

There is a relationship between AI and Learning-Teaching process in TVETs	
Chi-Square	889.95[a]
Df	4
Asymp. Sig.	.000

a. *0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 114.8*

The research therefore rejects the null hypothesis, "There is no relationship between AI and Learning-Teaching process in TVETs.*" as the calculated value of 889.95 is greater than the critical value of 9.49 at 5% level of significance.*

Therefore, the alternative hypothesis is accepted that "There is a relationship between AI and Learning-Teaching process in TVETs."

Test of hypothesis two

There is no impact of integrating artificial intelligence on assessment and grading process in TVETs.

Table 5

There is impact of integrating artificial intelligence on assessment and grading process in TVET

Response	Observed Frequency, O	Expected Frequency, E	Residual, (O - E)	$(O - E)^2$	
Yes	513	191.33	321.67	103471.59	524.14
No	47	191.33	-144.33	20831.15	108.88
Undecided	14	191.33	-177.33	31445.93	164.35
Total	574				797.37

Table 6

Test statistic

There is impact of integrating artificial intelligence on assessment and grading process in TVET	
Chi-Square	797.37[a]
Df	2
Asymp. Sig.	.000

a. *0 cells (0.00%) have expected frequencies less than 5. The minimum expected cell frequency is 191.33*

The researcher therefore rejects the null hypothesis, "There is no impact of integrating artificial intelligence on assessment and grading process in TVETs." *as calculated value of 797.37 is greater than the critical value of 5.991 at 5% level significance.*

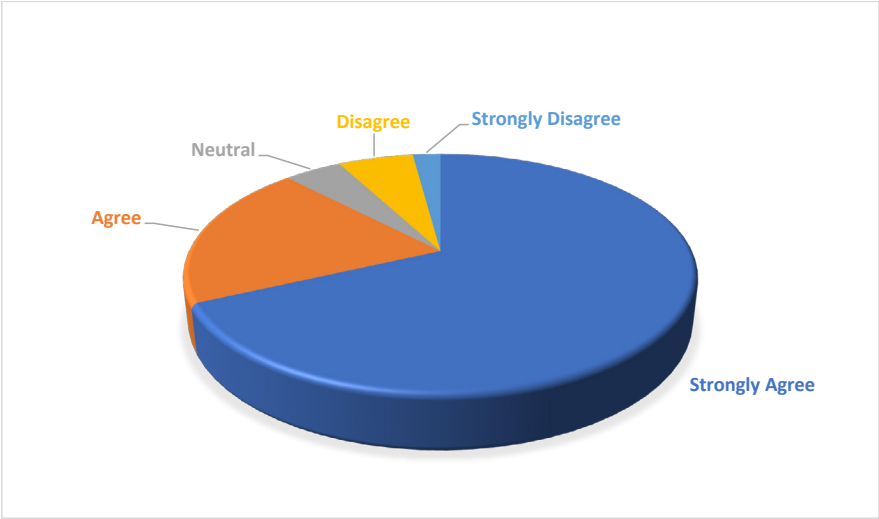
Therefore, the alternate hypothesis is accepted that states, "There is impact of integrating artificial intelligence on assessment and grading process in TVETs."

Impact of Artificial Intelligence on Teaching and Learning in TVET

There is a relationship between Artificial Intelligence and Learning and Teaching in TVET Available data tabulated as percentages indicate that, on average, most respondents 68.1% (n = 391) strongly agreed, 19.7% (n = 113) agreed, 4.4% (n = 25) were neutral, and 5.7% (n = 33) and 2.1% (n = 12) disagreed and strongly disagreed, respectively for the entire sample of 574 participants.

Figure 3

Impact of Artificial Intelligence on Teaching and Learning in TVET



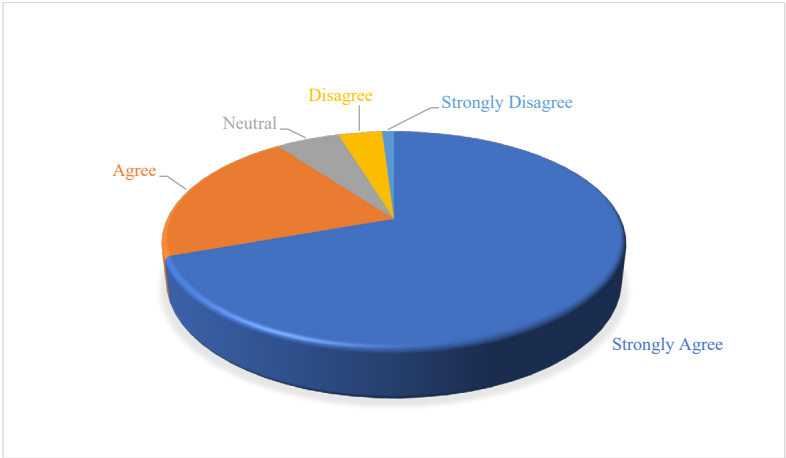
Based on the data collected from the respondents in relation to the two hypotheses, the following general percentages were calculated as shown in Figure 4.

Impact of Artificial Intelligence on TVET assessment and grading process

Regarding the impact of Artificial Intelligence on Assessment and Grading, most of the participants (399 respondents) agreed that Artificial Intelligence is effective. They also noted that it is more accurate and objective than humans in assessment, grading and evaluation. Figure 4.4 shows the proportion of the respondents on the impact of artificial intelligence on TVET assessment and grading process.

Figure 4

Impact of AI on TVET assessment and grading process



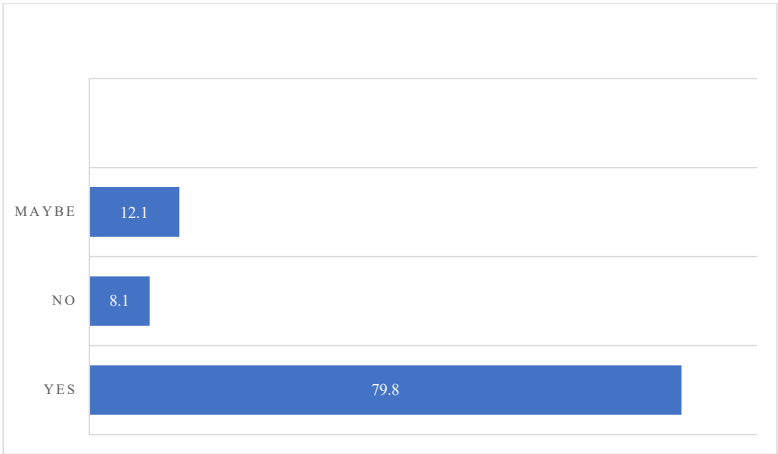
The findings are consistent with Brad Rose's (2019) views on the effectiveness and validity of artificial intelligence (Brad Rose Consulting, 2019 and Chin (2018). Other findings suggest that the use of AI in assessment and grading will be faster and allow students to receive timely feedback.

Impact of AI on the Future Careers of Graduates

Also, how will Artificial Intelligence impact the future careers of TVET graduates? Survey results showed that 79.8% of respondents believed the impact was positive, while 8.1% believed there was no impact. However, 12.1% were unsure whether the impact was positive or negative.

Figure 5

Impact of AI on the future careers of graduates



Therefore, results reveal that 79.8% think "Yes" we need to teach students new skills to meet future career requirements dictated by AI, with only 8.1% participants think "no" and 12.1% think "Maybe".

Table 7: *The impact of AI integrated courses to the TVET graduates towards the job market in the 21st century.*

Variables	Strongly Agree (5)	Agree (4)	Disagree (3)	Strongly disagree (2)
Administrators	66.7%	13.3%	13.3%	6.7%
Academic staff	82.6%	12.4%	3.0%	2.0%
Technical staff	57.2%	29.4%	9.0%	4.4%
Trainees	76.2%	12.3%	7.8%	3.7%
Alumni	81.5%	11.4%	4.2%	2.9%

Table 7 presents the participants' views on AI integration in TVET. The results showed that the integrated skills-related courses offered by TVET are relevant to the needs of the labour market. Most respondents agreed with this fact. The findings are consistent with Kisilu (2016) and Akpomudjere (2019) who stated that TVET courses are market-oriented. According to the findings, researchers interpreted this to mean that the use of ICT, with the necessary laboratory and training, plays an important role in the development of morality and affects cognitive and technical functions (Coward et al., 2017).

Discussion

Our data showed that 574 participants answered and responded to the survey, with an overall response rate of 100%. 65.7% of the participants were male and 34.3% were female. The majority of the participants were students (65.7%), academic staff (19.2%), technical staff (7.8%), administrators 1.7% and graduate students 5.6%. Existing literature and data demonstrate the impact of AI on learning and teaching in TVET. The inclusion of AI affects the technology used to deliver learning to students; because AI can include different types of slides and graphics while teaching. It also has an impact on graduates' future careers in the market and introduces them to business-relevant technologies.

Looking at the above results, most of the participants agree that artificial intelligence should be integrated into measurement and evaluation. Scores make the evaluation process more realistic and objective than manual evaluation and rating systems. According to the findings, the researcher explained that appropriate ICT, modern laboratories and training play an important role in improving ethical standards and influence the acquisition of TVET skills.

Conclusions and Recommendations

Conclusions

The use of artificial intelligence in education is rapidly increasing. Perrotta and Selwyn (2020) argue that this integration is useful in predicting future problems and increasing the effectiveness of teaching and learning for students. From the findings of this study, the use of AI has impacted more on the teaching learning process by making it simpler and easier and integrating smart devices that enable universal classrooms to accommodate visually impaired or hearing-impaired people and the students who cannot attend class due to illness.

Findings from the research show that AI will have a significant impact on TVET education in many areas, such as learning and teaching, assessment and marking, future employment and skills required for future education and graduate careers. In the assessment and grading process, AI has created a more efficient, faster, accurate process that also allows the trainees to receive a timely report. Further, the research showed that the skills acquired by the trainees upon completion of their courses are relevant and makes them well equipped for the job market. The graduates are able to perform tasks assigned to them in their careers and at the workplace as a result of the AI integration learning process they underwent. Based on the findings presented in this research paper, integration of Artificial Intelligence for Technical Vocational Education and Training, TVET is essential for all TVET organizations.

Recommendations

(a) Trainers and trainees need to be well trained in the use of artificial intelligence to effectively benefit from its immense impacts.

(a) The institutions and policymakers should ensure that strong value frameworks and ethical guidelines concerning the use of AI are put in place. Ultimately, technical education and training institutes should manage AI in a way that works for the benefit of humanity rather than destroying it.

(a) Public funding for AI initiatives, including research and development, industrial and investment funds, and related digital infrastructure

(a) The researcher also recommends affordable connectivity for all should be prioritized by governments in both policies and domestic spending. In line with growing calls for internet access to be considered a basic human right, governments and institutions should give priority to the infrastructure required to ensure strong national ICT infrastructure.

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2

GREENING AND DIGITALIZATION OF TVET AND LIFELONG LEARNING

Determinants of Green Transitions in Technical and Vocational Education and Training Institutions in Kenya

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Abstract

Taking urgent action to combat climate change and its devastating impacts is critical to save lives and livelihood, and key to achieving vision *2030 and Sustainable Development* goals. *The call to embrace environmentally sustainable practices has become crucial in Kenya and the contemporary world, where the Technical and vocational education and training (TVET) sector plays an important role in the development of workforce skills for a sustainable development. Greening TVET is an essential and cross-cutting theme for sustainable green mind-sets development and job creation. However, the extent to which TVET institutions in Kenya have embraced green transitions/growth remains unexplored. This study sought to address this gap by establishing the level of awareness of green transition practices. The study further established factors that determine the extent of greening the TVET institutions in Kenya. The research adopted a mixed-methods approach, incorporating both qualitative and quantitative methods. Qualitative data was collected through semi-structured interviews in sampled* forty-seven *TVET institutions with a total of 160 respondents across the country. Thereafter, a total of 140 filled questionnaires were collected. This translated to 87.5% response rate which the researcher considered an adequate representative. The data collected was analyzed using content analysis and statistical techniques. The study established that; most of the staff and students in TVET were not aware of some key green transitions' actions. Further, on the second objective, the study reveals that: Policy and Regulatory Frameworks; Funding and Resources; Awareness; Governance; Curriculum Integration; Infrastructure and Technology; Partnerships and Collaboration; Cultural and Environmental factors were key determinants of green transitions in most of the TVET institutions in Kenya. The study recommended strengthening policy and regulatory frameworks; increased funding and resources; enhanced awareness and capacity building; and incorporation of green transitions into the curriculum of the TVET institutions in Kenya.*

Keywords: Green transitions, greening, sustainable development goals.

Introduction

This study aimed at investigating the determinants of green transitions in Technical and Vocational Education and Training (TVET) in Kenya. The call to embrace environmentally sustainable practices has become crucial in Kenya and the contemporary world. To embrace these environmentally sustainable practices, the TVET sector will play an important role in the development of the workforce with the necessary skills for a sustainable development future. According to Singh & Feuerriegel (2013), Mustapha (2015), Mertineit (2016) and Cavanagh et.al (2013), greening TVET is an essential and cross-cutting theme for sustainable green mind-sets development. Greening TVET creates a large number of green jobs and opportunities while contributing to climate change mitigation and adaptation. It is strongly advocated as an international agenda by multilateral stakeholders in TVET including the United Nations and its specialized agencies, like the United Nations Educational, Scientific and Cultural Organization, UNESCO, International Labour Organization (ILO), Consumer Product Safety Commission (CPSC) and others. However, despite the global call for sustainable green practices, the extent to which TVET institutions in Kenya have embraced green transitions/growth remains unclear and unexplored. Jahonga, Ngore & Muramba (2015) study on transforming and greening TVET for sustainable development in western Kenya found out that the majority of TVET institutions had not integrated green growth or transition in training. This study sought to address this gap by examining the factors that hinder or facilitate the adoption of green growth practices in TVET institutions.

Objectives of the study

The specific objectives of the study were:

i. To establish the level of awareness of green transition practices in the TVET institutions in Kenya
ii. To establish factors that determine the extent of greening the TVET institutions,

Significance of the study

This study holds significant importance as it provides insights into the factors influencing the adoption of greening practices in the Kenyan TVET sector. The findings are valuable for policymakers, educational institutions, and stakeholders aiming to develop strategies that align TVET programs with sustainable development goals. Additionally, the study contributes to the existing body of knowledge on sustainability education within TVET contexts.

Through a comprehensive exploration of the factors affecting integration of green practices within TVET curricula and operations, this study provides insights that can inform policy decisions and educational strategies to promote sustainable development within the TVET sector.

Theoretical and Empirical Literature

Theoretical Literature

The study was built on theories of organizational change, diffusion of innovations, and sustainable education to provide a theoretical framework for understanding the factors influencing TVET greening. These theories guide the exploration of determinants, challenges, opportunities, and prospects within the context of educational institutions.

Empirical Literature

A review of existing literature was conducted to identify empirical studies related to TVET greening efforts, both in Kenya and internationally. This review helped contextualize the challenges and opportunities specific to the Kenyan TVET sector. Some of the studies reviewed include but not limited to: Pavlova (2016), Manase & Omondi (2019) and Walaba (2023)

Methodology

The research adopted a mixed-methods approach, incorporating both qualitative and quantitative methods. Target population included all registered TVET institutions in Kenya of which a sample of forty-seven TVET institutions were chosen. A total of 160 respondents were targeted. Qualitative data was collected through semi-structured interviews with TVET administrators, trainers and students. Quantitative data was gathered through surveys distributed to a representative sample of TVET institutions across different regions of Kenya. Stratified random sampling was used to ensure diverse representation. The data collected was analyzed using content analysis and statistical techniques.

Results and Discussions

Environmental sustainability has played an important role in providing sustainable development especially in the technical and vocational education and training (TVET) institutions. The institutions provide an instrument for equipping people with the required skills and knowledge that assist in adapting to and reducing the effects of climate change.

The success of green transformations in TVET centers depends on factors and conditions such as policy and regulation, funding and resource availability, understanding green change and management leadership, curriculum integration and pedagogical approach for green skills and competence development, infrastructure and facilities for green teaching and learning. The purpose of this study was to investigate the extent of awareness and adaptation to green transition in TVET institutions in Kenya.

Response Rate

160 semi-structured questionnaires were administered to the staff and students in forty seven TVET institutions in Kenya. Thereafter, a total of 140 filled questionnaires were collected. This translated to 87.5% response rate which the researcher considered an adequate representative. Edwards, Clarke and Kwan (2002) recommend a response rate of 80% and above.

Table 1

Response Rate

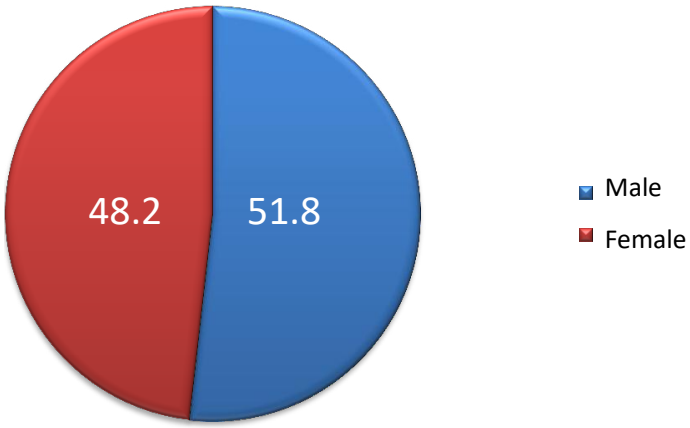
Response Rate	Frequency	Percentage
Filled	140	87.50
Not filled	20	12.50
Total	**160**	**100.00**

Gender of Respondents

The study intended to find out the extent to which different genders were aware about green transitions in TVET institutions among TVET trainees and trainers in Kenya**.** The study findings are expressed in Figure 1.

Figure 1

Distribution of respondents by Gender



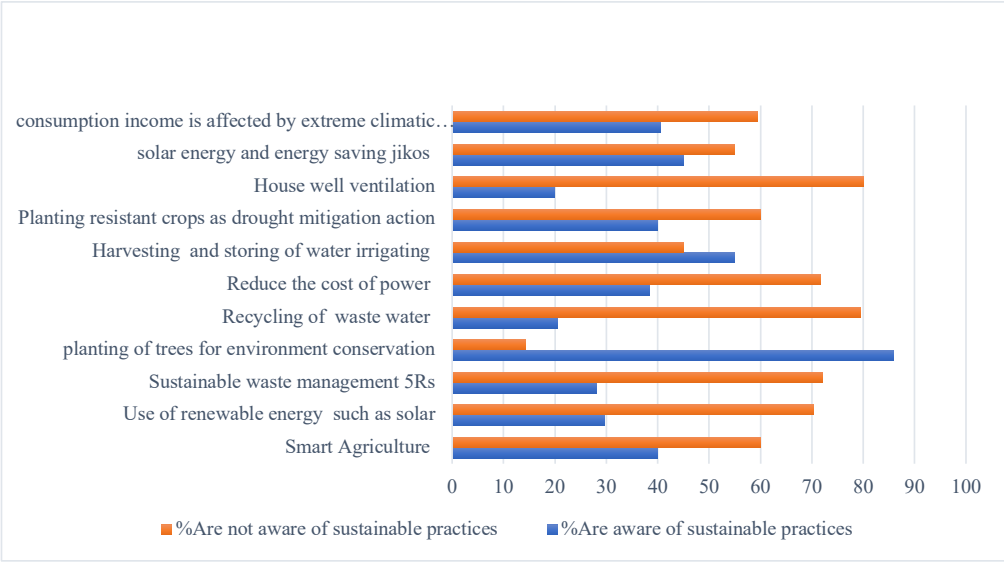
From Figure 1, a slight majority (51.8%) of the respondents were male while the remaining 48.2% were female. This is a clear indication that the distribution of questionnaires was representative in terms of gender parity among respondents.

Level of awareness about green transitions in TVET institutions among TVET trainees and staff in Kenya

The study sought to establish the level of awareness of green practices in TVET institutions in Kenya. The findings are presented in Figure 2 and Figure 3.

Figure 2

TVET Staff and trainee Awareness on Green Transitions



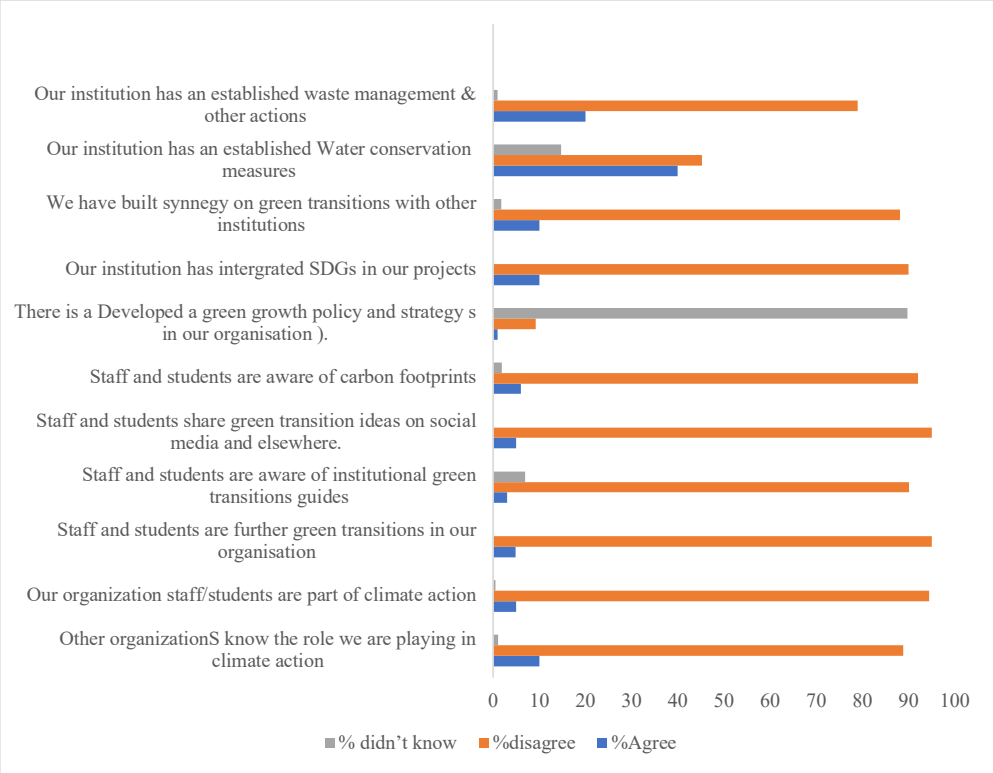
Based on results presented in Figure 2, the majority of TVET staff and students (60%) were not aware of the concept of smart agriculture while 40% of TVET staff and students were aware of sustainable practices in smart agriculture. This suggests a significant knowledge gap that needs to be addressed through awareness campaigns and educational programs. Only 29.7% of respondents were aware of sustainable practices regarding the use of renewable energy, such as solar energy. The remaining 70.3% of TVET staff and students were not aware of the importance of renewable energy sources. This finding highlights the urgent need to educate the TVET community on the benefits and significance of renewable energy. A large majority (72%) were not aware of the 5Rs (reduce, reuse, recycle, recover, and refuse) concept. This indicates a substantial knowledge gap that needs to be addressed to promote sustainable waste management within the institution.

A high percentage (85.8%) of the respondents were aware of sustainable practices related to planting trees for environmental conservation. Only 14.2% were not aware, indicating a relatively high level of awareness in this area. This finding suggests that the institution has already made progress in promoting awareness of the importance of environmental conservation through tree planting.

Finally, only 20.5% of TVET staff and students were aware of sustainable practices related to recycling waste water while the majority (79.5%) were not aware of this practice. Thus, it highlights a crucial area where efforts should be focused to educate individuals on the benefits and significance of recycling wastewater.

Figure 3

TVET Green Transition Actions



It is encouraging to observe from figure 3 that; 10% of TVET staff and students agreed that other organizations, including the government and private entities, know the role their institution plays in climate action. However, a significant majority of 88.9% disagreed with this statement, indicating a lack of external recognition. Only 5% of TVET staff and students agreed that their organization actively promotes students and staff to engage in climate action, while 94.5% disagreed. This suggests a potential gap in efforts to encourage participation in sustainability initiatives. A mere 4.9% of respondents agreed that staff and students are obligated to discuss how to further green their organization, with 95.1% disagreeing. This indicates a lack of proactive measures to involve stakeholders in shaping institutional sustainability goals.

While 3% of TVET staff and students agreed that staff and students are aware of institutional green guides available, a significant majority of 90.1% disagreed. This highlights a need for better communication and dissemination of resources to increase knowledge in this area. Additionally, 5% of respondents agreed that staff and students share green transition ideas on social media and other platforms, while 95% disagreed. This therefore, suggests a potential scope for enhancing awareness and fostering a culture of sharing sustainable practices. Furthermore, 6% of respondents agreed that staff and students are aware of carbon footprints, while 92.1% disagreed. Thus, it indicates a need for educational initiatives to improve awareness and understanding of carbon emissions and their impact on the environment. Only 1% of TVET staff and students agreed that there is a developed green growth policy and strategy in their institution, while 9.2% disagreed. A significant majority of 89.8% reported not having knowledge about such policies. This highlights a potential gap in institutional commitment towards sustainable development. TVET staff and students reported low levels of synergy between their institution and other government departments or non-governmental institutions in green transitions. The percentage of TVET staff and students who agreed that their institution has established water conservation measures was only 40%. These findings highlight the need for further actions to address water conservation and waste management practices.

Determinants of adoption of green transitions practices in TVET institutions in Kenya

The study further established the factors that affect adoption of green transition practices in TVET institutions. The respondents rated how their institution had progressed in each of the following factors that affect the adoption of green transitions. Each factor was measured on a scale of 1 to 5, with higher scores indicating greater progress or effectiveness in that particular area. The descriptive findings are presented in Table 2.

Table 2

Descriptive Statistics showing measures of central tendency (Mean Standard Deviation)

	Mean	Std. Deviation	N
Institutional Integration	2.28	1.274	140
Policy and Regulatory Frameworks	2.54	1.377	140
Funding and Resources	2.14	1.243	140
Awareness	1.44	.916	140
Curriculum Integration	2.69	1.082	140

	Mean	Std. Deviation	N
Governance	3.09	1.357	140
Infrastructure and Technology	2.69	1.088	140
Partnerships and Collaboration	1.77	.826	140
Cultural and Environmental	3.48	1.269	140

Table 2 provides descriptive statistics for nine different factors related to education. The mean scores in the factors vary from 1.44 to 3.48, the lowest-ranking factor is awareness with the mean score of 1.44. This implies that the respondents have little or no comprehension of this issue. However, the highest mean score is cultural and environmental at 3.48. This implies that progress or efficiency is rather advanced in this dimension or factor relative to the other ones. Each factor had a standard deviation, which is the measure of spread or variability of the scores in each factor. Among all the other factors, Partnerships and Collaboration and Awareness appear to be the most constant ones, having standard deviations of 0.826 and 0.916, respectively. For both of these factors, the scores around their means are very close. On the contrary, the factors with highest standard deviation are Governance and Policy and regulatory frameworks at 1.357 and 1.377.

Multiple Regression Analysis

The study ascertained the strength of associations between determinants of adoption of green transitions practices and Institutional integration (performance) of green transitions practices.

Table 3

Model Summary

Model	R	R^2	Adjusted R^2	Std. Error
1	.723	.523	.475	.31381

a. Predictors: (Constant), Policy and Regulatory Frameworks, Funding and Resources, Awareness, Curriculum Integration, Governance, Infrastructure and Technology, Partnerships and Collaboration, Cultural and Environmental factors.

The model summary results show a strong association (R= 0.723) between determinants of adoption of green transitions practices and Institutional integration (adoption) of green transitions practices. The adjusted R-Square value of study was 0.475 which implies that 47.5% of the Institutional integration (performance) of green transitions practices variance can be explained by determinants of adoption of green transitions practices.

Analysis of Variance

ANOVA was executed to test the regression model's goodness of fit. ANOVA recorded a 0.2% level of significance which implies that the analytical model has a goodness of fit and therefore reliable in establishing the associations between determinants of adoption of green transitions practices and Institutional integration (performance) of green transitions practices. The findings are as indicated in Table 4

Table 4

Analysis of Variance (ANOVAa)for comparing variances across means

ANOVA[a]					
Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	2.254	8	.2818	11.9915	0.002 [b]
Residual	3.076	131	.0235		
Total	5.730	139			

a. Dependent Variable: Institutional integration (performance) of green transitions practices

The result of the ANOVA analysis shows that the independent variables are related to the dependent variable. The regression model as confirmed by a F-value of 11.9915, P= 0.002 indicates that the model was statistically significant.

Regression Model

Institutional integration (adoption) of green transitions practices was used as the dependent variable. The explanatory variables included: Policy and Regulatory Frameworks, Funding and Resources, Awareness, Curriculum Integration, Governance, Infrastructure and Technology, Partnerships and Collaboration, Cultural and Environmental factors. The results are as indicated in Table 5.

Table 5

Regression Results

Model	**Coefficient**	**T**	**(p-value)**
(Constant)	.062	5.166	.000
Policy and Regulatory Frameworks	.206	3.212	.002
Funding and Resources	.264	3.034	.004
Awareness	.307	2.875	.001

Model	Coefficient	T	(p-value)
Curriculum Integration	.204	2.598	.0012
Governance	.129	3.516	.006
Infrastructure and Technology	.211	2.144	.034
Partnerships and Collaboration	.234	2.228	0.001
Cultural and Environmental factors	-.050	-.646	0.80

The equation for the regression model is expressed as:

$Y = 0.062 + 0.206X_1 + 0.264X_2 + 0.307X_3 + 0.204X_4 + 0.129X_{5+} 0.211X_6 + 0.234X_7 + -0.050X_8$

Where:

Y – Institutional integration (adoption) of green transitions practices (the dependent variable)

X_1- Policy and Regulatory Frameworks

X_2- Funding and Resources

X_3- Awareness

X_4- Curriculum Integration

X_5- Governance

X_6- Infrastructure and Technology

X_7- Partnerships and Collaboration

X_8- Cultural and Environmental factors

In the regression model above, each coefficient represents the effect of a specific independent variable on the dependent variable.

- Policy and Regulatory Frameworks account for 20.6% of the variation in institutional integration/ adoption.
- Funding and Resources explains 26.4% of the variation in institutional integration/ adoption.
- Awareness contributes 30.7% to the variation in institutional integration/ adoption.
- Curriculum Integration has a 20.4% impact on institutional integration/ adoption.
- Governance explains 12.9% of the variation in institutional integration.
- Infrastructure and Technology accounts for 21.1% of the variation in institutional integration.
- Partnerships and Collaboration contribute 23.4% to the variation in institutional integration.

The regression model suggests that various factors have different levels of influence on the institutional integration of green transition practices. The variables Policy and Regulatory Frameworks, Funding and Resources, Awareness, Curriculum Integration, Infrastructure and Technology, and Partnerships and Collaboration have positive effects on institutional integration, indicating that improvements in these areas contribute to a higher level of integration.

On the other hand, Governance and Cultural and Environmental factors have a relatively lower impact compared to other variables. The negative coefficient for Cultural and Environmental factors implies that they hinder or have a detrimental effect on the institutional integration of green transition practices.

Discussion

This study examined the determinants of green transitions in TVET institutions in Kenya. As depicted in Figure 1, the results reveal a slightly skewed gender representation among the respondents. The data showed that 51.8 % of the respondents were men and 48.2 % of them women. This meant that more male person's respondent to the questionnaire as compared to female persons. It should however be noted that the distribution shows that the questionnaires were not biased but fairly represented both genders. Regression analysis results indicated a considerable and positive relationship between determinants of adoption of green transitions practices and institutional integration of green transition practices. The model summarized shows that the variables have strong correlation (R=0.723) therefore there exists a significant relationship between the determinants and their integration within the institutions.

The 47.5% of the variations in institutions' integration could be explained by the determinants.In the case of the analysis of variance (ANOVA) p-value is 0.002. The F-test is used to evaluate the collective significance of the regression model, and this p-value is its level of statistical significance. For statistical purposes, a p-value of 0.002 meant that it is likely to obtain the observed F-statistic, or more extreme values, only in 0.2% occasions if null hypothesis holds.

In this context, the null proposition would be that the determinants of adoption of green transitions practices are not related to the institutionalization of green transitions processes. This indicates that all determinants – policy and regulatory frameworks, funding and resources, awareness, curriculum integration, governance, infrastructure and technologies, partnerships and collaboration, cultural and environmental factors had significant cumulative effects towards the enhancement Regression coefficients indicate that all these determinants contribute in a statistically significant and positive manner to the institutional integration.

These findings are consistent with the findings and recommendations found in the following studies; Pavlova, M. (2016), Manase, G. W., & Omondi, M. (2019) and Walaba, P. (2023). There are different challenges that affect these determinants, for instance, lack of funding, insufficient awareness, and unsatisfactory policy frameworks. Nevertheless, green transitions also provide opportunities such as work-force education for green jobs, innovations and research and adoption of climate change effects.

Conclusions and Recommendations

Conclusions

Although Kenyan TVET institutions acknowledge the importance of green transition, a number of impediments still limit its effectiveness. The determinants of green growth adoption in TVET institutions are outlined in the study to help appreciate the factors that shape green development. Green transitions are driven by policy and regulatory frameworks, funding and resources, awareness, governance, curriculum integration, infrastructure and technology, partnerships and collaboration, and cultural and environmental factors. Nevertheless, each determinant has corresponding problems that should be overcome.

Lastly, this study revealed the chances of going green. These involve training of the green job force, innovation and research opportunities, efficiency gains, compliance requirements, and adapting to climate change effects. These can further facilitate the green growth in TVET institutions towards the sustainable goals development.

Recommendations

(a) Based on the findings of the study, the following recommendations were proposed to promote green transitions in TVET:
(b) Strengthen policy and regulatory frameworks: There is a need to put in place measures that will promote environmental sustainability in TVET institutions. This may entail incorporation of sustainable environmental practices into curriculum and policy guidance for resource conservation.
(c) Increase funding and resources: Green transitions at TVET institutions require sufficient funding and resources. The government and other stakeholders should budget sufficiently and offer support to infrastructure development, training, and research.
(d) Enhance awareness and capacity building: Students, staff, and wider community need to be sensitized on the importance of green transitions. Capacity building programs, workshops and training sessions, must be arranged to enable individuals to acquire the knowledge, and skills for sustainable development.
(e) Foster partnerships and collaboration: However, collaboration between TVET institutions, industry and other stakeholders remains critical in enhancing green transitions.) Knowledge sharing, resource-sharing as well as innovative solutions to environmental problems can be achieved through partnerships.
(f) Incorporate green transitions into the curriculum: By integrating green transitions in the curriculum, the students will also be prepared well for sustainable development. This may involve the introduction of new courses or the integration of green approaches in existing ones.

(g) Promote a culture of sustainability: Green transition in TVET institutions requires a cultural shift to sustainability. Measures should be put in place to foster attitudes and values geared towards the protection of the environment and sustainable practices.

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Transformative Synergy: Greening Education and Digitization in Kenya's TVET Sector for Sustainable Development

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Abstract

In response to urgent global environmental challenges and rapid technological advancements, this research explored the synergistic integration of greening education and digitization within Kenya's Technical and Vocational Education and Training (TVET) sector. Positioned as a transformative pathway toward sustainable education, the study emphasized Kenya's vulnerability to environmental challenges and the profound impact of digital technologies on the educational landscape. Through qualitative content analysis, the research paper thoroughly examined policy documents, ongoing initiatives, and relevant case studies related to greening and digitization in the Kenyan TVET sector. The study revealed a commitment by Kenyan TVET institutions to embed sustainability principles and enhance digital literacy, incorporating initiatives such as digital libraries, tree planting, and green technologies. Policymakers crafted enabling policies, including the Green Economy Strategy and Implementation Plan (GESIP) and the National Open, Distance, and eLearning Policy (ODeL). Educators demonstrated adaptability by incorporating digital tools like solar-powered tablets. Challenges persisted, including resource disparities, curriculum implementation consistency, and socio-economic boundaries. Kenyan TVET institutions actively integrated greening and digitization, preparing trainees for a future emphasizing environmental responsibility and digital fluency. The synergistic integration positioned Kenya to make significant progress in achieving SDGs, contributing to environmental protection, economic growth, and social equity. Challenges persisted, requiring further research, and addressing resource limitations for hands-on environmental projects and sustainability education for trainers. To address challenges, a centralized fund for sustainability initiatives should be established, guided by policy frameworks. National TVET standards should incorporate sustainability guidelines, and specialized courses on green and digital technologies should be introduced. Specialized training programs for TVET instructors, facilitated by the TVET authority, should prioritize sustainable practices. Collaboration among TVET and sustainability stakeholders is crucial for a more inclusive, sustainable, and digitally vibrant future, aligning with national and global sustainability goals.

Keywords: Greening education, digitization, synergistic integration, sustainability.

Introduction

In the contemporary era marked by heightened environmental concerns and rapid technological innovation, Technical and Vocational Education and Training (TVET) emerges as a pivotal force for transformative change (Jasmi *et al.,* 2019). The urgency to address global environmental challenges and embrace digital technologies is more pressing than ever. The convergence of greening education and the digitization of learning presents a unique pathway toward sustainable education. Recognizing this, educational institutions worldwide, propelled by initiatives like the United Nations Sustainable Development Goals (SDGs), emphasize the role of greening education in TVET (Kanwar *et al.,* 2019). The COVID-19 pandemic has further accelerated the adoption of digital learning, underscoring the need for greener and more digitally integrated educational systems (Jarvinen, 2022). Beyond curriculum development, efforts to synergize greening education and digitization in TVET encompass sustainable infrastructure investments and the incorporation of digital tools for assessment, personalization, and accessibility (UNESCO-UNEVOC, 2019). This holistic approach aims to produce environmentally conscious, digitally competent learners capable of adapting to the evolving job market demands.

The TVET sector in Kenya is integral to the country's workforce development and economic growth (Wakiaga, 2023). Evolving from an academic-oriented system to a practical and skills-based approach, the sector has adapted to the changing demands of the labour market (Ngure, 2022). With 2,396 public and private TVET institutions as of 2021 (Statista, 2023), offering diverse courses from artisanal training to degree programs, the sector plays a crucial role in skills development and industry alignment (Kikwai, 2021; Langat, 2019). An environmentally conscious TVET sector in Kenya aligns with the achievement of SDGs, contributing to Vision 2030 and the objectives set in the Big 4 Agenda (Khatete & Chepkoech, 2018). TVET equips individuals with practical skills, fostering employment opportunities and entrepreneurship (Wanyeki *et al.,* 2018; Cheruiyot, 2022). However, amidst burgeoning environmental concerns and technological advancements, TVET in Kenya stands at the crossroads of transformative change (Odhiambo, 2023). The digital revolution is reshaping learning methods, demanding a nimble and tech-savvy approach beyond formal schooling (Barasa, 2021).

Research Objectives

To navigate these challenges, this research aimed to:

1. Analyze the current state of greening education and digitization in Kenya's TVET sector.
2. Identify challenges and opportunities in integrating sustainability principles and digital literacy.

3. Formulate recommendations for a more sustainable, inclusive, and technologically vibrant TVET landscape.

The TVET subsector in Kenya has deep historical roots, originating from indigenous traditions emphasizing practical skills transfer within community life (Ngure, 2022). In colonial times, missionaries contributed to the transformation of technical education, introducing skills like carpentry and agriculture (Mackatiani & Ejore, 2023). This marked the foundation for structured technical education, culminating in the establishment of the Native Industrial Training Depot in 1924 (King, 2007).

Post-independence, Kenya's TVET sector saw substantial governance changes with key statutes like the Technical and Vocational Education and Training Act of 2013 and the Industrial Training Act of 2011 (ROK, 2013; ROK, 2011a). These legislative frameworks established entities such as TVETA and NITA, shaping the institutional landscape for TVET in Kenya. The Kenya National Qualifications Framework Act of 2014 further standardized qualifications recognition, aligning with global benchmarks (Laws of Kenya, 2014). Despite these structural foundations, challenges persist in the TVET curriculum development landscape, including inadequate funding, inter-institutional tensions, and the need for clearer strategies (Ujana 360 Program, 2019). The transition from KICD to CDACC-curated curricula has faced implementation complexities, reflecting the evolving nature of TVET governance in Kenya.

Efforts to incorporate sustainability and digital literacy in TVET programs encounter hurdles, from curriculum inconsistencies to unequal digital resource access among institutions (KTTC, 2021). The Ujana 360 program's survey reveals challenges in entry levels, infrastructure, and learning environments, highlighting the need for a more coordinated and resource-aligned approach (Ujana 360 Program, 2019). Internationally, countries like Finland, Sweden, and Singapore showcase integrated sustainability frameworks in education, fostering environmental awareness and conservation (Manni, 2023; Mykrä, 2023; Zguir et al., 2021). Digital technologies have become a global phenomenon in education, with nations like South Korea, Estonia, and the UAE embracing digitization to foster innovation and critical thinking (Cha & Kwon, 2018; Oyetunde, 2023). Kenya's journey in adopting sustainability practices and digital education aligns with global trends, resonating with UN SDGs and Vision 2030 (Nalugala, 2020; Kembo et al., 2019). However, challenges persist in bridging urban-rural technology gaps and ensuring teacher capabilities in sustainability education and digital proficiency (Nyatuka, 2020).Therefore, addressing the challenges and seizing the opportunities in Kenya's TVET sector requires a comprehensive understanding of the current state of greening education and digitization. By analyzing the historical context, legislative frameworks, and international best practices, this research seeks to formulate recommendations for a more sustainable, inclusive, and technologically vibrant TVET landscape in Kenya.

Greening Education in TVET

Chinedu *et al.,* (2018) proposed a sustainability literacy curriculum for TVET teacher training in Malaysia using a modified Delphi method. While valuable, this study may not fully address Kenya's unique challenges. A transformative synergy-focused study is needed to integrate sustainability and digital literacy in Kenya's TVET, aligning with Vision 2030 and UN SDGs. Pavlova & Chen (2019) suggested a pedagogical model for green skills development in TVET, but its applicability to Kenya is uncertain. A tailored study for Kenya can bridge the gap between literature and practice, evaluating local challenges and aligning with national policies. Roofe and Ferguson (2018) explored ESD integration in Jamaican TVET, but the geographical focus limits universal applicability. A study focusing on transformative synergy in Kenya's TVET sector can adapt its findings to local contexts. Njuki & Mukundi (2021) examined digital libraries' impact on green learning in Nyeri County, Kenya. While insightful, a broader study across regions can enhance generalizability and explore the potential impacts of transformative synergy.

Digitization of TVET

Abdul Razak *et al.,* (2022) assessed digital learning in a Malaysian university during the pandemic. However, the study's limitations hinder its generalizability. A transformative synergy study in Kenya is warranted for clearer insights. Njuki and Mukundi (2023) explored information literacy integration at Nyeri National Polytechnic during the pandemic. A more inclusive study in Kenya, encompassing transformative synergy, is needed to align with national educational policies Grech and Camilleri (2020) offered a global perspective on TVET digitization.

A focused study within Kenya is necessary to provide specific insights for the country. Wekesa's (2020) dissertation on digital literacy in Bungoma County's TVET institutions lacks a broader scope. A transformative synergy study across diverse institutions in Kenya is essential for comprehensive insights. Mahdi & Wani's (2021) study on e-learning adoption in Afghanistan has limitations in scope.

A comparative transformative synergy study between Afghanistan and Kenya is justified, considering unique socio-cultural, infrastructural, and educational contexts. Agallo's (2023) research on e-LMS adoption in Nairobi County provides valuable insights. However, a transformative synergy study within Kenya's TVET sector is necessary for a more comprehensive understanding.

Methodology

This paper employed qualitative content analysis, a method often used to analyze textual information in qualitative research (Mayring, 2019 and Selvi, 2019). Under this approach, the appropriate texts and data sources that aligned with the research objectives, including surveys, documents, articles, policy documents, ongoing initiatives, and relevant case studies were first identified and selected. Through the data thorough content analysis was conducted to capture key concepts, themes, and patterns to represent the meaningful context of the study.

Results and Discussions

Current State of Greening Education and Digitization in Kenya's TVET Sector

The qualitative content analysis of the identified textual data produced several codes that highlighted themes that coalesced around policy documentation and regulatory frameworks, ongoing initiatives, and cases of successful greening and digitizing TVET in Kenya.

Policy Documentation and Regulatory Framework

Kenyan policymakers acknowledge the importance of greening and digitizing Technical and Vocational Education and Training (TVET) for sustainability. The Ministry of Education implements the Green Economy Strategy and Implementation Plan (GESIP), aligned with Vision 2030, emphasizing Education for Sustainable Development (ESD) through curriculum reforms and capacity building. The Kenya Youth Development Policy (2019) aligns with global agendas, focusing on youth empowerment, education access, and economic opportunities, contributing to a green and informed youth population (Nyakiangana, 2022).

The National Environment Policy (2013) addresses environmental challenges, emphasizing governance and public engagement, aligning with greening efforts in the educational sector (ROK, 2013). The National Open, Distance, and eLearning Policy for TVET in Kenya supports equitable and flexible education, contributing to greening by promoting accessible and quality TVET education through digital learning (KTTC, 2016). Kenya's Regulatory Framework, including Vision 2030 and the TVET Act of 2013, prioritizes education, inclusivity, and quality assurance.

The Presidential Working Policy on Education Reforms emphasizes digital literacy and sustainability, aligning with President Ruto's vision. The Marrakech Framework for Action strengthens adult education, emphasizing governance, quality, and investment, contributing to greening education and digital advancement in Kenya's educational landscape.

On-going Initiatives Targeting Greening and Digitizing of TVET

President William Ruto's commitment to sustainable development in Kenya is evident through initiatives within the Technical and Vocational Education and Training (TVET) sector (PWPER, June 2023). To address challenges like inadequate infrastructure and digital literacy, the Presidential Working Party on Education Reforms (PWPER) emphasizes policy frameworks, industry partnerships, gender inclusivity, unified management, and public-private collaborations (PWPER, June 2023). The Jitume Lab initiative, aligned with the National Education Sector Strategic Plan and Kenya National Adaptation Plan 2015-2030, empowers youth for the 4th Industrial Revolution by providing digital access, learning opportunities, and certification (Kenya Kwanza).

The Curriculum-Based Education and Training (CBET) initiative, supported by the Ministry of Education (MOE,2017), focuses on competency-based curricula emphasizing digital literacy, green skills, and sustainability, contributing to Kenya's 2030 middle-income goal. The Kenya Forestry Research Institute (KEFRI) plays a key role in a green initiative by supplying tree seeds to 210 TVET institutions, aiming to cultivate 20,000 tree seedlings for the 2023/2024 planting season. This collaborative effort between the Ministry of Education and the Ministry of Environment supports President Ruto's ambitious plan to plant 15 billion trees in a decade, highlighting the importance of TVET participation in achieving this target (KEFRI, Ministry of Education). Such initiatives not only address socio-economic factors influencing educational transitions but also bridge skill gaps in the TVET sector, contributing to a more sustainable and resilient future for Kenya.

Case Studies of Greening and Digital Integrations

Kenyan TVET institutions, such as the Kenya Technical Trainers College (KTTC), have shown a commitment to integrating sustainability and digital literacy into their programs (KTTC, 2021). Mukundi and Njuki (2019) emphasized the transformative synergy needed in TVET institutions in Nyeri County, Kenya, advocating for green learning and training through Digital Libraries. They highlighted the positive impact of digital libraries on competency-based education and training (CBET) for sustainable development. Jahonga *et al.,* (2015) studied efforts to green TVET in Western Kenya, identifying barriers like lack of resources and skills. They proposed a paradigm shift in Technical Training Institutes (TVET) to effectively adopt green technologies. Kibondeni College, in collaboration with industry partners, launched the Kibondeni Sustainable Greening TVET initiative on June 2, 2023, aiming to unite technology and industry alliances for digitalization and sustainability. Notable guests planted trees symbolizing a joint commitment to sustainability. Kibondeni, with expert partners, seeks to embed green solutions in curriculum and facilities for a digitally conscious world.

Don Bosco Technical Secondary School Embu, supported by DB Tech Africa's Global program, focuses on a Green Campus, Community, and Culture. Collaborating with the Planning and Development Office, they've established tree nurseries in five counties, initiating afforestation drives during the rainy season for sustainable environmental preservation. The initiative also plants fruit trees for local community and biodiversity benefits, highlighting the significance of partnerships for lasting environmental objectives.

Challenges and Opportunities in Integrating Sustainability Principles and Digital Literacy

The study highlights efforts to integrate sustainability and digital literacy into Technical and Vocational Education and Training (TVET) in Kenya but reveals challenges in curriculum implementation, access to digital resources, and trainer competencies across institutions (Odondi *et al.,* 2022). Despite a commitment to technology integration, disparities persist, necessitating greater synergy between environmental sustainability and technology in educational programs (Jebungei, 2020). Policymakers in Kenya recognize the importance of technology in education but struggle with resource allocation and equitable access, particularly in rural areas lacking basic infrastructure (Daily Nation, 2021). Educators show adaptability by incorporating digital tools into teaching, considered enhanced training, yet uneven student access to digital resources, especially in underserved areas, remains a concern (Odondi *et al.,* 2022). Although trainers introduce hands-on eco-conscious projects, further research is required to assess their long-term impact on students' environmental attitudes and behaviours (Mukundi & Njuki, 2019; Walaba, 2023).

Discussion

This study contributes valuable insights to the discourse on greening and digitizing Technical and Vocational Education and Training (TVET) in the context of a developing nation. Policy and regulatory frameworks have been established to guide these initiatives, aligning with existing literature and advocating for qualified teaching staff in the implementation of sustainable TVET reforms (Edel, 2022). Paryono (2017) emphasizes the importance of incorporating sustainable development into the TVET curriculum and institutional policies, reinforcing the study's focus on policy guidelines in TVET. The study highlights that various colleges have initiated efforts in line with global trends toward green practices and digital integration in education. Acknowledging the pivotal role of education in promoting sustainability and harnessing digital technologies, the study aligns with global advancements in greening education and digitization (Abad-Segura *et al.,* 2020; Grishaeva *et al.,* 2020). Kenya's incorporation of Education for Sustainable Development (ESD) in TVET aligns with countries like Finland, Sweden, and Singapore, which have comprehensive frameworks emphasizing environmental awareness and ecological preservation (Manni, 2023; Mykrä, 2023; Zguir *et al.,* 2021).

Kenya's commitment to the global trend of integrating digital technologies into education is evident through the establishment of a Sustainable Education Framework. This mirrors efforts in South Korea, Estonia, and the United Arab Emirates, advocating for e-learning platforms, coding education, and digital literacy (Cha & Kwon, 2018; Oyetunde, 2023). The fusion of green and digital technologies fosters innovation, critical thinking, and problem-solving skills essential for addressing sustainability challenges in our increasingly technology-centric world. Despite challenges such as resource disparities and implementation consistency, the study proposes a synergistic approach between greening education and digitization in TVET. This synergy holds promise for promoting eco-consciousness among learners, utilizing interactive digital platforms for virtual simulations and immersive experiences (Hameed, 2023). Virtual field trips to eco-friendly transitional metrics through digital technologies reinforce a culture of sustainability within the TVET sector Arisa and Wangari (2022).

Green technologies, such as solar-powered classrooms and energy-efficient devices, offer infrastructure enhancements for TVET institutions, especially in areas with limited access to the electrical grid (Irena, 2019). These technologies reduce energy costs and ensure a consistent power supply, facilitating uninterrupted learning experiences. Additionally, digital technologies in TVET programs bridge geographical and socio-economic disparities, providing access to quality educational content (UNESCO,2020). E-learning platforms enable personalized learning, allowing students to progress at their own pace and enhancing digital literacy skills crucial for success in modern technical careers (Hoftijzer *et al.,* 2020).

Conclusions and Recommendations

Conclusions

Kenyan TVET institutions and educators are actively incorporating greening and digitization into technical education, aligning with sustainable development goals. The establishment of a sustainable education framework reflects a positive shift, preparing trainees for a future emphasizing environmental responsibility and digital fluency. Initiatives in Kenya leverage green and digital technologies to enhance education accessibility, transcending geographical and socio-economic barriers. These inclusive approaches contribute to a more equitable and digitally connected educational landscape. The synergistic integration of greening and digitization positions Kenya to make significant progress in achieving SDGs, particularly in TVET. These efforts support environmental protection, economic growth, and social equity, showcasing Kenya's commitment to providing high-quality, inclusive, and environmentally conscious education. However, challenges persist, including resource disparities, implementation consistency, and the need for more research. Despite advancements, there's untapped potential in green and digital technologies for revolutionizing technical education's delivery, accessibility, and eco-consciousness.

Ongoing challenges include resource limitations for hands-on environmental projects and sustainability education for trainers, hindering the development of environmentally responsible citizens. Addressing these issues will further enhance the positive impact of integrating greening and digitization into TVET in Kenya.

Recommendations

To tackle the greening and digitization challenges in Technical and Vocational

Education and Training (TVET) institutions, establishing a dedicated fund for sustainability initiatives guided by policy frameworks is essential. This fund would support eco-friendly practices, acquire modern green technology training equipment, and offer grants for environmentally conscious projects. National TVET standards should integrate sustainability guidelines, emphasizing eco-conscious practices in curricula and operations. Regular evaluations would ensure compliance with these standards.

Specialized courses or modules on green and digital technologies should be introduced across disciplines, providing hands-on training in renewable energy, sustainable agriculture, eco-friendly construction, and digital skills. Training programs for TVET instructors should prioritize sustainability practices, enhancing their ability through workshops and seminars.

The TVET authority, with support from CDAAC, should emphasize sustainability integration throughout curricula to promote eco-consciousness and responsible citizenship. Encouraging interdisciplinary approaches highlighting the intersection of technology, environmental stewardship, and societal needs is crucial.

The synergy between greening education and digitization in Kenya's TVET sector is vital for sustainable development. Collaboration among TVET and sustainability stakeholders can foster a more inclusive, sustainable, and digitally vibrant future, advancing Kenya's TVET system towards a more equitable, environmentally responsible, and digitally connected educational landscape, aligned with national and global sustainability goals.

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Sustainability Drivers and Growth of Technical and Vocational Training Institutions in Kenya: A Case Study of Vihiga County

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Abstract

Despite the fact that appropriate Technical and Vocational Education and Training (TVET) is critical to the attainment of the Millenium Development Goals (MDGs), the 2063 African Agenda, and Vision 2030, studies have shown that in low- and middle-income economies, Technical and Vocational skills do not match the needs of the labour markets. This study sought to establish the effects of sustainability drivers on performance of TVET institutions in Kenya. The study was anchored on three specific objectives namely; to establish the effect of skill development on growth of TVET institutions in Kenya, to determine the effect of innovation on growth of TVET institutions in Kenya and to establish the extent to which strategic partnerships influences growth of TVET institutions in Kenya. The researcher used descriptive research design. The target population was derived from Technical and Vocational Colleges (TVCs) and Vocational Training Centres (VTCs) in Vihiga County. Vihiga County has four TVCs, managed by the National Government and 30 VTCs, managed by the County Government. Purposive sampling was used to sample 180 respondents that included Principals or Deputy Principals, Registrars and Academic departmental heads from the institutions. The data collected through questionnaires were analysed using Statistical Package for Social Sciences (SPSS). The findings showed that sustainability drivers namely Skill development (r=.707), innovation(r=.645) Strategic partnerships (r=.175) have a positive and significant relationship with growth of TVET institutions in Kenya. It is therefore important to transform TVET from a second-tier education track to one that provides high-quality and relevant skills training. Technological improvements also give considerable opportunity for middle-income nations to reform TVET collaborations between industry, government agencies, politicians, education providers, businesses, and development partners is essential for the successful implementation of TVET reforms.

Keywords: Sustainability drivers, Skill Development, Innovation, Partnerships, Growth, TVET Institutions.

Introduction

While the overall goal of Technical, Vocational Education and Training (TVET) is to produce qualified graduates for a competitive and vibrant economy, the findings of a joint study by World Bank, UNESCO and International Labour Organization revealed that in many low- and middle-income economies the skills do not match labour market needs. The findings raised questions regarding the suitability of the training programs since the countries rely on them for economic transformation, industrialization and sustainability (Paryono, 2017). According to UNESCO-UNEVOC (2017), TVET is concerned with the acquisition of knowledge and skills for the workplace. Apprenticeship training, vocational education, technical education, technical and vocational education, professional and vocational education, occupational education, and workforce education are some of the several designations.

Many countries, regional blocs, and associations around the world are emphasizing TVET as an important driver for the development of economies. The TVET is prominently featured in the important and strategic agendas of regional and economic organizations. The European Union (EU), Caribbean Community, African Union are examples of organizations that have placed great emphasis on empowering TVET for economic and social sustainability. Their impact has been felt within and beyond their respective regions (Gyimah, 2020). Technical and vocational training is commonly prioritized in both developed and developing countries due to a scarcity of human capital with critical skills and technical competence. Many governments are emphasizing TVET to drive national progress and education agendas (Marope, Chakroun, & Holmes, 2015).

Skills developed through TVET have been shown to improve living standards by providing graduates with the essential skills to obtain, create, and keep jobs. These abilities also aid in the resolution of economic, social, and environmental issues. These abilities also enable the kids to enter the workforce, engage in entrepreneurship, and become more robust in the face of market changes that demand flexibility, resulting in increased productivity and salaries. Skills development has shown to be one of the driving forces behind the achievement of the UN Sustainable Development Goals 4 and 8 (Pambudi, & Harjanto, 2020).

In Africa, TVET is a critical subject for the continent's economic success and increased productivity. As a result, there is a compelling economic argument for investing in TVET. This argument emanates from an understanding that TVET gives a crucial platform for the knowledge, skills and technology required to transform into a knowledge-based society capable of adapting to modern times and the future. Technology, knowledge, and advanced skills are very key for a country's global competitiveness.

Improved international appeal can lead to greater political and economic power stability, which contributes to global stability and peace (Allais,2022). In Uganda, the ministry of labour has put emphasis on TVET, pointing out that university graduates have been fighting for few available jobs unlike TVET graduates who are job creators. Employment creation is a key element contributing directly to economic and social sustainability of a nation. An economy with graduates without technical skills worsens the unemployment status of the citizens (Okumu & Bbaale,2019).

The Kenyan government views TVET as a vehicle that provides both formal and informal training which culminates in acquisition of technical and professional competencies which are key for onboarding the country on a growth trajectory. As a result, the agenda concerning TVET development in Kenya conjures major themes in The Constitution, and development plans such as The Vision 2030, Big Four agenda and the Bottom-Up Economic Transformation Agenda (BETA) (KIPPRA, 2018).

Skill Development and growth of TVET Institutions

Countries have diverse approaches to offering higher education major developments. Technical and vocational training can be traced from the efforts of universities to offer technical education. The latter has been associated with mismatch of skills, thus emergence of efforts to streamline skill development in technical and vocational training institutions. Developed countries have taken the lead in refining technical and vocational education emphasizing approaches such as engaging industry stakeholders in curriculum design, dual learning, competence-based evaluation and testing among others. With the trend toward higher education, educational institutions are increasingly moving away from their traditional role of producing and disseminating academic information and focusing more on developing employable skills. The result is a shift towards professionalization of higher education and the integration of academic and professional learning.

Vocational training now plays an important role in the advancement of skilled workers. Although vocational education is no longer classified as secondary education, several measures are still needed to strengthen its mission, strategy, implementation, and monitoring in an environment of global trends. In other words, innovations in VET delivery in the context of VET governance and management, teacher training, curriculum and pedagogical challenges, social partners and VET, and private and public engagement all help to better establish existing education systems. and management needs to be revisited. Operating the VET system effectively (International Labor Organization, 2010).

Vocational training efforts therefore need to be tailored to the needs of the 21st century skills and new economy workforce. Alagaraja and Kim (2014) conducted a literature review to identify the various components of the vocational education to develop a framework that inculcates development of human resources. Three key themes were highlighted. Theme one provides nine elements for the success of technical and vocational institutions. These include a national TVET policy, regional TVET policies, training, participation, curriculum, coordination of stakeholder and organizations, aligning attitudes of individuals and organizational towards skills, managing mismatches between demand and supply, supply, economic and includes social development outcomes. Theme two entails dealing with the overlap and workforce interdependence, economic development and social development Theme three entails an effective technical and vocational training system that connects the two aspects.

The findings of Iqbal (2022) which focused on the existing skill development scenario in Bangladesh also analyzed the challenges in skill building and its impact on employment and finally included the need for creation of vocational education-based curriculum. The author recommended several policy options to ensure that as many students as possible participate in national skills development programs in other areas of education.

Chandrasekar and Murugesan (2019) investigated policy issues and best practice models for an enabling system for synchronizing a systemic approach for skills training and vocational and technical education in a country like India. In response to the sector's size, scope, and demand, policy governing technical education, skills training, and apprenticeship training has changed. The difficulty remains in establishing how systems must respond to overall needs while taking local and regional requirements into account in a global context.

Innovation and Growth of TVET Institutions

Many studies have been undertaken by researchers on the innovation leadership attributes associated with a variety of leadership styles viewed from various perspectives. Innovation leadership is key to boosting corporate success. As a result, in order to ensure success and remain competitive in the light of a dynamic environment and changing technology. Innovative leadership is a key driver to innovative thinking and development. (Osman & Kamis, 2019).

According to Mbore (2021), respondents were enthused about pursuing entrepreneurship as a career option. Students are not actively engaged in entrepreneurial activities at TVET colleges, however, due to a lack of an adequate platform or infrastructure. The study also concludes that TVET institutions should prioritize entrepreneurship education in order to provide graduates with key inputs to achieve personal, strategic and enterprise goals. To achieve a greater market share, TVET graduates must be prepared with entrepreneurial skills that will allow them to grow their businesses or places of employment.

Strategic Partnerships and Growth of TVET Institutions

Siddiky and Uh (2020) examine current patterns in Hong Kong, China, India, and Malaysia, where government policies over the previous two decades have prepared the path for rapid expansion of these industries, resulting in new job opportunities and skill requirements for young people. It examines how these are satisfied and highlights some effective approaches from governments and TVET providers. Finally, it proposes an evidence-based, holistic approach to facilitate the construction of road maps applicable to various situations, extending beyond TVET to all levels of education, and involving close collaboration between governments, industry, civil society, and education.

Due to the high level of unemployment and the desire for technological advancement, industrialization, and economic expansion, TVET is in great demand all over the world. Oviawe (2018) investigated the necessity for PPP in TVET, strategic challenges for TVET in Africa, TVET reforms, PPP models for skill development, and methods of revitalizing TVET through PPP. PPPs, according to the paper, should be encouraged. It is also recommended that TVET colleges and industry share tools and equipment in order to keep learners up to date on advancements in the workplace.

A survey conducted by Kayere, Schmidt, & Paquin (2018) on the collaboration and partnerships between TVET institutions and industry to improve skills development in Kenya showed that the industry partners were generally less satisfied with their collaboration and partnerships with the institutions, with only 25% satisfied. Furthermore, just 8.8% of industry partners polled believe TVET delivery is demand-driven and competency-based. Employers believe that collaborations between industry and training institutions are vital to ensuring TVET course curriculum is relevant and linked to job capabilities, and that industry is involved in training to reduce the need for re-skilling. Partnership arrangements, collaborative applied research projects between industry and TVET universities, and coordinated industry interactions can all help.

Problem Statement

In the modern era, TVET is a key component of lifelong learning and plays an important part in achieving the goals of a culture of peace, environmentally sound sustainable development, social solidarity, and global citizenship. While TVET can assist in the development of a new generation of people who will face the task of achieving long-term socioeconomic growth (Kossey & Ishengoma, 2017), Technical and vocational education and training in is not aligned with skills and labor market needs, according to a joint study by the World Bank, International Labor Organization (ILO) and UNESC (2020).

Despite the fact that relevant technical and vocational training is critical in the process of accomplishing the Millennium Development Goals, the 2063 African Agenda, and Vision 2030, this remains the status to date, the sector's potential still remains underutilized. If not addressed the implications include waste of funds and other resources invested in TVET, widening of unemployment, low contribution to economic growth and development among others. The study sought to establish the effects sustainability drivers have on growth of Technical and vocational Training institutions in Kenya.

Objectives of the Study

The general objective of the study was to assess the sustainability drivers in the TVET sub sector in Kenya. The specific objectives were to:

i. Establish the effect of skill development on growth of TVET institutions in Kenya.

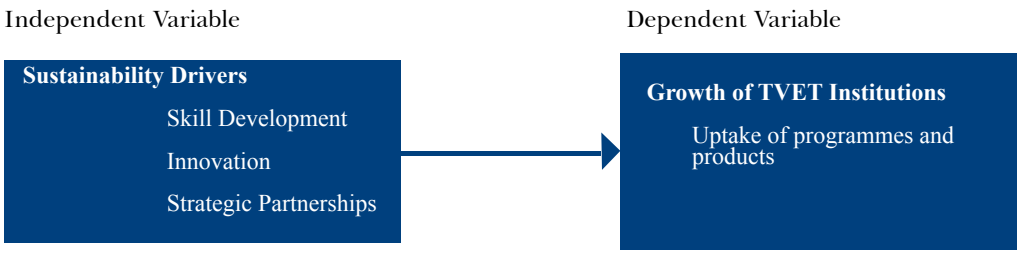
ii. Determine the effect of innovation on growth of TVET institutions in Kenya;

iii. Establish the extent to which strategic partnerships influences growth of TVET institutions in Kenya.

Conceptual Framework

Figure 1

Conceptual Framework



Methodology

The researcher employed a descriptive study design, which entails explaining the current condition of affairs using data gathered via surveys and interviews. Correlation analysis was also utilized to determine the link between the dependent and independent variables. Descriptive research, according to Creswell (2014), aims to identify factors linked with certain occurrences, outcomes, situations, or types of behaviour. The target population was derived from National government TVET Institutions and County Government Vocational training centres. Vihiga County has 4 National government TVET institutions and 30 County government Vocational training centres.

Purposive sampling was used to sample the principal or deputy, registrar and academic departmental heads were sampled from the institutions thus an average of 6 respondents per institution thus a sample of 180. The categories of personnel were preferred because they have information about study variables such as skill development, innovation and strategic partnerships. Data was collected through a questionnaire. The responses were analysed using Statistical Package for Social Sciences (SPSS).

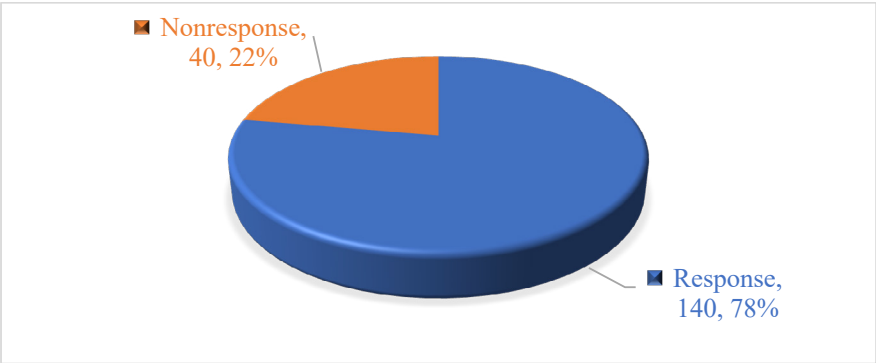
Results and Discussions

Response Rate

Out of the 180 questionnaires issued,140 were returned. The response rate was 70%, which is over the 65% threshold that Bryman (2019) considers to be a satisfactory response rate. As such, conclusions, suggestions, and decision-making can be based on the findings.

Figure 1

Response Rate



Statements on Skill Development

Individuals who lack relevant skills are more likely to be unemployed, endure employment insecurity, and struggle to cope with the labour market's continual fluctuations. Several studies have found a link between an individual's educational achievement and their participation in civil society, improved mental and physical health, and social engagement. As a result, skills and employability are critical contributors to poverty alleviation, improved social cohesion, and higher political stability. The respondents were asked to rate their agreement with a number of statements about skill development in their institutions. Respondents (39.3%) indicated Skills imparted to TVET trainees are in line with market needs. Technical skills have made trainees adoptable in industry at 26.4%. The remaining 15.7% indicated that Professional skills are imparted to establish and build a career.

The findings are in line with Ngware, *et al.*, (2022) that skill development enables the youth to acquire technical, management and interpersonal skills. The skills enable them to venture into entrepreneurship and also contribute to industrial development.

Table 1: *Statements on Skill Development*

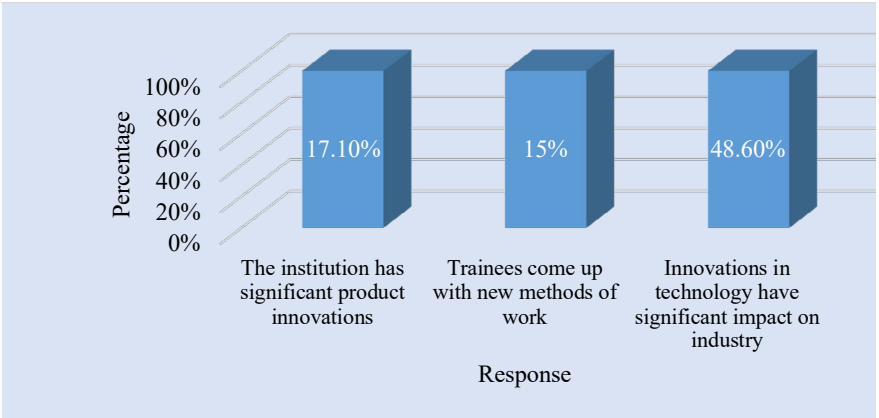
		Frequency	Valid Percent
Valid	Skills imparted to TVET trainees are in line with market needs.	55	39.3
	Technical skills have made trainees a doptable in industry	37	26.4
	Professional skills are imparted to establish and build a career	22	15.7
	Total	140	100.0

Innovation

Respondents were asked to indicate the degree to which they agreed with a number of statements on innovation in the technical. Respondents (17.10%) agreed that their institutions have significant product innovations,15% that trainees have come up with new methods of work and 48.5% that innovations in technology have significant impact on the industry. The findings are in line with Obe, Madu & Onah (2021) that TVET institutions contribute to generating solutions to industry-based problems. Innovations have the potential of placing TVET institutions on the global map and growth trajectory. The benefits of such innovations are accrued to both the innovators and end users. The results are shown in Figure 2.

Figure 2

Statements on Innovation



Strategic Partnerships

The respondents were requested to express their opinion on various statements on strategic partnerships in the technical and vocational institutions. Majority of the respondents at 37.1% indicated that Strategic partnerships provide learning opportunities followed by 35% Strategic partnerships support technology transfer. The remaining 27.9% indicated that the institution partners with stakeholders in various sectors. The findings are in line with Nölting, Molitor, Reimann, Skroblin, & Dembski, (2020) that technology transfer unlocks new potentials in institutions of higher education by providing access to new possibilities. The findings are presented in Table 2.

Table 2

Statements on Strategic Partnerships

	Frequency	Percentage
The institution partners with stakeholders in various sectors	39	27.9
Strategic partnerships support technology transfer	49	35.0
Strategic partnerships provide learning opportunities.	52	37.1
Total	140	100

Correlation

The findings show that Skill development (r=.707), innovation(r=.645) Strategic partnerships (r=.175) have a positive and significant relationship with TVET sector sustainability. The findings are in Table 3.

Table 3

Correlation between Independent and Dependent variables

		Skill Development	Innovation	Strategic Partnerships	Growth of TVET Institutions
Skill Development	Pearson Correlation	1			
Innovation	Pearson Correlation	0.615*	1		
Strategic Partnerships	Pearson Correlation	293	347*	1	
Growth of TVET I nstitutions	Pearson Correlation	0.707**	0.645*	0.175	1

Conclusions and Recommendations

Conclusion

The study sought to establish the effects of sustainability drivers on growth of TVET institutions in Kenya. The objectives were; to establish the effect of skill development on growth of TVET institutions in Kenya, to establish the effect of innovation on growth of TVET institutions in Kenya and to assess the extent to which strategic partnerships affect growth of TVET institutions in Kenya. Findings indicate a positive correlation between skill development, innovation, strategic partnerships and growth of TVET institutions in Kenya. Skill development Skill development ($r = 0.707$) influences growth of TVET institutions in various ways. Skills imparted to TVET trainees in line with market needs ensure that trainees are adoptable in industry. Professional skills are imparted to help TVET trainees establish and build a career in their respective fields.

Innovations ($r = 0.645$) have an effect on growth in TVET institutions in Kenya. TVET institutions are expected to create an environment that supports innovations. Innovation in terms of products, methods, technology among others are absorbed as inputs in various industries. Sustainable innovations in fields such as engineering, food processing, business processes, technology if adopted and used enhance growth of TVET institutions. The innovation adoption rate continues if they offer savings on production costs, reduction of environmental harm among other benefits.Strategic partnerships ($r = 0.175$) have a positive and significant relationship with growth of TVET institutions. TVET institutions strategically partner with industry and other stakeholders for various benefits. The strategic partnerships provide access to learning opportunities, access to technology, tools and equipment, finance, product markets, employability among others which are great contributors to growth of TVET institutions.

Recommendations

Policy Recommendations

To boost growth, TVET requires a significant transition, as follows: a. Re-align TVET programs with national goals and market demands; b. Increase accessible TVET opportunities for greater access; and c. Delegate and decentralize TVET training to counties to ensure equal opportunity.

Skill Development

There is a need to transform TVET from a second-tier education track to one that provides high-quality and relevant skills training. The three policy priorities underlying this transformation encourage countries to focus on the primary clients of TVET (companies and learners), prioritize foundational and relevant technical skills, and promote an integrated ecosystem with flexible pathways, work-based learning, and quality inputs, particularly teachers.

The need for a shift from an emphasis on inputs to an emphasis on outcomes emphasizes the significance of expanding autonomy for TVET providers while guaranteeing more accountability for results. In this change, policy considerations include striking the correct balance between autonomy and accountability, as well as realigning TVET funds to reward reforms and address priority needs.

In TVET systems, there is a need to overcome the scarcity of data and evidence. The objective here is to close information gaps by collecting and disseminating precise data on TVET returns, skill demands, and TVET provider inputs and practices, allowing all stakeholders to make educated decisions.

Innovation

Technological improvements also give considerable opportunity for middle-income nations to reform TVET. By incorporating technology into course design, program delivery, work-based learning, and quality assurance, TVET can be made more accessible, relevant, and efficient. However, in order to realize their full potential, these technical breakthroughs must be accompanied by complementary expenditures in the training of TVET teachers and administrators.

Strategic Partnerships

Collaboration among industry, government agencies, politicians, education providers, businesses, and development partners is essential for the successful implementation of TVET reforms. The Building Better Formal TVET Systems report can inspire stakeholders to work together to realize the true potential of TVET and ensure a brighter future for trainees and TVET institutions by sharing experiences, best practices, and lessons learned.

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3

ENABLERS OF A RESPONSIVE TVET SUBSECTOR

Examining the Relationship Between Self-Efficacy and Employment of Youth Who are either Deaf or Blind from SNE TVETs in Kenya

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Abstract

Unemployment rates for people with disabilities ranged from 80% to 90% in developing countries and 50% to 70% in developed economies. Over the years, studies have explored community, institutional, and policy factors impeding the employment of youth with disabilities. New knowledge is required to expand this scope; one way is to evaluate the role played by the individual. This study aimed to analyse the relationship between self-efficacy and the employment of trained youth who were either blind or deaf. The modern capitalist economy emphasises employee skills and competencies regardless of job level, industry, or employer type. Further theory states that individual competencies, autonomy, and readiness are intrinsic motivations that impact social contexts. A cross-sectional study design was used to collect data from youth who were TVET graduates and were either deaf or blind. The tool used was adapted, and Cronbach alpha ran to establish reliability. The graduation lists from the four National Special Needs TVETs were used as the sampling frame. The population comprised 112 and 127 youths who were blind or deaf, respectively. The sample size was determined using the Krejcie and Morgan technique. Descriptive statistics were used for quantitative data, while thematic analysis was used for qualitative data. The research findings indicated that 63% and 81% of respondents with high and very high technical skills are employed, significantly higher than 21% and 27% of youth with low and very low technical skills, respectively, are employed (p=0.002). Similarly, 55% and 97% of those with high and very high soft skills, respectively, are employed, which is significantly higher compared to 20% and 16% of youth with low and very low soft skills, respectively are employed (p=0.002). Further, 93% and 87% of those with high and very high self-efficacy, respectively, are employed, which is significantly higher compared to 19% and 12% of youth with low and very low self-efficacy, respectively are employed (p=0.001). It is thus concluded that a nexus exists between self-competencies and the employment of youth who are either deaf or blind from technical training institutes in Kenya. Recommendations drawn from this study include the need to support a continuous upgrade of artisan and certificate qualifications to higher competencies for youth who are deaf or blind and to have soft skills taught during training. Similar studies involving all categories of disability would help understand what categories are likely to face more significant challenges in employability.

Keywords: Blind, deaf, self-competencies, employment.

Introduction

Persons with disabilities (PWDs) in developing countries face unemployment rates ranging from 80% to 90%, while in developed economies, the rate is between 50% and 70% (UN, 2005). This issue is particularly prevalent among the youth, defined in this study as between 18 and 35 years, per the Constitution of Kenya (2010) article 260. In Kenya, as in many other countries, providing inclusive and equitable vocational training and employment opportunities to persons who are deaf, or blind remains challenging (Kelly *et al.,* 2022; Vandana, 2022). Further, transitioning from Special Needs Technical and Vocational Education and Training (TVET) institutions to gainful employment is more tasking. The physical and logistical barriers have been addressed in policy, but there seems to be a need to develop and nurture self-competencies to improve the work absorption rate (Kilag *et al.,* 2023). This study focuses on the relationship between self-efficacy and employment outcomes among young people who are either deaf or blind who are graduates of Kenya's National Special Needs TVET sector.

Education is geared not only towards technical skills but also towards developing and promoting social inclusion for youth who are blind or deaf (Leigh *et al.,* 2022). Further, Vocational training plays a crucial role in the provision of appropriate skills and open access for underprivileged and marginalised groups, such as persons with disabilities, to compete successfully in the labour market. (Naomi *et al.,* 2015) However, limited research explores the effectiveness of these programs in nurturing self-competencies, promoting self-efficacy and enhancing employment prospects for graduates. Understanding the dynamics of the TVET system and its impact on the lives of young persons who are either blind or deaf is essential for achieving Sustainable Development Goal 4 (SDG4) goals of inclusive education and economic empowerment without leaving anyone behind.

Bandura (1977) explained that self-competency is rooted in the notion that people's beliefs about their capabilities influence their motivation, behaviour, and overall level of achievement. Self-efficacy is a crucial component of self-competence and refers to an individual's belief in their ability to perform specific tasks or achieve goals successfully. In the context of self-competence, which encompasses an individual's overall sense of capability and effectiveness, self-efficacy focuses specifically on one's confidence in handling activities and situations. It involves assessing one's capacity to overcome obstacles, meet demands, and attain desired outcomes in specific domains of life (Luszczynska & Schwarzer, 2005). Self-efficacy, contributed to self-awareness, self-regulation, communication, interpersonal skills, and adaptability (White, 2023), are essential attributes for successful employment in today's dynamic labour market. For individuals who are deaf or blind, these skills are even more critical, as they often face additional barriers when seeking employment, such as employer biases and limited accessibility (Jahan & Holloway, 2020).

This study pursued the significance of self-efficacy in the context of employment of youth who are either deaf or blind and postulates that a better understanding of how these competencies relate to employment outcomes is critical for designing effective support systems and policies that promote absorption into the workforce of graduates who are either deaf or blind. There exists a research gap in the context of Kenya on this matter. While there is a growing body of international literature on the employment challenges faced by individuals with sensory impairments and the role of self-competencies, few studies have focused on the Kenya, particularly in the context of Special Needs TVET (SNTVET) institutions. To address this gap, this research aimed to answer the following questions: What is the relationship between self-efficacy and employment of youth who are either deaf or blind from SNTVET institutions in Kenya? By shedding light on these critical aspects, this study aimed to provide valuable insights for policymakers, educators, mentors, coaches, and stakeholders seeking to enhance the vocational training and employment prospects of young people who are either blind or deaf.

Literature Review

The study was based on a theoretical framework that combined three different theories: the Self-Determination Theory (SDT) by Deci & Ryan (1985), the Capability Theory of Human Development by Sen (1996), and the Resource-Based View (RBV) theory by Wernerfelt (1984). The Self-Determination Theory focuses on individuals' intrinsic motivation, autonomy, and self-regulation, which are essential in shaping actions and choices that one pursues. This theory helped to explain how people who are blind or deaf can be motivated to acquire skills and find employment through the development of competencies such as self-efficacy. The Capability Theory of Human Development is composed of two fundamentals. First, the freedom to achieve well-being is basic to every person and second, an understanding of people's capabilities. Finally, the Resource-Based View theory, commonly used in business and management, was adapted to examine how self-efficacy can be a valuable internal resource contributing to competitive advantage in the labour market.Lindstrom & Benz (2022) conducted a study in the United States to investigate the link between self-efficacy and employment among young people with disabilities.

The study focused on 450 youth from San Francisco and used an explanatory research design. The results showed that self-determination skills, a part of self-competency, positively impacted the employment outcomes of young people with disabilities. While the study generally found that higher levels of self-competency led to better employment outcomes, it did not specifically target young people graduating from particular institutions of higher learning.

Additionally, the findings were not limited to specific disability groups, such as the deaf or blind, but instead focused on youth with general physical disabilities. Therefore, the study's findings may not fully reflect the unique employment challenges faced by deaf or blind youth graduating from TVET institutions. In Canada, the work of Smith *et al.,* (2023) delved into self-competency and employment for youth with amputation disabilities. Sampling 330 youth from Toronto, Canada, the descriptive study revealed that self-efficacy, an essential aspect of self-competency, was positively associated with successful employment outcomes for young adults with disabilities. The study demonstrates that self-competency positively correlates with job readiness and employment success. The study focuses on amputation disabilities, which may not be generalizable to the deaf or blind disabilities that are the present study's focus. Furthermore, the Canadian study focuses on urban populations, potentially neglecting the experiences of youth with disabilities in rural or remote areas.

A qualitative study conducted by Stuart & Burchardt (2023) in the United Kingdom sheds light on the role of self-competency in shaping employment prospects for young people with disabilities. The study focused on a sample size of 10 youth in England and Wales and emphasized the significance of self-competency in determining employment opportunities for young people with disabilities. However, the study had a limited sample size and did not extensively consider employer-side attributes such as attitudes. Although it used qualitative methods to uncover nuanced experiences, the study was limited by small sample sizes and did not fully consider youth graduating from tertiary institutions. Moreover, the study was not specific to the deaf or blind but to disabilities in general, which may not fully capture the employability challenges faced by the deaf or blind.

In Guangzhou, China, Li & Ma (2020) conducted a qualitative study exploring the relationship between self-competency and employment among young people with disabilities. The study provided valuable insights, focusing mainly on urban areas. A more comprehensive exploration of rural contexts is needed, as rural regions have unique cultural and societal factors affecting self-competency development and employment. Thus, research that explores these dynamics is necessary, especially in the context of SNTVETs in the country. A mixed-methods approach could offer a more comprehensive understanding of these dynamics. Oyefeso & Ajuwon (2021) investigated the employment struggles of young people with disabilities in Nigeria. Their research revealed the challenges posed by the lack of inclusive educational opportunities and explored self-competency about employment among youth with disabilities. However, their approach was limited as they only conducted descriptive statistics on employment challenges, failing to link them to employment outcomes. This made establishing causal relationships between self-competency development and employment outcomes difficult.

Watermeyer *et al.,* (2020) conducted a quantitative study in South Africa, examining the intersectionality of self-competency and employment outcomes for 300 youth in Johannesburg. While the study made an important contribution to the literature by considering factors such as race and gender, it did not factor in the nuanced individual experiences of job seekers and employers. Thus, more qualitative studies that offer a broader perspective on how individuals with different levels of self-competency experience employment opportunities are needed. In Kenya, Ong'ango (2019) argued that individual characteristics and personal attributes are crucial indicators of a staff member's capacity to perform tasks successfully. Self-competence is becoming increasingly important in contemporary society, and emotional intelligence is much sought-after. Technical skills and knowledge of the job subject are no longer the only requirements for employment. A holistic approach that accounts for technical and soft skills is observed worldwide, regardless of a country's development structure. Both developed and developing countries are embracing this trend.

Methodology

This study was based on the constructivist paradigm and adopted a cross-sectional descriptive survey design with mixed-methods research (MMR) to collect and synthesize quantitative and qualitative data. The study focused on the four National Special Needs TVETs of St. Joseph Technical Institute for the Deaf, Nyang'oma, Sikri Technical Training Institute for the Blind and Deaf, Karen Institute for the Deaf, and Machakos Technical Institute for the Blind. The target youth were either blind or deaf and had completed college between 2014 and 2018. The target population included 239 graduates, 4 administrative officers, one from each institution, and employers of the youth. The study targeted graduates between 18 and 35 years of age. A complete enumeration sampling method was used to sample administrative officers, and all four officials participated in the study. For each employed youth, their employer was also identified as a study participant. During data collection, 54 out of 146 TVET graduate youth indicated they were employed, and 22 employers were reached. Survey questionnaires were used to collect data from the youth, while interview schedules were applied for administrative staff and employers to gather qualitative data.

Statistical methods were used to analyze quantitative data, including descriptive, bivariate, and multivariate techniques. Regressions were also run on the data to identify the relationship between the variables. Thematic analysis was used to analyze qualitative data, and content analysis was conducted using the six-phase model proposed by Braun & Clarke (2014). The six phases included getting acquainted with the information, creating basic coding, finding, evaluating, determining, recognizing, and generating themes.

The first phase involved examining the 22 responses from employers to understand the nature and scope of the responses and emerging attitude-related issues. This cycle involved identifying initial groups that were physically written into a Microsoft Excel spreadsheet document, which expanded as more data became available during coding. The study was conducted following scientific and ethical best practices. Prior to the study, a research permit was obtained from the National Commission for Science Technology and Innovation (NACOSTI). Informed consent was obtained from the participants, who were informed that their data would only be used for academic purposes.

Results and Discussion

Self-reported Technical Skill Application by TVET Graduates who are either Deaf or Blind

The investigation aimed to examine the relationship between self-efficacy and employment of youth who are either deaf or blind. Self-efficacy, as used in this study, includes different sets of technical skills, soft skills, and self-awareness as drivers of employment by graduate youth who are either deaf or blind. According to Christensen & James (2017), self-efficacy plays a crucial role in reconstructing oneself. The study used a module Imperial College of London developed to measure individual self-efficacy.

Table 1

Self-reported technical skill application by TVET graduates who are either deaf or blind

		Percent	Number
I can demonstrate technical expertise in my area of training.	Strongly agree	32.2	47
	Agree	47.9	70
	Not sure	5.5	8
	Disagree	6.2	9
	Strongly disagree	8.2	12
I can show exemplary skills in what I am trained in	Strongly agree	19.9	29
	Agree	56.8	83
	Not sure	8.2	12
	Disagree	8.9	13
	Strongly disagree	6.2	9
I can apply specialised and detailed technical expertise	Strongly agree	14.4	21
	Agree	50.7	74
	Not sure	19.9	29
	Disagree	6.8	10
	Strongly disagree	8.2	12

		Percent	Number
I can demonstrate an immediate understanding of new ideas in my area of training	Strongly agree	8.9	13
	Agree	61.0	89
	Not sure	15.8	23
	Disagree	7.5	11
	Strongly disagree	6.8	10
I can demonstrate high standards for quality of work	Strongly agree	17.1	25
	Agree	58.9	86
	Not sure	9.6	14
	Disagree	10.3	15
	Strongly disagree	4.1	6
I complete tasks on time	Strongly agree	21.2	31
	Agree	58.9	86
	Not sure	6.2	9
	Disagree	6.8	10
	Strongly disagree	6.8	10

Although the TVET graduates mentioned 25 different courses, only five courses were popular and accounted for 57.5% of all the graduates. The most popular courses were Food and Beverage Production (15.1%), Japanese Massage (14.4%), Knitting (13%), Leatherwork (8.2%), and Practical Agriculture (6.8%). The least mentioned areas of specialization were ICT and beauty-related disciplines. The study found that 88.4% of these courses were offered at the craftsman level, 8.7% at the diploma level, and 2.9% at the grade test level.

Table 2

Self-reported soft skill competencies by TVET graduates who are deaf or blind.

		Percent	Number
I can express my opinions clearly	Strongly agree	16.4	24
	Agree	61.6	90
	Not sure	7.5	11
	Disagree	8.9	13
	Strongly disagree	5.5	8
I may fail to communicate fluently	Strongly agree	10.3	15
	Agree	44.5	65
	Not sure	13	19
	Disagree	26	38
	Strongly disagree	6.2	9
I don't like to be given many instructions	Strongly agree	6.8	10
	Agree	40.4	59
	Not sure	10.3	15
	Disagree	26	38
	Strongly disagree	16.4	24

		Percent	Number
I get along well with others	Strongly agree	22.6	33
	Agree	59.6	87
	Not sure	4.1	6
	Disagree	8.9	13
	Strongly disagree	4.8	7
I come to work on time	Strongly agree	24	35
	Agree	54.8	80
	Not sure	7.5	11
	Disagree	8.2	12
	Strongly disagree	5.5	8
I am sometimes absent from work	Strongly agree	6.8	10
	Agree	58.2	85
	Not sure	15.8	23
	Disagree	14.4	21
	Strongly disagree	4.8	7
I can maintain high ethical standards	Strongly agree	23.3	34
	Agree	53.4	78
	Not sure	8.2	12
	Disagree	8.9	13
	Strongly disagree	6.2	9

According to the data presented in Table 2, many TVET graduates possess the technical expertise and skills necessary to excel in their respective fields. Expressly, 47.9% of graduates agree, and 32.2% strongly agree that they can demonstrate technical expertise. Moreover, 76.7% of graduates display exemplary skills in their training area, 65.1% can apply specialized technical expertise, and 69.9% can quickly comprehend new concepts. Additionally, 76% of graduates have high standards for the quality of their work, and 80.1% complete their tasks on time. These results indicate that TVET graduates have the necessary competencies and high self-efficacy to succeed in their training field.

Even though these results are based on self-reporting, they concur with the capability theory that individuals with disabilities can acquire technical skills just as effectively as those without disabilities, as all humans have capabilities. This confirms Lyles (2004), who indicated that individuals with disabilities can develop management skills through appropriate training, mentorship, and experience. One of the graduates supported this claim, who confirmed the importance of these factors in gaining expertise.

"*I believe that I am pretty good at my work. Since I started working in this hotel, I have developed a good working relationship with my colleagues, and we have gained more clients for the place than before*" (GD22.G, 24 years female)

The study revealed that among TVET graduates who were deaf or blind, 78% could express their opinions clearly. However, 54.8% had difficulty communicating fluently, and 47.2% did not prefer being given many instructions. Notably, 82.2% had good interpersonal skills, 78.8% came to work on time, while 65% sometimes absented themselves from work. In terms of maintaining high ethical standards, 76.7% said they could do so.

Seven test items on a 5-point Likert scale (1=Strongly Disagree, 2=Disagree, 3=Not Sure, 4=Agree, 5=Strongly Agree) were used to measure technical skills. Lower scores across the seven test items indicate lower technical skills, while higher scores correspond to higher technical skills. The arithmetic mean of the seven test items for technical skills was computed, and the results were rounded up to the nearest whole number, such that 1=Very Low, 2=Low, 3=Average, 4=High, and 5=Very High.

Similarly, soft skills were computed based on seven test items using the same method as technical skills. Self-efficacy was determined by combining technical skills and soft skills measured on a 3-point Likert scale coded to reflect frequency such that never=1, sometimes=2 and always=3. The interpretations of the self-efficacy scale are the same as technical and soft skills. To examine the relationship between technical skill, soft skill, self-efficacy, and employment of TVET graduate youth who are deaf or blind, a crosstabulation with a chi-square test of association was used as a bivariate method. The results are presented in Table 3.

Table 3

Association between Self-efficacy and employment status of TVET graduates who are deaf or blind (N=146)

Variable		Not employed	Employed	P-value
Technical skill	Very low	73%	27%	0.002
	Low	79%	21%	
	Average	100%	0%	
	High	37%	63%	
	Very high	19%	81%	
Soft skill	Very low	84%	16%	0.002
	Low	80%	20%	
	Average	72%	28%	

Variable		Not employed	Employed	P-value
Self-efficacy	High	45%	55%	0.001
	Very high	3%	97%	
	Very low	88%	12%	
	Low	81%	19%	
	High	7%	93%	
	Very high	13%	87%	

As presented in Table 3, 63% and 81% of those with high and very high technical skills are employed, which is significantly higher compared to 21% and 27% of youth with low and very low technical skills, respectively, who are employed. The p-value (p=0.002) shows a positive association between technical skills and employment. Similarly, 55% and 97% of those with high and very high soft skills are employed, which is significantly higher compared to 20% and 16% of youth with low and very low soft skills, respectively, who are employed. The p-value (p=0.002) shows a positive association between soft skills and employment. These results confirm that technical and soft skills are critical in employment.

Based on these findings, it could be concluded that a combination of both technical and soft skills significantly increases self-efficacy and helps in the employment of youth with disabilities. This conclusion was supported by recent research by Succi and Canovi (2020), which found that companies consider soft skills more important than technical skills when hiring. Findings show that 93% and 87% of those with high and very high self-efficacy are employed, which is significantly higher compared to 19% and 12% of youth with low and very low self-efficacy, respectively, who are employed. The p-value (*p=0.001*) shows an association between self-efficacy and employment status. This trend suggests that those with high self-efficacy tend to be more employable than those with self-efficacy.

The study results revealed that there was a relationship between self-efficacy and the employment of youth who are either deaf or blind. It aligns with several anchoring theories, shedding light on the mechanisms at play. Notably, the results resonate with the Self-Determination Theory, which emphasises the motivation and autonomy that come with a sense of self-efficacy. This can drive active job-seeking and better employment outcomes. The findings also reflect Social Cognitive Theory's concept of self-efficacy, as the youth's confidence in their competencies and skills can boost job search efforts and performance. Furthermore, the study underscores the importance of appreciating the capabilities of individuals with disabilities to enhance their employability and overall life fulfilment.

Together, these theoretical perspectives underscore the significance of training youth with disabilities to bolster a strong sense of self-competency and efficacy to facilitate access to employment opportunities, thereby maximising their potential. The study accomplished its objective: to investigate the correlation between self-efficacy and the employment of blind or deaf youth from the four national SN TVETs in Kenya.

Conclusions and Recommendations

Conclusions

In delving into the intricate relationship between self-efficacy and employment outcomes among youth who are either Deaf or Blind graduates of SN TVETs in Kenya, this research illuminates key patterns that underscore the nuanced interplay of self-efficacy in the employment trajectory. Those with higher proficiency of self demonstrate elevated employment rates, underscoring the importance of honing self-competencies to secure job opportunities. This observation accentuates the need for targeted interventions in educational and vocational training programs to empower youth who are either Deaf or Blind with the requisite life skills and soft skills that would increase self-efficacy, a demand by the job market. Furthermore, the research accentuates the integral role of soft skills in shaping employment trajectories.

Individuals who are either Deaf or Blind with heightened levels of soft skills exhibit significantly improved employment rates compared to their counterparts with limited soft skills. This implies that beyond technical expertise, the cultivation of interpersonal and adaptability skills is paramount for success in the professional arena. It reinforces the call for a comprehensive approach to education that not only imparts technical know-how but also fosters the development of soft skills, ensuring a well-rounded preparation for the challenges in the workforce.

Lastly, this research piece underscores the profound impact of self-efficacy on the employment prospects of youth who are either Deaf or Blind. Those who are either Deaf or Blind with a strong belief in their capabilities consistently demonstrate higher rates of employment, emphasising the critical role of confidence in navigating the complexities of the job market. This highlights the necessity of interventions that bolster self-efficacy, recognising it as a pivotal factor in enhancing the overall employability and socio-economic integration of youth who are either Deaf or Blind in the context of technical training in Kenya. Collectively, these insights advocate for a holistic approach to education and training that goes beyond technical instruction, embracing a broader spectrum of skills and personal development.

Recommendations

The study highlights a strong correlation between technical skills, self-efficacy and employment outcomes for youth who are either deaf or blind in SNTVETs in Kenya. Based on this, the study recommends that educational institutions continuously enhance soft skills alongside technical skills. This can be achieved through regular curriculum updates, aligning training programs with evolving industry demands, and providing advanced training opportunities. Collaborative efforts with industry partners can ensure that the training remains relevant to the dynamic job market, ultimately improving the employability of graduates while creating confidence in the trainee youth in their capabilities. Secondly, the research emphasises the importance of soft skills beyond technical proficiency in shaping employment outcomes for youth. Therefore, it is recommended that TVETs integrate soft skills training into their programs. Modules focusing on effective communication, teamwork, time management, and interpersonal skills can be incorporated and emphasised. This holistic approach to education ensures that graduates not only possess technical expertise but also exhibit the interpersonal and adaptability skills crucial for success in the professional arena. While the current study provides valuable insights into the employment challenges faced by youth who are either deaf or blind, future research may consider including all categories of disability and conducting a comparative analysis among different disability categories. A comprehensive understanding of the unique challenges and needs of various disabilities can inform targeted interventions and policies.

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The Influence of College Agricultural Student's Training Skills and Competencies on their Career Progression Prospects

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Abstract

The study focused on vocational college's agricultural student's training skills and competencies influence on prospects of their career progression prospects. Agriculture is the backbone of several economies world over, with regards to food production, providing market for farm inputs, raw materials for industries, income, source of foreign exchange and employment. The benefits come as a result of incorporating agriculture in Kenya education system from basic education to a higher level of education. The objectives were to: establish learner's learning achievement in practice with respect to frequency of practical lessons; determine the impact of field trips on students' inclination towards pursuing farming as a supplementary occupation and find out students' interest in agriculture as a professional career. The sample size was picked randomly from teachers and students pursuing agricultural course. The opinions and perceptions of 100 students enrolled in agricultural courses and 6 teachers at Meru National Polytechnic were taken through survey design, questionnaires, interview and observation. 50% students that were performing practicals were able to practice agriculture compared to those who never practice. 55% of the students were interested in Agriculture as a career while 83% said they might engage in farming to supplement their income. The study concluded that although the students had high interest in agriculture, its recommended that these learners needed more of 21st century skills and competencies to enable them pursue agriculture efficiently in the farm.

Key words: Skills, competencies, career, learning achievements

Introduction

In emerging nations, agriculture remains a significant component of their economies. In Africa, the agricultural sector accounts for approximately two-thirds of the workforce and half of the total exports, as reported by Woldemichael *et al.,* (2017). Agriculture remains a key contributor to prosperity and a pivotal element in the overall economic functioning of many African nations. The rise in agricultural growth over the near to medium timeframe aligns with elevated earnings for impoverished individuals involved in farming, as well as those working in agricultural processing businesses, leading to higher wages for individuals in low-income agricultural roles (Jayne *et al.,* 2021). Both urban and rural populations allocate a significant portion of their expenses to food, and the progress in agriculture plays a crucial role in ensuring food security.

Like numerous other fields of education, the imparting of knowledge to students in agricultural programs employs various methods, either individually or in combination. These methods encompass demonstrations, lectures, discussions, and electronic means like instructional videos. Cano *et al.,* (1992), elaborate, individuals who orient their thoughts towards the context around them tend to adopt a learning approach that is reliant on the surrounding field. Furthermore, those who organize items distinctly within their environment lean towards a learning style characterized as field-dependent. Teachers employing field-dependent teaching methods encourage their students to collaborate as a cohesive unit, fostering social bonds among them. Such educators prioritize a learner-centred approach, predominantly utilizing problem-solving techniques due to their perceived difficulty in resolving issues. In contrast, educators following a field-independent approach teach students to recognize their role as facilitators rather than strict instructors. These teachers are primarily focused on the subject matter, striving to attain predetermined learning objectives. Field-independent instructors emphasize critical thinking and often employ a problem-solving methodology, placing a strong belief in individual accomplishments (Cano *et al.,* 1992). Kirimi (2015) Expressed that among various teaching methods, educational tours and lectures significantly impact the selection of agricultural courses in vocational and technical colleges.

Auwal (2003) articulated that utilizing the demonstration method in teaching agricultural courses enhances learners' ability to retain information more effectively compared to employing discussion methods. Furthermore, Lui *et al.,* (2015) documented that only a meagre percentage of less than 10% of agricultural learners are taught through hands-on practical experience contrary to 44% who receive teaching through lectures from their tutors. It is the sole duty of a teacher to ensured that one teaches a learner not only to memorize but to develop higher thinking skills and competencies in scientific discipline like generating, solving synthesizing among others among others (Barrick, 2018).

Literature Review

The Dunkin & Biddle's (1974) model comprises four variable components for examination: presage (trainer characteristics, experiences, training), context (properties of students, technical and vocational college, community, lecture halls), process (trainer and student actions), and product (immediate and long-term effects) (Groccia, 2020). This framework defines what constitutes a professional. In Tanzania, Muggonzibwa *et al.,* (2000) found that the perception of a profession is shaped by positive experiences with professionals. Over 80% of respondents in their study considered caring and supportive professionals, as well as those commanding respect in society, to be significant factors in career choice. Work or profession features were the second-ranking factor, and course characteristics ranked third.

Curbelo (2016) emphasizes that teachers bear the sole responsibility for creating a welcoming learning environment for students. In agriculture courses, students attribute their increased knowledge to teachers' effective performance in the classroom (ibid). Secondary program teachers are perceived as successful in teaching agriculture, influencing students' enrolment in agricultural education programs (ibid). Agricultural Education instructors, regardless of student interest, play a crucial role in helping students understand the practical value of their learning. This, in turn, opens avenues for students to explore potential future careers (Ryan, 2015).

Agriculture is deemed the backbone of Kenya's economy by the Ministry of Education, contributing to food production, supplying raw materials for industries, generating income, providing foreign exchange, and offering employment opportunities (Jones *et al.,* 2020). The teaching of agriculture in primary, secondary, and tertiary institutions has contributed to these benefits. Competency, defined as the ability to perform a task efficiently, is acquired through learning psychomotor acts. Competence involves observable behaviour resulting from hands-on experiences and related knowledge (Lindner and Dooley, 2003; Prosekov *et al.,* 2020).

Technical and vocational college education places a significant emphasis on hands-on practical activities. Instructors strive to convey knowledge of the natural world and develop students' understanding of theories, ideas, and models. However, the lack of infrastructure, such as agricultural laboratories and tools, hampers effective teaching. The curriculums for agricultural courses aim to equip students with the knowledge and skills for self-reliance (Lideke, 2022). The difficulty of measuring affective and psychomotor domains results in a focus on the cognitive domain in content, instruction, and assessment (Rao, 2020).

Determinants of competencies through hands-on experience are subject to variations based on cultural, institutional, and course-specific contexts (Mlambo, 2011). While students perceive agricultural courses as beneficial to themselves, their institutions, and their nation, they often need guidance and encouragement to develop an interest in these courses (Muchiri *et al.,* 2013). Changing students' perceptions and fostering appreciation for agricultural courses can be achieved through incorporating more hands-on practical activities in their training.

In Kenya, approximately 82% of teachers in technical and vocational colleges teaching agricultural courses possess the requisite qualifications (Obeng-Mensah *et al.,* 2012). Continuous assessment is widely regarded as an effective method of delivering agricultural education in these institutions (Ikeoji *et al.,* 2016). The majority of teachers hold bachelor's degrees, meeting the minimum academic qualification for teaching in technical and vocational colleges in Kenya. With adequate teaching and learning materials, these teachers can leverage their experience to deliver optimal results (Kumi *et al.,* 2016). Similarly, in Delta State, most agriculture teachers are qualified to teach agriculture courses (Olajide *et al.,* 2015).

Objectives of the Study

1. To establish learner's learning achievement in practice with respect to frequency of practical lessons.
2. To investigate the impact of field trips on students' inclination towards pursuing farming as a supplementary occupation.
3. Find out student's interest in agriculture as a professional career.

Methodology

The research employed a survey design to elucidate the prevailing issues within the Department of Agriculture at Meru National Polytechnic (MNP). According to Orodho (2009), a survey is a means of gathering information through the distribution of questionnaires to a sample group or by conducting interviews with individuals. This method is commonly used to collect data on people's attitudes, behaviours, opinions, or various social issues associated with education. In line with this, the study employed random sampling techniques to gather the opinions and perceptions of 100 students enrolled in agricultural courses and 6 teachers at MNP. The data collection methods included the use of questionnaires, interview schedules and observation.

Results and Discussions

Distribution of Respondents by Gender among Students

The survey was conducted on 81 male and 18 female trainees. The students were requested to specify their gender, and the results are displayed in Table 1. The results revealed that 82% of the students were male, while 18% were female. This suggests that a majority of female students opt not to pursue Agricultural courses at the polytechnic.

Table 1
Gender distribution of student participants

Frequency	Gender	Expressed as a percentage
Male	81	81.8
Female	18	18.2
Summation	99	100

The study indicates that a higher proportion of male students opt for Agricultural Courses programs compared to their female counterparts at the tertiary level (refer to Table 1). This aligns with the findings of Ajayi and Buessing (2013), who noted that in Ghana, more than 25 percent of female applicants to tertiary institutions prefer Home Economics and General Arts, while males tend to dominate in Agricultural courses and General Science programs. This observation is consistent with the conclusions drawn by Kumi *et al.,* (2016), who reported a greater representation of males over females in science and agricultural courses across various institutions in Ghana. This trend is attributed to a general lack of interest among Ghanaian female students in pursuing science and related programs.

Student Enrolment in Courses

Figure 1 illustrates that among the responses from ninety-nine students, 43.4% of students were pursuing a Craft Certificate in General Agriculture (CRA) while 57% wanted a diploma in agriculture (DAG) course. In this respect, certificate in agricultural is a one-year course given to the beginners in agriculture and those students who had performed below average in agriculture at form four level. The diploma in agriculture exposes learners to a variety of both crop and animal husbandry practices as well as manufacturing agricultural products. This is desired course geared towards meeting Vision 2030 and SDGs.

In reinforcing these findings, Mutinda (2023) asserts that the economic landscape of Kenya underscores the significance of agriculture as a fundamental pillar, playing a crucial role in income generation, food production, and job creation.

Recognizing agriculture as the backbone of the economy, the Ministry of Education bears the responsibility of aligning its policies with government directives to fully harness the potential of agriculture. In this pursuit, the ministry is tasked with evaluating and enhancing the standards of agricultural education and training to propel Kenya towards becoming an agro-industrialized nation.

Figure 1
Course distribution of students

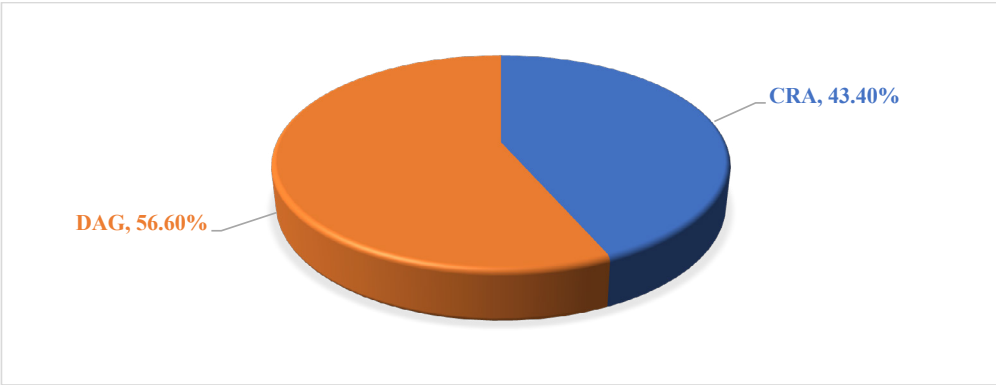


Table 2
Evaluating students' practical performances by teachers in correlation with regularity of practical lessons

Frequency/ Output	**Students' performance during practice**					**Total**
	75% or more	More than 50%	About 50%	More than 25%	None	
Each month	2(33%)	0(0%)	2(33%)	2(33%)	0(0%)	6(100%)
Once a term	2(50%)	1(25%)	1(25%)	0(0%)	0(0%)	4(100%)
Never	0(0%)	0(0%)	0(0%)	0(0%)	1(100%)	1(100%)
Total	4	1	3	2	1	11

Results from table 2 show that Fifty percent of teachers, who conduct practical lessons once per term, reported that students can independently engage in agriculture to a level exceeding seventy-five percent. Additionally, 25% of teachers mentioned that students with practical lessons once a term can handle agricultural practices independently, reaching a proficiency of fifty percent or more. Conversely, another 25% of teachers stated that students with practical lessons once a term can manage agriculture on their own, achieving approximately fifty percent proficiency.

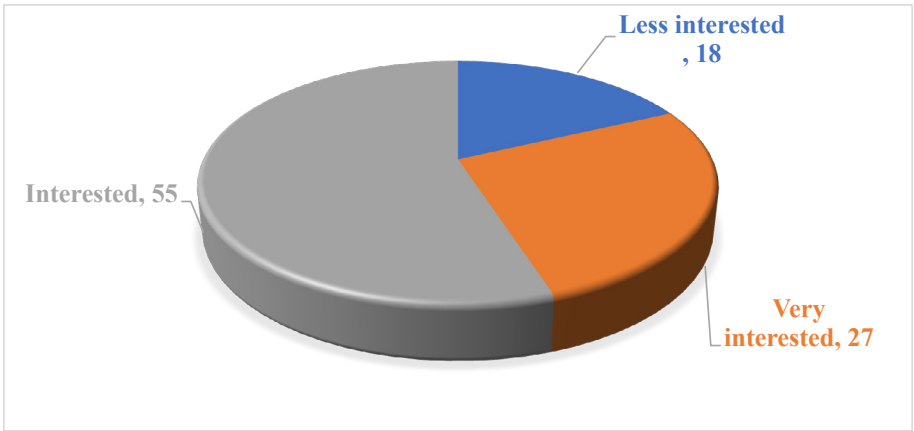
None of the surveyed teachers asserted that students with practical lessons once a term could surpass a twenty-five percent proficiency in practicing agriculture independently. Furthermore, none of the teachers agreed that students without any practical lessons could independently achieve more than a twenty-five percent proficiency in agriculture. Unanimously, all teachers concurred that students lacking practical lessons cannot independently engage in agriculture at a proficiency of even twenty-five percent. In contrast, 100% of teachers agreed that students who never had practical lessons are unable to practice agriculture independently. Overall, teachers reached a consensus that students with regular practical lessons, occurring at least once per term, can independently practice agriculture at a 50% proficiency level. Additionally, teachers expressed the opinion that students who never had practical lessons (25%) lack the capability to engage in agriculture independently. In support of these findings, Wootoyitidde (2019) noted that many Heads of Department face delays in receiving government funds, resulting in a scarcity of practical lessons due to the dependence on specific equipment and consumable materials for practical demonstrations.

Student Interest in Agriculture as a Profession

The data presented in figure 2 indicates that 27% of agriculture learners expressed a strong interest in the subject, while 55% stated that they were generally interested in Agriculture. Conversely, 18% of students conveyed a diminished interest in agriculture as a chosen course of study. These findings reveal a concerning pattern in a nation where agriculture serves as the economic backbone and plays a crucial role in meeting the growing population's food needs. The unfavourable perception of agricultural courses among students is a matter that requires swift reversal to ensure the country can meet its agricultural commitments to the Sustainable Development Goals (SDGs) regarding food sustainability (Prosekov *et al.,* 2020).

Figure 2

Attitude of students taking agriculture towards their course



During the unstructured interview phase of data collection, it was discovered that certain items, such as vegetables, pasture grasses, and various farm tools, are brought into the classroom for identification and discussion regarding their growth and uses. This practice serves as a potential motivator for students to develop an interest in agriculture. This observation aligns with the conclusions drawn by Famiwole (2020), who pointed out that examination bodies often neglect to evaluate the competencies or skills acquired through practical experiences in school farms, which function as hands-on laboratories. To investigate the impact of field trips on students' inclination toward farming as an additional source of income, cross-tabulation was employed. The results of this analysis are presented in Table 3.

Table 3

Impact of field trips on students' inclination towards pursuing farming as a supplementary occupation

Frequency of Field trips	**Response**				**Total**
	Yes	May be	Not sure	No	
Not Applicable	25(79%)	4 (15%)	2 (5%)	1 (1%)	32(100%)
Regularly	4(83%)	11(11%)	0 (0%)	1(6%)	16(100%)
Sometimes	12(74%)	29 (24%)	1 (1%)	1 (1%)	43 (100%)
Once	41 (75%)	13 (24%)	1 (2%)	0 (0%)	55 (100%)

Table 3 showed that 79% of students lacking field trip experience are interested in pursuing farming for additional income, while 15% might consider it, and 5% are uncertain about choosing farming as an additional income source. Among students regularly participating in field trips, 83% express a definite interest in taking up farming for extra income, with 11% indicating a possibility and 74% of those occasionally on field trips stating their intent to engage in farming for additional income, while 24% are considering it. Notably, 75% of students going on field trips once a term affirms a definite interest in farming for additional income. In total, 76% of respondents express a definite intention to engage in farming for extra income, and approximately 20% are open to the possibility.

Figure 3

Teachers' evaluation of the implementation of agricultural enterprises following higher education level

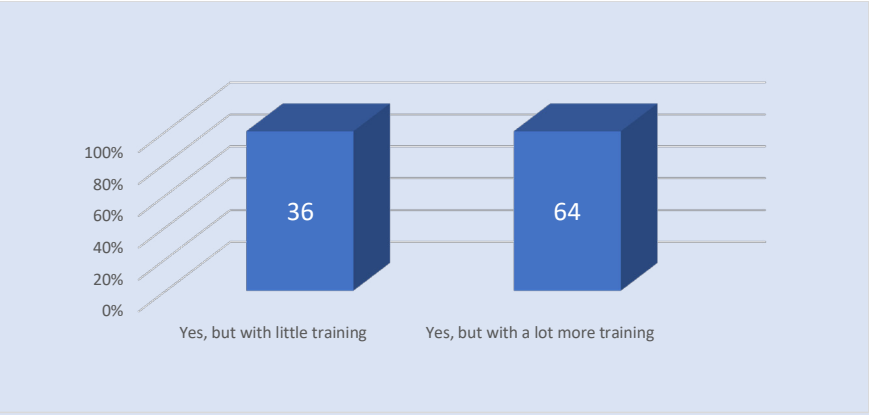


Figure 3 illustrates that 64% of agricultural trainee respondents express the belief that they could engage in agricultural practices after completing their college education, albeit with the condition of undergoing additional training in agricultural courses. Conversely, 36% of agricultural instructors concur that students enrolled in agricultural programs could independently practice agriculture upon program completion. Consequently, the evaluations provided by teachers imply that, despite students' keen interest in agriculture, they require more hands-on experience to effectively apply agricultural principles and demonstrate their skills and competencies in alignment with the demands of the 21st-century agricultural industry. In support of these findings, Perry (2020) has also noted a contemporary trend where students successfully pass external examinations in agricultural science without engaging in farm practice, relying solely on theoretical learning, which may hinder the development of their technical knowledge and practical orientation.

Conclusions and Recommendations

Conclusions

The assessments conducted by college tutors on students enrolled in agriculture revealed that while the students displayed a keen interest in the field, there was a need for increased practical experience to enhance their ability to efficiently practice agriculture and demonstrate their skills and competencies relevant to the modern agricultural industry. Field excursions play a crucial role as teaching and learning methods by providing learners with a firsthand experience of real-world situations, serving as motivating factors in their educational journey. Practical lessons are essential for learners to cultivate hands-on skills and competencies crucial for their career advancement in agriculture.

Recommendations

The research recommended that the education in agriculture should incorporate practical, hands-on learning that aligns with 21st-century skills and competencies. This approach ensures that trainees are well-equipped to meet the demands of the modern agricultural industry. Additionally, learners should be provided with practical lessons that match the skills and competencies required for successful entry into the job market.

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Assessing Non-Cognitive Skills among STEM Trainees at The Nyeri National Polytechnic

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Abstract

Science, Technology, Engineering and Mathematics (STEM) training in Competence-Based Curriculum (CBC) involves impartation of knowledge, skills and attitude. Skills development emphasizes more on cognitive skills training and assessment and neglects non-cognitive skills. So far, the assessable non-cognitive skills are communication, employability and environmental literacy. However, skills such as social skills and intrapersonal intelligence are assumed to be acquired during training and hence they are neither trained nor assessed. This structure fails to cater to the socio-emotional needs of a trainee yet these skills strengthen and account for cognitive skill development. With this regard, the present cross-sectional study aimed at measuring the following non-cognitive skills: grit, self-control and social skills using standardized tests among STEM trainees and determining relationships among them. A sample size of 200 students at the Nyeri National Polytechnic was targeted for the online self-assessed questionnaire. Statistical analysis in the form of descriptive statistics and bivariate Spearman Rho correlation index were performed using IBM SPSS Statistics 20. 94 students responded to the online self-assessed questionnaire thus a response rate of 47%. The study population was characterized by 57.4% certificate, 41.6% diploma, 64.9% male and 35.1% female. 98.2%, 90.3%, 77.6% of the participants satisfactorily attained scores above the average for grit, self-control and social skills respectively. Spearman correlation indices between grit and self-control: $r = 0.182$, $p = 0.08 > 0.05$; grit and social skills: $r = 0.169$, $p = 0.103 > 0.05$; self-control and social skills: $r = 0.007$, $p = 0.947 > 0.05$. There exists no significant relationship between grit and self-control, grit and social skills and self-control and social skills at $p < 0.05$, hence these variables are independent. Findings from this research provide clues on identifying the non-cognitive skill gaps in students and recommend strategies on promoting these skills at the pedagogical level.

Keywords: Non-cognitive skills, grit, self-control, social skills

Introduction

The concept of skill varies across different disciplines. For instance, economics and psychology describe the abilities acquired by a worker. These abilities are treated as independent variables in research activities. On the other hand, in sociology, skills are the characteristics of a job such as range, complexity, level of discretion, knowledge and training needed to learn the job. Unlike the economics and psychology perspective, these characteristics are treated as dependent variables in determining other variables such as time, occupations and economies (International Encyclopedia of the Social Sciences, 2022).

Skills can be classified into the following categories: cognitive, motor and non-cognitive skills; hard and soft skills. Cognitive skills can be interpreted as the ability to process aspects of comprehension (psychomotor speed, memory, and abstract reasoning) commonly referred to as fluid abilities or cognitive mechanics. In contrast, abilities that are drawn from the sociocultural environment (vocabulary, literacy, numeracy, knowledge of world history, specialized domain knowledge and skills) are often referred to as crystallized abilities or cognitive pragmatics (Lövdén *et al.,* 2020).

Non-cognitive skills, also called socio-emotional or "soft" skills, are personality traits, goals, characters, motivations, and preferences" that represent patterns of behavior. They encompass social skills, persistence, locus of control, motivation, empathy, temperament, attention, impulsivity, communication and personality. Personality has five dimensions namely extraversion, agreeableness, conscientiousness, neuroticism and openness (Morris *et al.,* 2021). According to Gutman and colleagues, they identified the following key non-cognitive skills: self-perceived abilities, motivation, perseverance, self-control, metacognitive strategies, social competencies, resilience, coping, and creativity (Gutman & Schoon, 2013).

The term 'self-perceived abilities' can be synonymously referred to as academic self-confidence, evaluation or estimation of intelligence/ abilities, and self-perceptions among others (Chamorro-Premuzic *et al.,* 2010). These abilities are assessed through self-reporting inventories whereby participants gauge on their own on a given scale. Key constructs in self-perception are ability, self-concepts and self-efficacy. Ability self-concepts use affective and cognitive ideas while self-efficacy is purely cognitive (Peiffer *et al.,* 2020). Examples of domains in self-perception are physical appearance, romantic appeal, behavioural conduct, social competence, close friendships and global self-worth. These domains have been indirectly linked to motor competence and self-identity among adolescents. Self-identity reflects on the image of a person and it is influenced by psychosocial factors such as culture, family, self-evaluation and so on.

On the other hand, motor competence involves manipulative skills, locomotory and stability (Timler *et al.,* 2019) Motivation is a multidisciplinary concept that exists in psychology, neuroscience and research on ageing, development and lifespan. According to social and personality psychology, motivation is viewed from why individuals make certain choices and the degree of selecting certain choices. Thus, the key areas of focus are on the direction and intensity of motivation which arise from the needs and expectations of individuals. Goals act as mental forms of the desired state and serve as the activator and directional factor of motivation (Braver *et al.,* 2014).

Grit is a trait associated with consistency of interests and perseverance to pursue long-term aspirations. Consistency of interests involves showing passion and interests while perseverance is a high-level persistence even after experiencing constant setbacks or failures. Grit acts as a positive predictor for performance in school and work, career outcomes and overall well-being (physical and psychological) (Datu, 2021). The distinct factor of grit is passion; excluding it makes grit become a grind. Passion creates a sense of emotions or feelings and thus leads to increased focus and concentration in goal pursuit. It acts as the unifying factor for consistency of interests and perseverance to fully actualize grit (Jachimowicz *et al.,* 2018). Also, grittier teachers are more diligent and this improves student performance. Thus, it acts as a predictor for teaching effectiveness and retention (Robertson-Kraft & Duckworth, 2014).

Self-control can be categorized together with responsibility, orderliness and conscientiousness. According to the renowned psychologist, Sigmund Freud, he considered self-control is a key challenge in childhood development. Moreover, a study done in New Zealand identified self-control as a key predictor of savings behaviour, financial security, occupational prestige, and physical and mental health during the first decade of life (Duckworth & Seligman, 2017). Self-regulation is another concept closely related to self-control. It primarily consists of standards, operations and monitoring actions that guide behaviour towards the intended goals (Gillebaart, 2018).

The term ‘metacognition’ was coined by John Flavell as the awareness of one’s cognitive processes and any other matter related. There exists a sound relationship between critical thinking and metacognition, developing consciousness and self-regulation during learning. Within the metacognition model, there exist eight pillars which promote deep knowledge off cognitive processes, self-regulation, functional adaptation to society, pattern recognition and operations, and meaningful memorization (Rivas *et al.,* 2022).

Social competence is characterized by the effectiveness of an individual in getting along with others through social interaction) and being well liked (Bitsko *et al.,* 2020). The development of social competence requires proper

management of cognitive, social and emotional abilities. It has the following behavioural aspects: interpersonal, adaptive and self-perceived. These elements enable in building interpersonal relationships, resolving interpersonal conflicts and developing clear self-identity (Luna *et al.,* 2020; Ma, 2012).

According to the American Psychological Association, resilience is the process of adapting to adversity, trauma, tragedy, threats or even significant sources of stress. The determinants of resilience consist of biological, psychological, social and cultural factors that influence how one responds to stressful stimuli. The concept of resilience can be explained through different perspectives: personal traits that an individual exhibits to face adversity, a process in which the individual interacts with the adversity over time and the outcome after the adversity experience (Liu *et al.,* 2018; Southwick *et al.,* 2014).

Creativity is a process that leads to the production of a new, useful idea or product. It is different from reproduction and non-reproduction. In this perspective, creativity has the following components: the ability to create, intentionality to create, the context in which creativity occurs and the idea/product being novel and useful. Within the scope of creative research investigation, problem-solving (whether well-defined or ill-defined) is a key area to consider (Ritter *et al.,* 2020; Schubert, 2021). Also, it relates to other skills such as mindfulness (Henriksen *et al.,* 2020). Creativity has been linked to positive psychology, personal growth, creating personal meaning and managing worries about one's future and legacy (Kaufman, 2018).

Coping refers to the thoughts and behaviours needed to manage internal and external stressful situations. It can either be a reaction following a stressor (reactive) or a probable reaction for a future stressor (proactive). The reactive mechanism is found in individuals who can thrive in different environments while the proactive is for those in a rigid, routinized environment. Scales used for determining coping mechanisms are Coping Orientation to Problems Experienced (COPE), Ways of Coping Questionnaire, Coping Strategies Questionnaire, Coping Inventory for Stressful Situations, Religious-COPE, and Coping Response Inventory. Apart from being reactive or proactive, it can also be viewed as: problem-focused, emotion-focused, meaning-focused and social-coping focused (Algorani & Gupta, 2023).

Problem Statement

The core objective of Competence-Based Curriculum is to impart knowledge, skills and attitudes to the trainees. In the context of non-cognitive skills, there are competencies for interpersonal skills such as communication, employability and environmental literacy. However, interpersonal skills such as social skills and intrapersonal intelligence are assumed to be acquired during training and hence they are neither trained nor assessed. Such curriculum designs fail to form a basis for personal, academic and professional development and growth (Santos & Soares, 2018).

Justification

Generally, non-cognitive skills reinforce cognitive ability and intelligence (Morris *et al.,* 2021). For self-efficacy and self-concept, they correlate positively with the learning process (Widha Nur *et al.,* 2020). Skills such as motivation, self-perception of ability are positively associated with academic achievement (Gutman & Schoon, 2013). In addition to that, non-cognitive skills influence learning acquisition and capacity since they are needed for situational evaluation, decision making and monitoring of action regulation (Sembill *et al.,* 2013). Intrapersonal skills are transferable in nature, enabling individuals to inhabit different ecosystems and achieve productivity (National Research Council, 2011). Moreover, non-cognitive skills have an impact on levels of educational attainment, job performance and employment outcomes. A study by Abdul Latif Jameel Poverty Action Lab found that offering non-cognitive skills along with technical skills training improved the educational and graduation rates, especially among disadvantaged groups (J-PAL, 2017). According to Zhou and colleagues (2016), personality traits act as strong predictors for labor performance in the market. Therefore, the assessment of non-cognitive skills is an indirect measure of assessing cognitive skills.

Research Objectives

The present case study sought to:

i. Measure the non-assessed non-cognitive skills among STEM trainees in the following fields: applied science, information and communication technology, and engineering (civil, mechanical and electrical) at Nyeri National Polytechnic.

ii. Determine a bivariate correlation between grit and self control, grit and social skills, self -control and social skills using the Spearman correlation coefficient.

Output generated from this research will provide insights into the different non-cognitive skills and advice on the strategies to promote these skills in the classroom (pedagogical level).

Research Methodology

The study was conducted with 200 trainees from Nyeri National Polytechnic from the following departments: Applied and health science, Engineering (Automotive, Building and Civil, and Electrical) and Information Technology. The study participants accessed the self-assessment psychometric test through a link hosted on: *https://docs.google.com/forms/d/1a2g0yKNZ560liwB7v7-jng-PCED5hfHoQD2dd0mHpSrc/edit*

Consent was sought from trainees before the onset of the study. The ethical conduct of the study and confidentiality of their responses were ascertained. Cluster random sampling was used to select participants from the different departments. The measurement of grit was done using two tests: World Bank STEP and Item Grit scale measurements. The World Bank STEP measurement is a 3-point rating based on a 1-4 Likert scale (almost never to almost always) (Z h o u, 2016) and the 12-point Item Grit scale is on a 1-5 Likert scale (very like much to not at all like me) (Duckworth & Quinn, 2009).

Table 1

The items present in 3-point World Bank STEP and 12-point Item grit questionnaire tests.

Construct	Item	Response scale
World Bank STEP (3 po3-pointing)	Do you finish whatever you begin?	1(almost never) to 4 (almost always)
	Do you work very hard? For example, do you keep working when others stop to take a break?	
	Do you enjoy working on things that take a very long time (at least several months) to complete?	
Item grit test (12-point rating)	I have overcome setbacks to conquer an important challenge	1 (very much like me), 5 (not at all like me)
	New ideas and projects sometimes distract me from previous ones	
	My interests change from year to year	
	Setbacks don't discourage me	
	I have been obsessed with a certain idea or project for a short time but later lost interest	
	I am a hard worker	
	I often set a goal but later choose to pursue a different one	
	I have difficulty maintaining my focus on projects that take more than a few months to complete	
	I finish whatever I begin.	

Construct	Item	Response scale
	I have achieved a goal that took years of work.	
	I become interested in new pursuits every few months.	
	I am diligent	

Self-control

The self-control scale was in accordance with self-control measurement (Tangney *et al.,* 2004).

Table 2

The items present in the self-control questionnaire test.

Item	Response scale
I have a hard time breaking bad habit	Not at all like me:5 A little like me: 4 Somewhat like me:3 Mostly like me: 2 Very much like me:1
I get distracted easily	
I say inappropriate things	
I refuse things that are bad for me, even if they are fun	
I'm good at resisting temptation	
People would say that I have very strong self-discipline	
Pleasure and fun sometimes keep me for getting work done	
I do things that feel good in the moment but regret later on	
Sometimes I can't stop myself from doing something, even if I know it is wrong	
I often act without thinking through all the alternatives	

Social Skills Inventory

The items in the social skills inventory were adopted from Riggio (1986) study (Riggio, 1986).

Table 3

The items present in the social skills questionnaire test

Item	Response scale
I usually feel uncomfortable touching other people	5-point scales from 1 (not at all like me) to 5 (exactly like me).
Sometimes I have trouble making my friends and family realize how angry or upset I am with them	
I often touch my friends when talking to them.	
I rarely show my feelings or emotions	

Item	Response scale
I can easily tell what a person's character is by watching his or her interactions with others	5-point scales from 1 (not at all like me) to 5 (exactly like me).
I always seem to know what peoples' true feelings are no matter how hard they try to conceal them	
I can accurately tell what a person's character is upon first meeting him or her	
I am not very skilled in controlling my emotions	
It is very hard for me to control my emotions	
I am very good at maintaining a calm exterior even if I am upset	
I am rarely able to hide a strong emotion	
I love to socialize	
I always mingle at parties	
At parties I enjoy talking to a lot of different people	
I enjoy going to large parties and meeting new people	
I am very sensitive of criticism	
It is very important that other people like me	
I am generally concerned about the impression I am making on others.	
I am often concerned what others are thinking of me	
When I am with a group of friends I am often the spokesperson for the group	
I find it very difficult to speak in front of a large group of people	
I am usually very good at leading group discussions	
I am often chosen to be the leader of a group	

The correlation test between variables was achieved using a bivariate Spearman correlation test by IBM SPSS.

Results and Discussions

Study population characteristics

Out of the total of 94 students who responded to the survey, 57.4% were undertaking for certificate and 41.6 were undertaking diploma programmes while 64.9% were males and 35.1% were females. The overall response rate was 47%.

Table 4

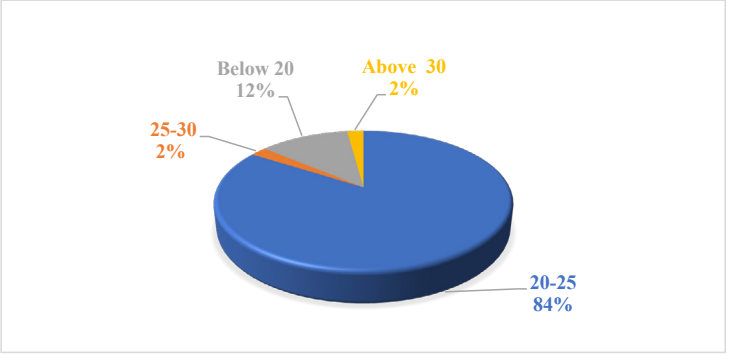
Descriptive statistics of the respondents from applied and health sciences, engineering and information technology fields

Field	**Applied and health sciences**		**Engineering**		**Information technology**	
Level population	Diploma	Certificate	Diploma	Certificate	Diploma	Certificate
Male	15	3	8	23	11	0
Female	13	12	2	1	6	0
Total	28	15	10	24	17	0
Total for each field	43		34		17	

The majority of the participants (84%) belonged to the 20-25, followed by below 20 age groups.

Figure 1

Age distribution of study participants with the following age cohorts: below 20, 20-25, 25-30 and above 30.



Grit

The measurement of grit was done using the World Bank STEP and 12-point item grit tests. The World Bank STEP results portray that the majority 57.40% occasionally exhibit grit followed by 26.06% who almost always have grit.

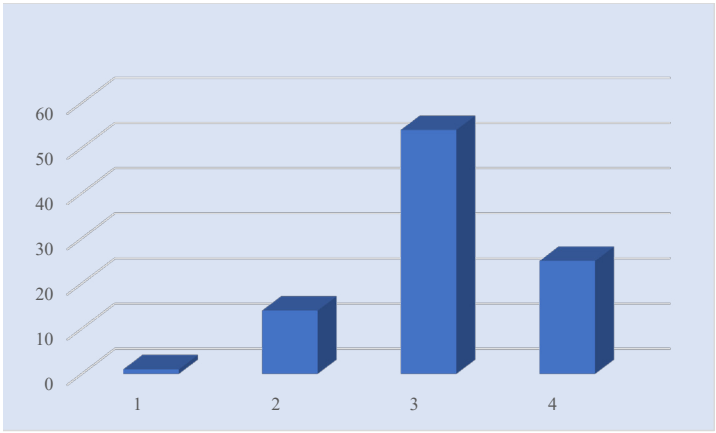
Table 5

World Bank STEP grit test results in percentage according to the 1-4 Likert scale (1= almost never, 4=almost always)

Scale	**1**	**2**	**3**	**4**
Frequency in %	1.06%	14.90%	57.40%	26.60%

Figure 2

World Bank STEP responses for grit using a 1-4 scale with 1(almost never) to 4 (almost always)



On the other hand, the 12-point grit test revealed 68.09% of the participants are much likely to exhibit grit.

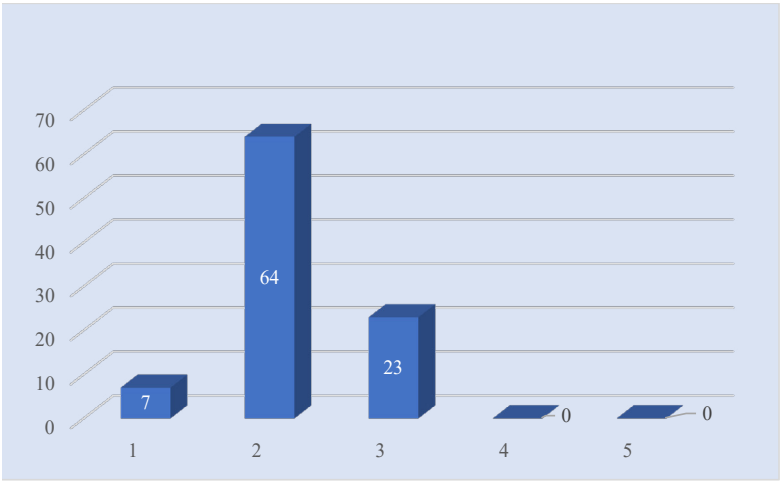
Table 6

12-point grit test results in percentage according to the 1-5 Likert scale (1=very much like me; 5 = not at all like me)

Scale	1	2	3	4	5
Frequency in %	7.44%	68.09 %	24.47%	0%	0%

Figure 3

12-point grit test responses using a 1-5 scale with 1 (very much like me), 5 (not at all like me) Self-control



There exists an equal response in terms of individuals who slightly exhibit or exhibit self-control.

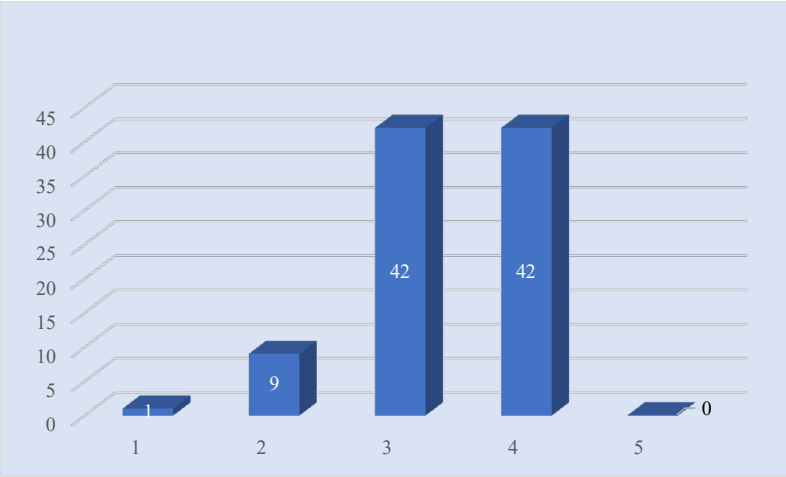
Table 7

Self-control test results in percentage according to the 1-5 Likert scale (5= not at all like me; 1= very much like me)

Scale	1	2	3	4	5
Frequency in %	1.06%	9.57%	44.68%	44.68%	0%

Figure 4

The self-control test responses on a 1-5 Likert scale (5: Not at all like me; 4: A little like me; 3: Somewhat like me; 2: Mostly like me; 1: Very much like me)



Social skills

62.7% of the participants attained the mean score for suitable social competence.

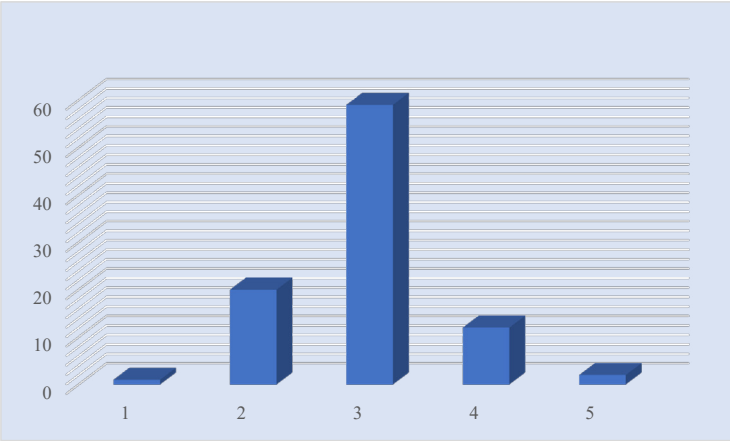
Table 8

Social skills test results in percentage according to the 1-5 Likert scale (5= exactly like me, 1= not at all like me)

Scale	1	2	3	4	5
Frequency in %	1.06%	21.27%	62.77%	12.77%	2.12%

Figure 5

Social skills test responses with 5-point scales from 1 (not at all like me) to 5 (exactly like me).



Correlation test

Further analysis was done to test the relationship between the non-cognitive skills using Spearman at $p<0.05$. There exists no significant relationship between grit and self-control, grit and social skills and self-control and social skills.

Table 9

Correlation values between non-cognitive skills

Variables	R	P	Inference
Grit and self-control	0.182	0.08	No significant relationship
Grit and social skills	0.169	0.103	No significant relationship
Self-control and social skills	0.007	0.947	No significant relationship

Discussion and Conclusion

This study used a cross-sectional design to analyze the non-cognitive skills among students and identify any present relationships between these variables and self-assessment tests were deployed in the form of self-reporting questionnaires. Other psychometric tools that can be used for assessment are structured interviews, situational judgment tests, implicit association tests, conditional reasoning tests and day reconstruction (Lipnevich *et al.,* 2013).

Among the non-cognitive skills tested, social skills performed poorly followed by self-control. Pedagogical strategies for enforcing self-control among students: promoting goal formulation and planning, devising situational strategies to reduce the likelihood of temptation and cognitive strategies for handling negative emotions (Duckworth & Seligman, 2017).

According to the Practical Handbook of School Psychology: Effective Practices for the 21st Century, the key principles for effective teaching of social competency skills are problem definition, solution identification, modelling, role-playing, performance feedback, removal of problem behaviours, self-instruction and self-evaluation, training for generalization and maintenance (Peacock *et al.,* 2009).

Analysis of data of Spearman correlation shows that there is no significant relationship between grit and self-control: $r = 0.182$, $p = 0.08 > 0.05$; grit and social skills: $r = 0.169$, $p = 0.103 > 0.05$; self-control and social skills: $r = 0.007$, $p = 0.947 > 0.05$. Therefore, these variables are independent of each other. In comparison, other studies suggest grit and self-control are highly correlated and good predictors of success. However, this trend is not in a perfect fashion (Duckworth & Gross, 2016). In other reports, grit was found to correlate with social-emotional competence (Zhang *et al.,* 2022). For instance, resilience is a characteristic of grit (Stoffel & Cain, 2018).

Grit is a trait associated with consistency of interests and perseverance to pursue long-term aspirations. Consistency of interests involves showing passion and interests while perseverance is a high level of persistence even after experiencing constant setbacks or failures. Grit acts as a positive predictor for performance in school and work, career outcomes and overall well-being (physical and psychological) (Datu, 2021). Self-control can be categorized together with responsibility, orderliness and conscientiousness. Moreover, a study done in New Zealand identified self-control as a key predictor of savings behaviour, financial security, occupational prestige, and physical and mental health during the first decade of life (Duckworth & Seligman, 2017). Social competence is characterized by the effectiveness of an individual in getting along with others through social interaction and be well liked (Bitsko *et al.,* 2020).

The development of social competence requires proper management of cognitive, social and emotional abilities. It has the following behavioural aspects: interpersonal, adaptive and self-perceived. These elements enable building interpersonal relationships, resolving interpersonal conflicts and developing clear self-identity (Luna *et al.,* 2020; Ma, 2012).

Conclusion

The present study was capable of assessing non-cognitive skills (grit, self-control, and social skills) and studied the relationship among them. In terms of the study implications, these findings can assist educationists in identifying the non-cognitive needs of students and diagnosing them appropriately depending on the context. The low response rate was a major setback possibly attributed to the length of the questionnaire. In terms of study design, the longitudinal design would be more effective than the cross-sectional used as it includes a real-time data approach. Measurement of non-cognitive skills can be challenging due

to the difficulty in defining them, they are varying and situation-specific and they require an objective distinction between standard and poor performance (Crossley, 2016). These shortcomings are acknowledged and provide room for further investigation.

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The Influence of Online Resources on Skill Development in Technical and Vocational Education and Training (TVET)

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Abstract

This research study investigates the influence of online resources on skill development within the context of Technical and Vocational Education and Training (TVET) programs. In an increasingly digital world, the integration of online learning materials, including tutorials, videos, and interactive modules, has become prevalent in TVET institutions. Utilizing a cross-sectional mixed-methods design, the study aims to explore the frequency and types of online resource usage, assess their accessibility, and evaluate their influence on skill acquisition. The focus of this study comprised trainers and students within the 255 public TVET institutions in Kenya. To ensure a representative sample, a stratified random sampling technique was applied, resulting in the selection of 25 institutions, which accounted for 10% of the total public TVET institutions in the country. A carefully designed and pretested structured questionnaire was employed to collect reliable data, and 21 institutions responded to the questionnaire, reflecting a robust response rate of 84%. The findings illuminate a significant and daily reliance on online resources, particularly video lectures, underscoring their central role in daily instructional practices. Participants reported positive Influences on skill development, highlighting the potential of online resources. However, challenges such as technical issues and limited connectivity reveal existing digital disparities that necessitate urgent attention for effective online learning implementation. Qualitative insights provide a nuanced understanding, emphasizing the positive role of games, tutorials, and simulation labs in skill development. The research contributes essential perspectives for policymakers, educators, and institutions seeking to optimize the integration of online resources in TVET for enhanced skill development and equitable educational opportunities. The study recommends prioritizing digital infrastructure, diversifying online resources, and promoting standardization and free access to create an inclusive learning environment within the TVET sector. These findings provide valuable perspectives for shaping the path of TVET programs and ensuring seamless integration of online resources.

Key Words: Skill development, e-Learning, open educational resources

Introduction

In an era marked by rapid technological advancement and evolving educational paradigms, the integration of online resources has become a prominent and growing feature in the landscape of Technical and Vocational Education and Training (TVET) programs. The convergence of traditional teaching methodologies with digital tools offers unprecedented opportunities for skill development in the increasingly interconnected and dynamic global workforce. Recognizing the transformative potential of online learning materials, including tutorials, videos, and interactive modules, this research endeavours to delve into the intricate dynamics surrounding the influence of these resources on skill acquisition within the context of TVET programs.

With a diverse demographic of participants engaged in TVET in Kenya, this study seeks to explore the frequency and types of online resources commonly used, assess their accessibility, and evaluate their perceived Influence on skill development. The nuanced understanding derived from both quantitative and qualitative analyses will not only inform educational institutions and practitioners but will also provide invaluable insights for policymakers aiming to optimize the integration of online resources in TVET. As the educational landscape continues to shift towards digital enhancements, this research endeavours to contribute to the ongoing dialogue surrounding effective strategies for skill development in TVET, ultimately shaping the trajectory of technical and vocational education in a digitally enriched environment.

Current Integration of Online Resources in TVET Programs

Worldwide, there is a notable trend of educational institutions, including those offering TVET programs, increasingly embracing online learning resources. The COVID-19 pandemic has accelerated this shift in many parts of the world. Some countries, including Kenya, have taken steps to incorporate online resources into their education systems. Governments and educational authorities were recognizing the importance of technology in enhancing learning outcomes. (Mbego, 2023). There are a wide range of ICT Initiatives and projects ongoing in Kenya focused on e-Infrastructure, e-Learning and Skills development, Digital Inclusion, Business Process Outsourcing, Local Content Program, Information Security and Other Initiatives. (Current ICT Initiatives and projects - Republic of Kenya). A study by (Orwenjo & Erastus, 2018) reported that poor infrastructure, negative attitudes, lack of ICT competencies, and other skill gaps among teachers, as well as lack of administrative support, are some of the challenges experienced in the adoption and use of OERs in Kenyan schools.

The study further established that the rural, poor schools with limited resources adopted the materials because they had limited or no teaching resources, suggesting that online learning resources can reduce the cost of education in the country without compromising on the quality of learning. Many educational institutions are exploring blended learning models, combining traditional classroom instruction with online resources to create a more flexible and dynamic learning environment.

In the context of professional development for trainers and curricula, the advancement and incorporation of e-learning are anticipated to yield substantial benefits for both future learners and Technical and Vocational Education and Training (TVET) instructors. The enhanced accessibility of courses resulting from these developments is expected to have a particularly positive Influence on youth situated in remote areas. The adoption of e-learning methods is poised to mitigate challenges related to long travel distances and the associated costs linked with the physical attendance of TVET programs, presenting a more inclusive and cost-effective approach to skills development (Swiss Contact, 2021).

Influence of Online Resources on Skill Acquisition

According to (UNESCO-UNEVOC, 2018), the idea of Open Educational Resources (OER) remained largely unfamiliar to stakeholders in Technical and Vocational Education and Training (TVET). However, it is simultaneously recognized as having great potential to enhance access to high-quality TVET. A discussion document by (COL, 2020) states that Well-designed blends of TVET, particularly when combined with workplace learning, can use technology to increase quality and access, reduce costs and be more inclusive. The discussion further suggests that Countries that have implemented strategies for blended TVET are more likely to be able to up skill the 500 million people who were previously unemployed or underemployed, the 400 million estimated to have lost work since COVID-19, and the millions who are predicted to need re-skilling in response to future technological changes.

Research by (Iftikhar, Riaz, & Yousaf, 2019) underscores the significance of YouTube as a pivotal tool in skill development, particularly in the individual or intrapersonal learning domain. The study affirms the platform's role in providing valuable video tutorials that are instrumental for students seeking to enhance their skill sets. This highlights the pronounced importance of online learning resources in addressing the educational needs of the youth, serving as a central resource for problem-solving and academic development, and emphasizing its crucial role in the acquisition of essential skills. A study, conducted by (Rozano & Romero, 2016), emphasizes the pivotal role of educators not only in delineating learning objectives, course conditions, and assessment systems but also in furnishing students with a diverse array of resources tailored to the specific skills they need to develop (Rozano & Romero, 2016).

The integration of e-learning platforms enables teachers to provide students with access to an extensive range of resources, activities, and tasks, facilitating a more effective learning process and simplifying progress monitoring. The active engagement of students with these resources positively correlates with enhanced performance, particularly when leveraging various resource types throughout the course. Importantly, the significance of resource usage and variety varies across different assessment strategies, as demonstrated in the case study. Depending on learners' familiarity with a given assessment strategy, the importance of resources may vary (Rozano & Romero, 2016).

Justification of the Study

In an era characterized by rapid digital transformation, the integration of online learning materials has become increasingly prevalent in educational institutions, including those focused on TVET. This study seeks to comprehensively understand the influence of various online resources on the development of skills crucial for success in vocational and technical fields. The primary objectives are to assess the current state of online resource integration in TVET programs in Kenya, measure the quantitative improvement in skills attributable to online resources, and qualitatively explore the perceived advantages and challenges associated with their utilization. By employing a mixed-methods approach, combining quantitative analysis with qualitative interviews and surveys of both TVET students and instructors, the research aims to provide subtle insights into the ways online resources contribute to skill acquisition. Through a thorough examination of the Influence of online resources on skill acquisition, this research contributes to the broader discourse on effective educational practices in the digital age, specifically tailored to the unique requirements of technical and vocational training in Kenya.

Objectives of the Study

The main objective of this study was to investigate the influence of online resources on skill acquisition within TVET institutions. The specific objectives were to:

i. Determine the frequency of online resource usage;

ii. Identify commonly used online resources in TVET;

iii. Determine the accessibility of online resources;

iv. Determine the effect of integration of online resources in TVET on skill development;

v. Identify challenges faced on use of online resources.

Methodology

This study adopted a cross-sectional mixed-methods design, employing both quantitative and qualitative data collection methods to comprehensively investigate the influence of online resources on skill acquisition in TVET programs in Kenya. With a focus on 255 public TVET institutions; according to (UNESCO-UNEVOC, 2021), a stratified random sampling approach was utilized, ensuring representation from both urban and rural settings for a holistic examination of the Influence of online resources in diverse educational environments.

To capture a varied range of perspectives, participants were self-selected through the distribution of the survey link across multiple social media platforms within the targeted institutions. The study strategically sampled 25 institutions from the total 255 public TVET institutions, aiming to enrich the study with diverse insights from trainers, students, and professionals involved in TVET programs. In total, 100 participants from 21 institutions completed the online questionnaire, providing a robust dataset for analysis.

The primary data collection instrument, an online questionnaire designed using Google Forms, incorporated closed-ended Likert scale questions to quantify frequencies and perceptions, while open-ended questions encouraged participants to provide detailed qualitative responses. The survey link was disseminated widely through social media platforms to ensure a broad representation of TVET stakeholders, acknowledging the self-selection nature of respondents and making efforts to encourage diverse participation. The pre-testing of the survey instrument ensured clarity and relevance, contributing to the overall internal and external validity of the research design.

Results and Discussions

Demographic Profile of Participants

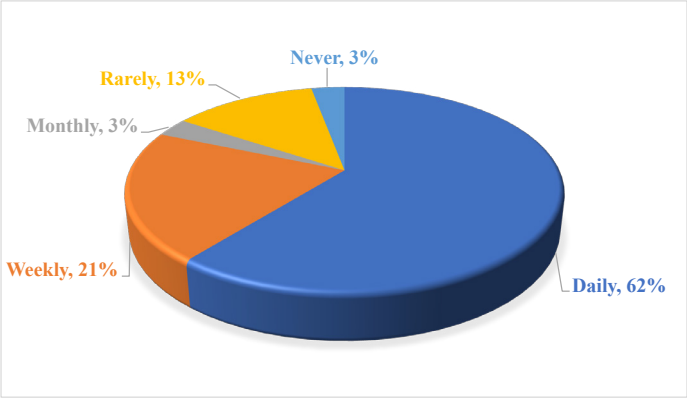
A total of 100 participants engaged in the survey, representing a diverse demographic within the Technical and Vocational Education and Training (TVET) community in Kenya. The majority of respondents were trainers, male and most respondents were below 35 years.

Frequency of Online Resource Usage

In the survey, participants were asked to provide insights into the frequency of their engagement with online resources for skill development in TVET. To ensure a comprehensive understanding, respondents were presented with a series of options designed as option buttons. These options ranged from daily to rare usage, allowing participants to choose the frequency that best represented their interaction with online resources.

Figure 1

Frequency of Online resource usage



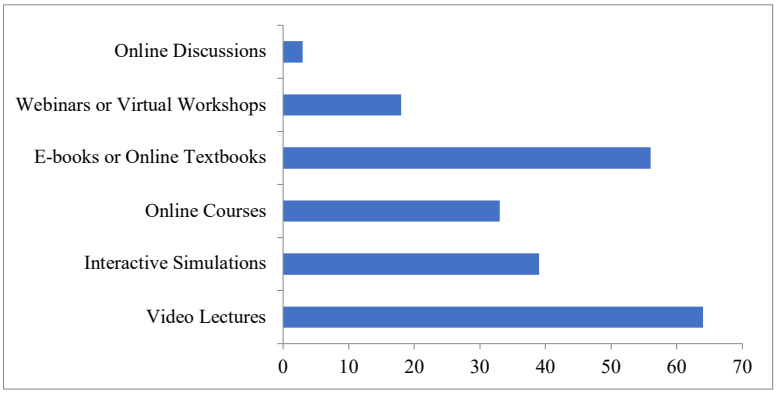
The survey revealed diverse patterns in the frequency of online resource usage among TVET participants: The study's findings resonate with existing literature on the integration of online resources in Technical and Vocational Education and Training (TVET) programs, contributing nuanced insights into the current landscape. The high frequency of daily online resource usage aligns with contemporary educational trends (Mbego, 2023); (Current ICT Initiatives and projects - Republic of Kenya), indicating an increasing reliance on digital tools.

Types of Online Resources Commonly Used

In exploring the types of online resources commonly used in TVET for skill development, a user-friendly approach was implemented through the utilization of checkboxes. Respondents were presented with a list of various online resource categories, including video lectures, interactive simulations, online courses, e-books or online textbooks, webinars or virtual workshops, and other potential resources such as online discussions. This design allowed participants to select multiple options that accurately represented their engagement with diverse online learning materials.

Figure 2

Types of online resources commonly used

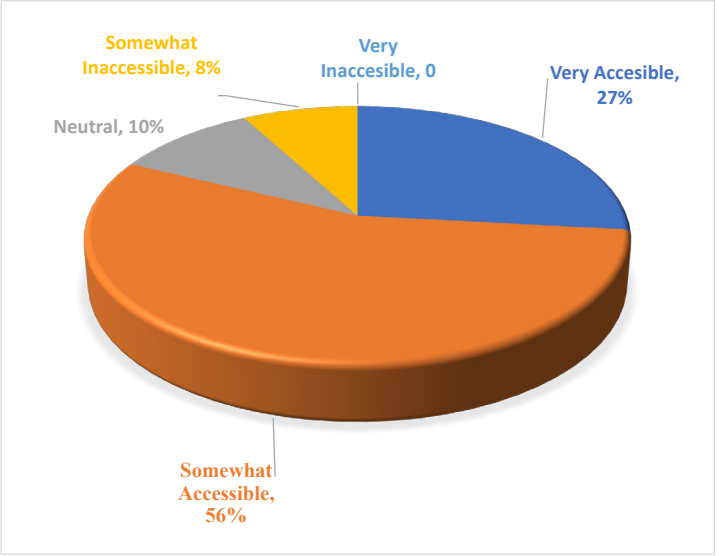


The prevalence of video lectures as the most commonly used resource aligns with research advocating for visual learning modalities in enhancing comprehension and retention (Iftikhar, Riaz, & Yousaf, 2019). However, the study's acknowledgment of 18% of participants expressing neutrality or disagreement emphasizes the need for a nuanced approach, echoing concerns raised by (Rozano & Romero, 2016) regarding individual differences in preferences for online learning.

Accessibility of Online Resources

A streamlined and focused approach was employed to gather data on the accessibility of online resources. Option buttons were strategically utilized to gauge participants' perceptions of the accessibility of online resources. Respondents were presented with a scale, ranging from "very accessible" to "very inaccessible," allowing them to express their views on the ease with which they could access online learning materials.

Figure 3
Accessibility of online resources



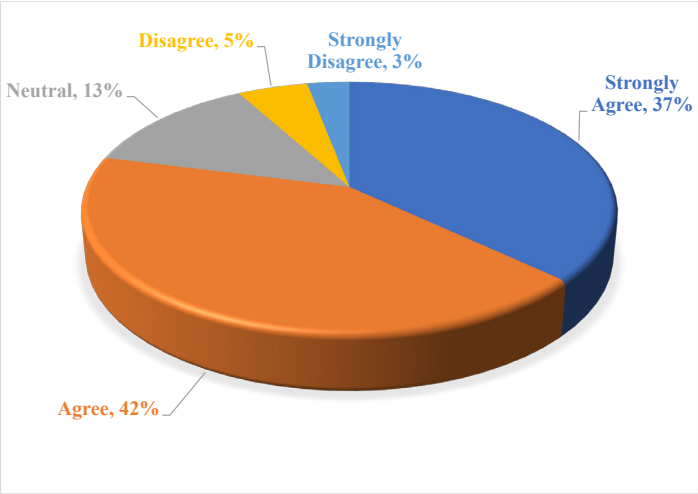
The high accessibility rate obtained in this study suggested a positive trend on the availability of digital learning materials within the TVET institutions. This resonates with (Geith & Vignare, 2006) agreeing that there is evidence of slow, steady uptake of online learning by institutions of all kinds around the world.

Influence on Skill Development

A structured survey approach was employed to comprehensively assess the Influence of online resources on skill development in TVET. The participants' perceptions on the extent to which online resources influenced their skill development was determined. Respondents were presented with a scale ranging from "strongly agree" to "strongly disagree," allowing them to articulate their views on the Influence of online resources with precision.

Figure 4

Influence on Skill Development



Majority of the participants (79%) expressed a positive Influence of online resources on their skill development. The agreement rates were notably high, with 37% strongly agreeing and 42% agreeing. This consensus underscores the perceived value of online resources in contributing to the acquisition of skills relevant to the TVET sector. Moreover, the positive perceptions regarding the Influence on skill development mirror the discussions in the (UNESCO-UNEVOC, 2018) report acknowledging the potential of Open Educational Resources (OER) to improve access to high-quality TVET. The study by (COL, 2020) further emphasizes that well-designed blends of TVET, especially when combined with workplace learning, can leverage technology to increase quality and accessibility while reducing costs. The positive sentiments expressed by participants in this study provide on-the-ground validation of these broader assertions in the literature.

Qualitative Insights

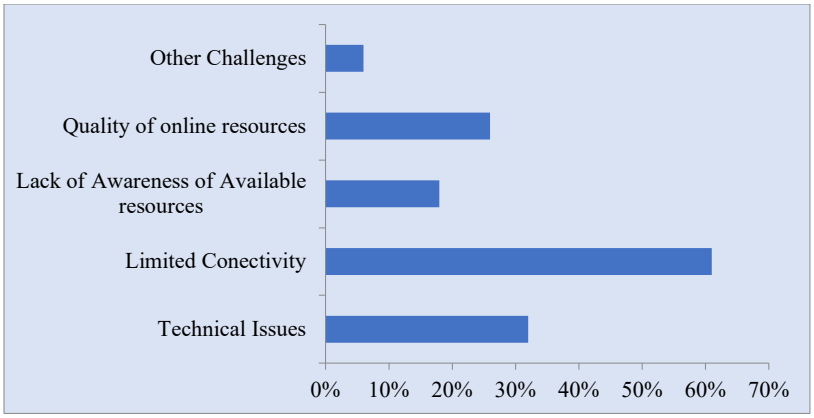
To delve deeper into the nuanced experiences of participants with online resources, the survey incorporated open-ended questions. These qualitative inquiries allowed respondents to articulate specific instances, examples, and anecdotes related to how online resources positively influenced their skill development. Participants were encouraged to provide rich and detailed insights, offering a qualitative layer to the quantitative data gathered through the structured survey. Thematic analysis of open-ended responses provided rich qualitative insights into specific experiences and examples where online resources positively influenced skill development. Common themes included use of games, online tutorials, simulation labs, E-books, educational videos, typing skills and lifelong learning.

Challenges in Using Online Resources

To comprehensively explore the challenges faced by participants in utilizing online resources, a checkbox format was employed in the survey. This approach enabled respondents to select multiple challenges from a predefined list, offering a structured yet inclusive method for capturing diverse issues. The checkboxes covered a spectrum of potential challenges, including technical issues, connectivity limitations, awareness gaps, concerns about resource quality, and other relevant aspects.

Figure 5

Challenges in using online resources



The significant portion of respondents (32%) reporting technical issues resonates with the observations made by (Orwenjo & Erastus, 2018), highlighting the challenges faced due to poor infrastructure and the skill gaps among teachers in the adoption of Open Educational Resources (OER) in Kenyan schools. This emphasizes the persistent nature of technical hindrances that continue to impede the effective integration of online resources into TVET programs.

Furthermore, the high percentage (61%) of respondents experiencing limited connectivity mirrors a common challenge recognized in discussions by (Mbego, 2023) on Kenya's government e-learning plans. The study points out the need for comprehensive infrastructure development to address issues of internet accessibility and connectivity. The current findings reinforce the urgent call for substantial investments in digital infrastructure to ensure equitable access to online resources, echoing the broader recommendations in the literature.

The concern expressed by respondents (26%) regarding the quality of online resources is in line with Commonwealth of Learning (COL, 2020) emphasis on the importance of establishing standards for online resources in TVET. This finding underscores the need for quality assurance measures to guarantee that the materials utilized in TVET programs meet specific criteria, aligning with the overall objectives of skill development.

Additional Comments

Participants were invited to share additional comments about their experiences with online resources in TVET. Common themes included Standardization of online resources; internet connectivity should be improved; all online resources used in teaching and learning should be free and a call to the government to equip TVET institutions. The emphasis on the need for improved internet accessibility aligns with discussions by (COL, 2020) about the critical role of infrastructure in successful online learning implementations. The qualitative insights from participants, emphasizing the importance of games, tutorials, and simulation labs, align with studies showcasing the multifaceted nature of effective online learning experiences (UNESCO-UNEVOC, 2018; Rozano & Romero, 2016). Furthermore, participants' calls for standardization and free access echo broader discussions on Open Educational Resources (OER) and affordability in education (Modernising the TVET system, 2021). These findings contribute to the ongoing dialogue on effective strategies for skill development in TVET, providing a foundation for future research in this rapidly evolving field.

Conclusions and Recommendations

Conclusions

In conclusion, this study illuminates the crucial role of online resources in daily TVET practices, particularly the widespread use of video lectures. The majority of respondents reported a positive Influence on skill development, emphasizing the significance of these resources. However, challenges such as technical issues and limited connectivity echo existing literature on hurdles in adopting Online Resources in Kenyan schools. Urgent interventions are needed, including investments in digital infrastructure, diversified online resources, and lifelong learning initiatives. Policymakers and institutions should prioritize these measures to ensure equitable access and maximize the positive Influence of online resources on skill development in the TVET community in Kenya.

Recommendations

1. Institutions to prioritize investments on digital infrastructure to address challenges related to limited connectivity and technical issues. Improved internet accessibility and robust technological support to create an environment conducive for effective online resource utilization in TVET programs.
2. Institutions to diversify online resources offered to cater to varied learning preferences. While video lectures are popular, incorporating interactive simulations, webinars, and virtual workshops can provide a comprehensive and engaging learning experience. This approach aligns with the diverse skill sets required in vocational and technical fields.
3. Stakeholders to regularly review standards for online resources in TVET. This includes ensuring the quality and accessibility of resources. Additionally, efforts should be made to provide free access to educational materials, fostering an inclusive learning environment and reducing financial barriers for learners.
4. Advocacy for increased funding for Information Communication Technology (ICT) infrastructural development to ensure that TVET programs are equipped with the necessary resources to meet the demands of digital learning in the 21st Century.
5. Enactment of policies to promote adoption and integration of Open Educational Resources (OER) in TVET. This could include providing funding for capacity building programs to enhance ICT competencies among teachers and establishing mechanisms for monitoring and evaluation to track the effectiveness of OER implementation.

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4

TVET AND INDUSTRIAL REVOLUTION: INTEGRATION OF MODERN TECHNOLOGIES IN TVET

Status of Preparedness of National Polytechnics Towards Effective Implementation of Dual Training

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Abstract

This study sought to investigate the preparedness of National Polytechnics towards effective implementation of Dual-TVET. The specific objectives of study were; *To identify level of institutional preparedness in implementation of Dual TVET, to investigate availability of resources and materials, to analyze trainer's capacity building and retooling and finally to acknowledge role of government in stakeholder engagement for effective Dual TVET implementation in National Polytechnics in Kenya. Descriptive research design was used for the study. Stratified random sampling technique was employed to obtain a sample of respondents where all the 23 national polytechnics,23 ILOs and 23 Registrars administrators and a total of 230 trainers were selected to participate in the study. A questionnaire consisting of both structured and open-ended questions was developed for the study. The results established that 60.71% of the National Polytechnics were prepared and ready for implementation of Dual TVET educational approach. It was also discovered that only 32.42% of respondents agreed that the government had established policy guidelines to guide in the Dual-TVET implementation. The study also showed that majority of institutions 67.14% had inadequate materials and resources to implement Dual- TVET and finally it was discovered that the majority of trainers about 77.38% had not been trained on Dual-TVET, hence slowing its implementation in the National Polytechnics. In conclusion, study findings revealed most of TVET institutions are establishing structures on how to implement Dual-TVET program though marred with the following challenges; lack of clear policies and framework to guide the Dual-TVET implementation, inadequate infrastructure, inadequate awareness and publicity on Dual-TVET, no clear structure for collaboration and industrial partnerships. Based on the findings it was recommended that the State Department for TVET to clearly give out structures, policies and framework that would guide the TVET institutions and industry stakeholders for effective implementation of Dual-TVET in the TVET institutions.*

Keywords: Dual-TVET, industry-specific skills, skill gap.

Introduction

Background Information

Dual Technical and Vocational Education and Training (DUAL-TVET) is a training approach that involves skilling youths through theoretical classroom instruction in TVET institutions with practical workplace training in actual workplace or industry settings. The state department for TVET has intensified the recrafting of curriculum for TVET institutions. These efforts have seen most TVET institutions implement different Competency Based Education and Training (CBET) curricula by the TVET CDACC and by the National Polytechnics in Kenya. The aim has been to address the current mismatch in skills witnessed in the industry according to study done by Kenya Association of Manufacturers (2017).

According to Dual TVET Kenya, trainees acquire knowledge and skills through a combination of classroom-based learning and hands-on experience. They receive theoretical instruction in the classroom, where they learn fundamental concepts and principles related to their chosen vocational field. Simultaneously, they engage in practical training within real work environments, allowing them to apply what they have learned and gain valuable practical skills in the industry. They are required to perform in accordance to the required standards in employment to match the industry needs.

The increasing industrial revolution and technological advancements, globally has contributed to the increased need to provide individuals who are skill oriented and industry driven to reduce the skill gap in the labour market. Most of the European countries such as Germany, France, Russia, South Korea among others. In Germany, the dual education system was conceptualized after the passage of the Vocational Training Act of 1969. Pritchard (1992), described the functioning of the dual education system in Germany, and later enhanced through reforms in 2005. Historically, vocational training was organized by the various guilds through apprenticeships, as their members sought to ensure that they had a talented labour pool to perpetuate their respective industries.

Germany introduced Competency Based Education and Training at vocational level training in the 1970s (Mulder *et al.,* 2007) with a view of addressing the issue of high rates of unemployment especially among the youths while the UK adopted it a decade later (Harris *et al.,* 1995). The Vocational Training Act codified and standardized this system across Germany, serving as the foundation upon which the state, the private sector, and trade unions could effectively coordinate to deliver the dual system for a modern Germany. This high level of coordination enhanced development of public education programs and firm specific apprenticeships that are complementary and mutually reinforcing.

In France dual education gained a lot of popularity since the 1990s, with Information technology being the greatest draw. The Dual Education system in France, also known as the "Alternance" system, is an approach to learning where students alternate between periods of academic studies and work experience. This hybrid model of education and vocational training is designed to give students both practical knowledge and theoretical skills, providing a comprehensive understanding of their chosen field.

In many Sub-Saharan countries, VET has an inferior status and there are high levels of contestation between social partners, making the conditions suboptimal for introducing dual approaches (von Maltitz, 2018). Most of the African countries are developing countries experiencing several challenges especially on unemployment rates, advanced technological changes and increased need for a skilled labor force to meet the changing labor market. This has seen some African countries such as Kenya, Nigeria, Namibia, South Africa and Ethiopia adopt dual education from European countries such as Germany where dual VET education has been successfully implemented.

The concept of dual VET emanates from a well-established tradition of cooperation and coordination among public and private actors in countries such as Austria, Germany, Liechtenstein and Switzerland (for details on key characteristics of dual VET see DC dVET 2016). In the region, VET generally refers to formal systems of provision of mid-level skills, usually including programmes at the level of upper secondary education and as well as some tertiary education below bachelor level (Allais, 2020). Access to these formal VET systems remains small in terms of enrolment and expenditure. Only 12.2% of students in upper-secondary education, on average, are enrolled in VET programmes as of 2014, although there are high variations across the region (Santos, Soto and Sosale, 2019).

The Kenyan government through the State Department for TVET, in response to the mismatch of skills in the industry, have put in place measures to ensure that trainees enrolled in TVET institutions acquire industrial specific skills. Some of the main reforms involves the development of Competency Based Education and Training (CBET) Curricula and recruitment of trainers to bridge in the gap witnessed in most of the TVET institution. Additionally, the Kenya School TVET in collaboration with Colleges and Institutes Canada (CICan) has been conducting training of trainers on CBET curriculum delivery.

The Dual TVET approach was first introduced in Kenya in 2019, when Ministry of Education (MoE) through State Department of TVET in an initiative collaborated with German Government and various industries to develop seven curricula, enrolled over 350 trainees in seven TVET institutions, and engaged 65 companies a pilot phase in 2019-2022 in 7 public TVET institutions in Kenya as listed below:

1. Nairobi TTI – Automotive Mechatronics level 6
2. Thika TTI – Automotive Body building level 6
3. Kiambu Institute of Science and Technology (KIST) – Industrial Mechatronics level 6
4. Bumbe TTI – Automotive Technician level 6
5. Kitale National Polytechnic – Agricultural Machinery Mechatronics level 5
6. Ramogi Institute of Advanced Technology (RIAT) – Refrigeration and Air conditioning level 5
7. Ekerubo Gietai TTI – Plant Technician level 5

The National Polytechnics, established under Section 26 (2) of the TVET Act of 2013. In reforms to restructure and revitalize the TVET sector in Kenya, National Polytechnics has been identified as major stakeholders in skilling Kenyan youths towards attaining competencies and skills that are market driven. The State Department of TVET has mandated the national polytechnics to recraft the curricula and develop a competency-based curricula, to address the skill gap currently witnessed in the country. Currently there are 21 National Polytechnics in Kenya, this after 10 new Technical Training Institutes (TTIs) were upgraded to National Polytechnic status.

The Dual TVET in Kenya has gained momentum, this follows the pilot phase with 7 public institutions, which has seen the State Department of TVET release directives that all the National Polytechnics should work out frameworks and strategies, working closely with all stakeholders especially the industry, to collaborate and implement the Dual TVET Educational approach.

Statement of the Problem

The government through, State Department for TVET (SDTVET) in the implementation of the Bottom -Up Economic Transformation Agenda (BETA), are in the process of skilling youths in the TVET sector. This is a strategy that aims to produce skilled youths with varied skills and manpower that aims at addressing the current unemployment rates and mismatch in skills witnessed in the country. In bid to achieve this, the SDTVET together with different stakeholders such as GIZ, Industries and TVET institutions with priority being the national polytechnics, have been mandated to implement the Dual TVET educational approach.

Though the first pilot on dual training was successfully done in seven TVET institutions, in scaling down to the rest of TVET institutions, there are still a lot of challenges in the implementation of the new model of training. It is therefore in this regard that this study aims at assessing the status of TVET institutions towards the implementation of Dual-TVET educational model.

Objective of the Study

The main aim of this study was to assess the status of Dual TVET implementation in the national polytechnics in Kenya. The specific objectives of the study were to:

1. To identify level of preparedness in the implementation of Dual TVET educational approach in the National Polytechnics in Kenya.
2. To investigate the availability of resources and materials for Dual TVET implementation in the National Polytechnics in Kenya.
3. To analyze the trainer's capacity building and retooling towards the implementation of Dual TVET approach in the National Polytechnics.
4. To determine the role of government in stakeholder engagement for effective Dual TVET implementation in the National Polytechnics in Kenya.

Methodology

The study adopted descriptive survey design. The study targeted the Trainers', ILO's and Registrars as part of administrators responsible for implementation of Dual-TVET in the selected National Polytechnics in Kenya. The target population for the study included all the 23 National Polytechnics accredited as Qualifications Awarding Institutions, including the newly upgraded 13 institutions according to TVET act 2013. The study included all National Polytechnics in Kenya since their number is considerably smaller. The respondents for the study included all the 23 Industrial and Liaison Officers (ILO), 23 Registrars and a maximum of 10 trainers selected from each institution through simple random sampling technique. The sample size, target population are shown in Table 1:

Table 1

Sample size and target population of respondents

Description	Population Size	Sample Size	%
ILO	23	23	100%
Registrars	23	23	100%
Trainers	4600	230	5%

The data collection involved a mix of Closed ended questionnaire with Likert scale and an open-ended questionnaire which increased the chance of further probing to obtain more information from the respondents. The reliability level of each instrument was determined at pre-test. Quantitative data collected was sorted, coded, analysed, and presented in the form of frequency tables. Data quality checks were done in order to eliminate errors or points of contradiction in data. Descriptive and inferential statistics was used in data analysis.

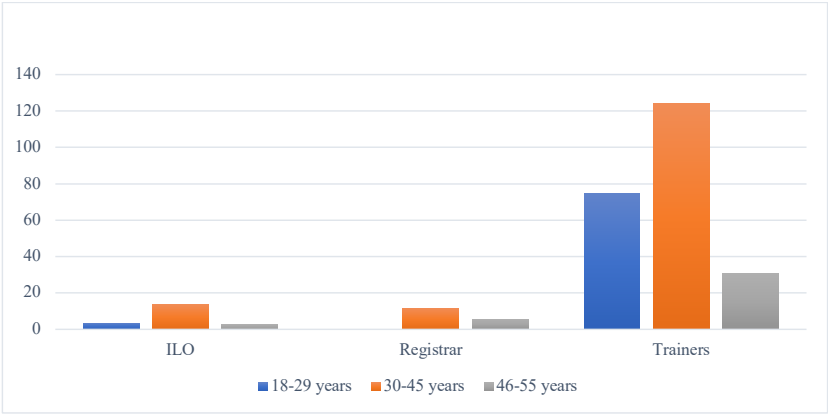
Results and Discussion

Response rate

The study was conducted in all the 23 National Polytechnics in Kenya. The response rate for the respondents was determined to be 97.46% of all the targeted respondents. The age of the respondents was classified into groups, whereby majority of the respondents are classified under 30-45 years, followed by 18-29 years and finally 46-55 years of age as shown in the Figure 1.

Figure 1

Age groups of respondents

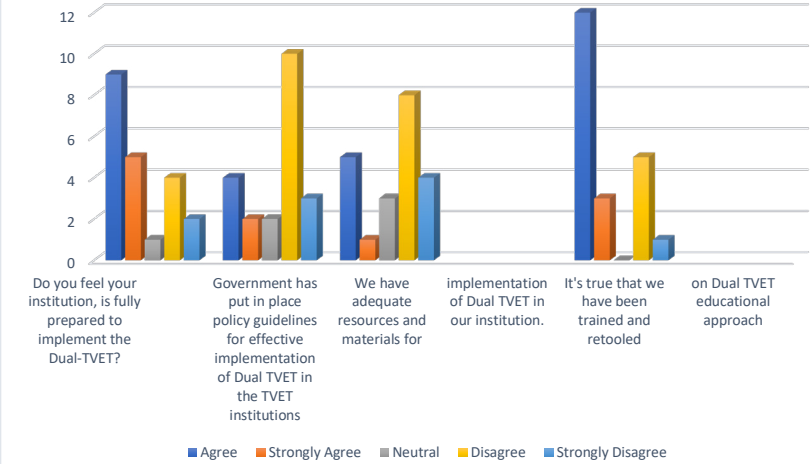


Industrial Liaison Officers' Responses on the Institutions' Preparedness on Implementation of Dual-TVET Approach

The Industrial and Liaison Officers (ILOs) play important roles in implementation of Dual-TVET in the National Polytechnics. They identify and link the respective institutions with the relevant industries, for industry-based training. Most respondents 42.9% and 23.8% agreed and strongly agreed respectively, that their institutions were fully prepared to implement the Dual-TVET approach. It is therefore regarded that the majority of the institutions are prepared for Dual TVET implementation. However, 4.8% of the respondents were not sure about their institutions level of preparedness, while 19% and 9.5% of the respondents, disagreed and strongly disagreed respectively indicating that their institutions were not ready for implementation of Dual-TVET.

A significant proportion of respondents 47.6% and 14.3% disagreed and strongly disagreed showing dissatisfaction on the efforts of the government through the State Department for TVET, indicating that no clear guidelines and frameworks have been put in place for effective implementation of the Dual-TVET. It was also noted that 9.55% of the respondents had a neutral view. While 19% and 9.5% agreed and strongly agreed, stating that the government is committed to developing policies and guidelines for effective implementation of the Dual TVET. The results were as shown in Figure 2.

Figure 2
ILOs Responses on Implementation of Dual TVET



It was also discovered that majority 57.1% of the institutions had inadequate resources and materials for implementing Dual TVET. About 14.3% of the respondents were not sure of their responses, while the remaining 28.6% held a view that their institution has adequate resources and materials for implementation. Lastly a large proportion of 57.1% and 14.3% agreed and strongly agreed that they have been trained and received capacity building on Dual TVET, as most workshops have been organized with the State Department for TVET and other development partners and stakeholders. The remaining 23.8% and 4.8% of the respondents disagreed and strongly disagreed respectively indicating that they had not received adequate retooling and capacity building. The findings from the respondents, clearly outlines that the majority of the institutions are prepared towards implementation of Dual TVET, though still having challenges as per the results obtained from the respondents.

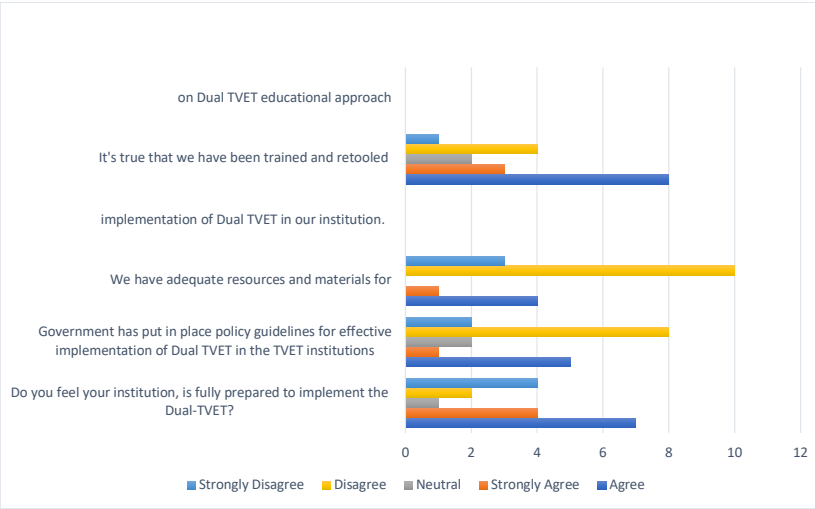
Registrars' responses on the institution's preparedness on implementation of Dual-TVET Approach.

The response rate for registrars was determined to be at 78.26% as compared to the target population. As administrators, they play a vital role in the implementation of different programmes within TVET institutions. The results showed that most of the respondents 38.9% and 22.2% agreed and strongly agreed respectively, revealing that their institutions are fully prepared to implement the Dual-TVET approach. On the other hand, about 5.6% had neutral feelings about their institutions level of preparedness, another 11.1% and 22.2% of the respondents, disagreed and strongly disagreed respectively stating that their institutions are doing very little in implementing the Dual-TVET approach.

A majority of respondents 44.4% and 11.1% disagreed and strongly disagreed with the statement, stating that the government through the state Department for TVET, had not provided clear frameworks and guidelines that would help the national Polytechnics in implementing the Dual TVET. About 11.1% of the respondents were unsure about the government's efforts in establishing Dual TVET policies. A small proportion of 27.8% and 5.6% of the respondents agreed and strongly agreed, stating that the government has put in place right strategies developing policies and guidelines for effective implementation of the Dual TVET. Figure 3 shows the responses from the Registrars.

Figure 3

Registrars' Responses on Implementation of Dual-TVET



The majority 55.5% and 16.7% of the respondents reported that their institutions had inadequate resources and materials making it difficult in implementing Dual TVET. Significantly about 22.2% and 5.6% of the respondents, held a view that their institution has adequate resources and materials for implementation. These findings prove that there are inadequate resources in most TVET institutions for training.

Finally, 44.4% and 16.6% of the respondents in their views, agreed and strongly agreed that most of them had been trained and received capacity building on Dual TVET. Through these training most of the respondents, reported that they understand and are in a position to effectively implement the Dual Programmes in their institutions. About 11.1% of the respondents had neutral views, while 22.2% and 5.6% of the respondents had contrary opinions disagreeing and strongly disagreeing respectfully about receiving adequate capacity building on Dual-TVET.

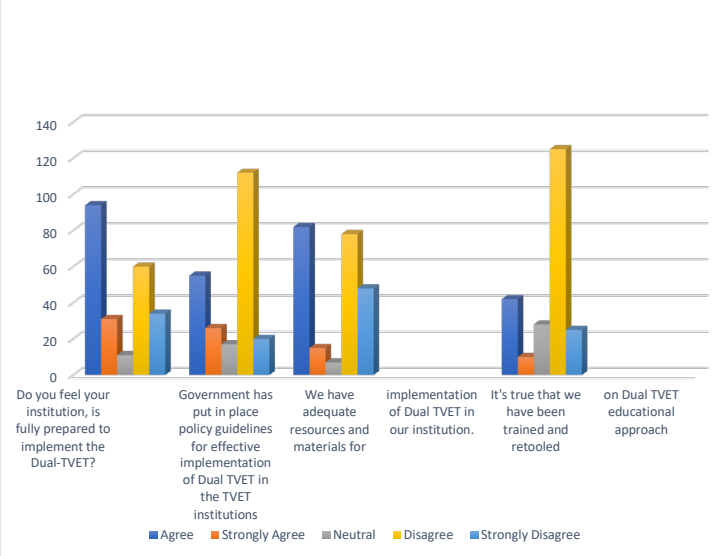
Trainers' responses on the institution's preparedness on implementation of Dual-TVET Approach.

The trainer's core implementers of training programmes within the institutions. They interact on a daily basis with the trainees; hence they had a great impact on the implementation of Dual-TVET programme in the national polytechnics in Kenya.The findings from the study revealed that about 40.87% and 13.48% of the respondents in their views, agreed and strongly agreed respectively, showing that their institutions are fully prepared to implement the Dual-TVET approach. It was also reported that 4.78% were not sure whether their institutions are either ready for Dual -TVET implementation or not. The remaining 26.07% and 14.78% of the respondents, had a divergent opinion disagreeing and strongly disagreeing respectively illustrating that their institutions are doing very little in implementing the Dual-TVET approach.

It was reported that 48.7% and 8.7% of the trainers in their opinions, disagreed and strongly disagreed with the statement, that government through State Department for TVET, has provided clear frameworks and guidelines that would help the institutions in implementing the Dual -TVET. It was also noted that majority of the trainers, haven't either seen or interacted with any of the policies on Dual-TVET. On another instance 7.39% of the respondents had neutral views towards the same. The remaining 23.91% and 11.3% of the respondents agreed and strongly agreed, stating that the government has put in place right strategies developing policies and guidelines for effective implementation of the Dual-TVET. The responses from the trainers are summarised in Figure 4.

Figure 4

Trainer's Responses on Implementation of Dual TVET



About 33.91% and 20.87% of the respondents disagreed and strongly disagreed with the statement acknowledging that their institutions had inadequate resources and materials for effective implementation of Dual TVET. It was also recorded that 3% of the respondents had neutral views, while 35.65% and 6.52% of the respondents held a view that their institution has adequate resources and materials for implementation hence agreeing and strongly agreeing with the statement.

The majority of the trainers 54.34% and 10.87% in their views, disagreed and strongly disagreed with the statement respectively, showing that they haven't received any training or capacity building on Dual-TVET. About 12.7% of the respondents had neutral views, while the remaining 18.26% and 4.35% of the respondents had contrary opinions agreeing and strongly agreeing respectively about receiving training and capacity building on Dual-TVET. It is therefore evident that the majority of the trainers or respondents, still do not have the capacity to implement the Dual-TVET approach within the National Polytechnics.

Conclusions and Recommendations

Conclusions

In summary, study findings established that about 60.71% of National Polytechnics are prepared and ready for implementation of Dual TVET educational approach. However, it was also noted that some institutions aren't ready for the implementation of the Dual-TVET programme due to specific challenges present in the individual institutions.

It was also discovered that only 32.42% of respondents agreed that the government has well established policy guidelines, while the majority (67.58%) of respondents strongly believed that government hasn't established effective policy guidelines to guide in the Dull-TVET implementation. The study also showed that most institutions (67.14%) did not have adequate materials and resources to implement the Dual- TVET and finally it was discovered that majority of the trainers (77.38%) had not been retooled and trained on Dual-TVET hence slowing implementation in the National Polytechnics.

In order to realize effective implementation of this training programme, there is an urgent need for adequate resources and materials within the institutions. However majority institutions have inadequate resources compared to the increasing population of trainees admitted in the National Polytechnics in Kenya. Finally, it was reported that most of the ILOs and Registrars have obtained at least a training on Dual-TVET programme, but this was not replicated among the trainers who felt that they needed capacity building to prepare them for implementation of the programme.

Recommendations

Based on the findings of the study, the authors made the following recommendations for effective implementation of the Dual-TVET in the National Polytechnics in Kenya:

1. National Polytechnics to develop more MOUs and partnerships with industries and set up Dual-TVET implementation committee for effective implementation of the programmes.
2. The government through the State Department for TVET, in collaboration with stakeholders to provide adequate resources for implementation of Dual-TVET.
3. The Technical and Vocational Education and Training Authority to ensure that all National Polytechnics establish and implement capacity building programs for all trainers on Dual-TVET.
4. The government to develop policy framework on Dual-TVET and organize regular sensitization of all stakeholders on the importance of Dual-TVET programs.

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