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Technology Integration in Technical and Vocational Education and Training (TVET): The Role of the Art Teacher

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Abstract: The quality of teaching and learning across all TVET disciplines can be enhanced by promoting technology-inclusive TVET. Using the Technological Pedagogical and Content Knowledge (TPACK) model, this study examines the interrelationships between the knowledge required by art teachers to effectively integrate technology in teaching at the TVET level. The study assumed that quality TVET practices could be achieved if TVET teachers had a solid understanding of their subject matter, pedagogical procedures and knowledge about employing technological tools. This research used a quantitative data approach and adopted a Structural Equation Modelling (SEM) analysis technique to measure the path coefficients of direct or indirect influence between exogenous and endogenous variables. A quantitative survey instrument based on the TPACK model was adopted to collect data from 152 art teachers sampled across various public educational institutions in Ghana. Data analysis was performed with SPSS and SmartPLS using an online data collection procedure. The study demonstrates a significant relationship between art teachers' knowledge and how much technology can be integrated with TVET. The following mechanisms were revealed: the mastery of technological tools, technologically driven instructional approaches, and a teacher's technical knowledge and abilities as the fundamental mechanisms required to foster efficient skill development at the TVET level. This implies that educators, training institutions, policymakers, and stakeholders in the TVET ecosystem should pay special attention to these mechanisms to strengthen the teaching and learning delivery of TVET.

Keywords: TPACK, art teacher, technology integration, TVET

1. Introduction

Technical and Vocational Education and Training (TVET) is a vital component of the educational system, focusing on developing skilled workers for a country. TVET is regarded as the primary key to economic growth and the reduction of unemployment (Choi, 2021). Countries such as Malaysia, India, and Jamaica have embraced TVET and used it to benefit their citizens (Brewer and Comyn, 2015). In the study area of Ghana, the present government has taken several initiatives to maximise the benefits of TVET towards national development (Ansah and Kissi, 2014). Key among the initiatives is the establishment of several technical and vocational schools, Science, Technology, Engineering, and Mathematics

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(STEM) schools, and converting Polytechnics into Technical Universities (Takyi, 2023). Over the years, efforts have also been made to retool the workshops and laboratories of existing TVET educational institutions with state-of-the-art equipment and facilities. Additionally, in 2006, the government of Ghana, with the help of an Act of Parliament, set up the Council for Technical and Vocational Education and Training (COTVET) to oversee technical and vocational education and training in the country, with the additional role of spearheading skills development. (Amedorme and Fiagbe, 2013).

Since the main aim of TVET education is to train students with adequate skills to fit into the industrial world and create job opportunities for themselves and the masses, it is necessary to prioritise those who impart the knowledge (Le et al., 2020). The vocational or technical teacher's professional competency is crucial in realising the goal of TVET in any country worldwide. Continuing Professional Development (CPD) can best sharpen the teachers' professional competencies. Njenga (2023) revealed that CPD is required by vocational and technical teachers, given the rapid technological changes in the TVET subsector. According to the source, these changes require that teachers continuously upgrade their skills and knowledge in their vocational areas, which will go a long way toward improving their competencies and teaching delivery. CPD is therefore necessary for improving the quality of teaching and learning and adding value to the students that are churned out. Triati et al. (2022) emphasised that intensive training for teachers helps build their capacity to handle TVET-related subjects easily.

An area critical to the TVET education delivery process is using technology to impart knowledge to students. This comes after the industrial revolution, which pressures TVET institutions to produce graduates with the requisite technological skills to work in the "new world" (Wulansari et al., 2021). According to the OECD (2018), technology has become a critical aspect of our daily lives, and it is increasingly important for 21st-century learners to possess technology-related skills and competencies. Training institutions, including those in the TVET domain, are paying attention to the role of technology integration in developing relevant skills and competencies in individuals capable of contributing to socio-economic growth and development (Paryono, 2017). According to Shamim and Raihan (2016), a study on the use of Information and Communication Technology (ICT) for teaching at technical schools in Bangladesh revealed that technology facilitates teaching and learning, saves time, and ensures quality compared to the traditional way of teaching.

Adopting technology by art teachers to train students for the job market is essential because the growing art industries need graduates with excellent technological competencies for employment. This is because most equipment being used in such industries nowadays is digital-based. To positively impart knowledge to students, there is a need for art teachers to be adequately trained in the use of technology-based applications. Kajjora (2017) reports that art teachers can successfully teach students in the TVET sector how to manipulate basic computer software such as Corel Draw, Adobe Photoshop, and Illustrator to draw, design, and produce competitive artefacts. In addition, the teachers can use animation, artistic simulations, and augmented reality to deliver their lessons (Rahmawati et al., 2021). Recent technological advancements make it compulsory for art instructors to embrace technology integration in their TVET instructional delivery.

1.1 Problem Background

Ghana and other Sub-Saharan African countries have faced challenges in fully implementing Technical and Vocational Education and Training (TVET) reforms. Even though TVET offers several benefits, such as socio-economic developments, these obstacles hinder its effective implementation. These include inadequate facilities and materials for student training, a shortage of technical teachers and instructors for technology-related subjects in TVET and negative parental attitudes towards TVET. The inability to incorporate technology into TVET, particularly in art, hampers Ghana's creative output and socio-economic progress. Art teachers struggle to effectively integrate technology into their teaching due to the lack of competence and knowledge in technology-based applications related to art.

This study investigates the correlation between art teachers' technological competence teaching methods and how these impact the effective teaching and learning of TVET subjects. It utilises the Technological Pedagogical Content and Knowledge (TPACK) model developed by Harris et al. (2019). Through a survey-based quantitative approach involving art teachers from various public educational institutions in Ghana, the research evaluates the extent of technology integration among TVET art teachers. It identifies factors that contribute to the low level of integration. Additionally, the study employs Structural Equation Modelling (SEM) to measure the path coefficients of direct or indirect influence between exogenous and endogenous variables. This study is novel as it delves into the under-explored area regarding technology integration in Technical and Vocational Education and Training (TVET) within Ghana. While previous studies have touched on technology integration and the application of the TPACK model, existing literature lacks investigations into the specific role of art teachers in incorporating technology into TVET. The findings of this study will serve as a reference point for further research by international scholars into the improvement of TVET delivery, with a particular reference to art.

2. Review of Related Literature and Hypothesis for the Study

2.1 Conceptual Framework of the Study

This study is anchored on a framework for teacher knowledge for technology integration called Technological Pedagogical Content and Knowledge (TPACK) (Harris et al., 2009). The TPACK framework explains how teachers' knowledge of educational technologies and Pedagogical Content Knowledge (PCK) interact to generate effective teaching. This approach views teaching as an interaction between instructors' existing knowledge and how it is applied to specific conditions or environments in their classrooms (Harris et al., 2009).

The TPACK model has evolved to reflect the complexities involved in teaching with technology (Harris et al., 2009; Mishra, Koehler, and Henriksen, 2011). The current TPACK framework developed by Koehler and Mishra (2009) offers a productive approach to many of the dilemmas teachers face in implementing educational technology in their classrooms. With a focus on incorporating technological knowledge in teaching, this model provides three main components of a teacher's knowledge: content, pedagogy, and technology. The interactions among these knowledge bodies form a crucial part of the framework, and they are represented as Pedagogical Content Knowledge (PCK), Technological and Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and the entire TPACK. According to the TPACK framework (Fig. 1), these elements represent a key synthesis of information employed by the best teachers for effective teaching and learning.

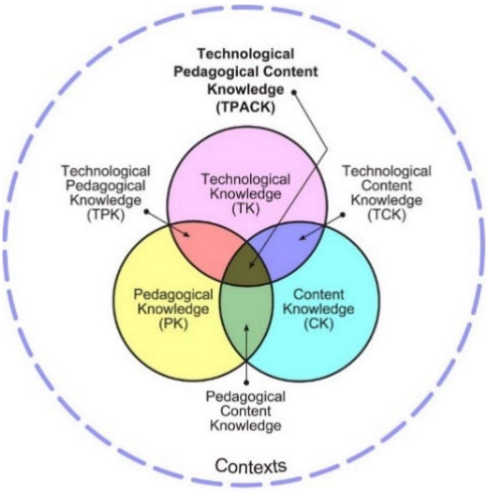

Fig. 1 - TPACK framework

Source: Koehler, M. J. (2011)

2.2 Technological Tools Mastery and Integration in TVET

Technology has become one of the inevitable means of acquiring quality education (UNESCO-UNEVOC, 2020; Thapa, 2022). According to Thapa (2022), exposure to technology and its integration into education is necessary for social equity and social justice. However, a lack of exposure to technology will prevent students from pursuing lucrative vocations and jobs in the global labour market (Thapa, 2022). Technology allows learners to develop twenty-first-century skills in digital competencies, including collaboration, critical thinking, problem-solving, innovation, and creativity (UNESCO-UNEVOC, 2020; Mohammad Yunus and Mohamad, 2022).

According to UNESCO-UNEVOC (2020), the effective adoption of technology is necessary to promote quality TVET. Technology has made TVET more accessible to students and has also given teachers and trainers more tools to manage their tasks and engage students in technologically advanced settings. In TVET institutions, teachers and instructors significantly influence learners' learning outcomes and competences. Competent human capital will result from a competent TVET instructor (Shahroni, Mingha, and Mustakim, 2022). Therefore, it is necessary to equip the TVET teacher or instructor with the necessary technological tools and skills to ensure the efficient delivery of high-quality TVET. According to available literature, the extent to which TVET teachers master and apply technological tools in the classroom has an influence on how much they can incorporate technology into a TVET course. (Mudau, Patience.K., & Van Wyk, 2021; Legg-Jack and Ndebele, 2022; Mohammad Yunus and Mohamad, 2022; Shahroni, Mingha, and Mustakim, 2022). Thus, it is crucial for TVET teachers to be up to date with modern technology tools to effectively impart the necessary knowledge and skills to students. **H1:** *The mastery of technological tools by teachers may influence their ability to integrate technology into TVET programmes.*

2.3 Technology Integration and Teaching Approaches in a TVET Discipline

Technology significantly affects the instructional strategies used for teaching and learning (Basilotta-Gómez-Pablos et al., 2022; Cabero-Almenara et al., 2022). According to Yasak and Alias (2015), there is a need for TVET educators to adopt technology that can support TVET practices in the three domains: affective, cognitive, and psychomotor. The integration of technology into the various teaching philosophies in a TVET discipline calls for a comprehensive approach (Mohammad Yunus & Mohamad, 2022). Anthony and Abubakar (2021) perceived that teachers and instructors within the TVET ecosystem need to use technology-enhanced teaching materials such as computers, digital cameras, video recording devices, etc. as a means of exposing students to relevant knowledge and skills necessary to face the world of work. This approach will facilitate effective training and skill acquisition for the individual student. As a result, a self-reliant TVET graduate who is capable of reshaping society will be created (Anthony and Abubakar, 2021).

Several studies have recognized the blended learning approach as one of the ideal learning models suitable for TVET (Yasak and Alias, 2015; Islam, Abdullah, and Mamun, 2022; Eze, 2023). Blended learning is a pedagogical strategy that gives students exposure to both in-person and online educational learning environments (Islam, Abdullah, and Mamun, 2022). It is a learning model that combines online solutions with traditional or face-to-face approaches to teaching and learning. This learner-centered strategy ensures that instructions are delivered effectively and at the targeted learning outcomes while enabling students to learn whenever and wherever they want (Islam, Abdullah, and Mamun, 2022; Eze, 2023). **H2:** *There is a significant influence of technology in the teaching approaches used in TVET programmes.*

2.4 Technology and Teachers' Technical Knowledge and Skills

There is a growing concern among educational technologists about the state of digital competencies necessary for teachers to make effective use of technology (Omar, Zahar, and Rashid, 2020; Basilotta-Gómez-Pablos et al., 2022). According to Basilotta-Gomez-Pablos et al. (2022), a teacher must possess a combination of knowledge, abilities, and attitudes to use technology effectively in the classroom. The authors admitted that teachers lack several digital competencies that are necessary to produce high-quality instruction. Among these are the ability to use ICT to solve problems, collaborate with a network of connections, and evaluate using 2.0 tools (Basilotta-Gómez-Pablos et al., 2022). Each teacher's attitude toward the use, integration, and adaptation of ICT in the classroom has an impact on how their competency develops (Cabero-Almenara et al., 2022).

One of the fundamental features that characterizes TVET education is the ability to provide technical knowledge and skills involving a wide variety of occupational disciplines, production processes, services, and livelihoods (Gretch and Camilleri, 2020; Legg-Jack and Ndebele, 2022). Technology-infused TVET education is seen by Gretch and Camilleri (2020) as a pathway to flexible and lifelong learning. It was argued that digital technologies have the potential to revolutionize the TVET sector soon (Gretch and Camilleri, 2020). This implies that TVET teachers or instructors and other stakeholders, including training institutions, government and state agencies, policymakers, and industry players, must support initiatives that promote technology focused TVET. It is therefore imperative for TVET teachers and instructors to develop critical competencies in the practical application of technical knowledge and skills with reference to technological tools and procedures if they are to employ technology in a TVET subject effectively. This will result in an enhanced TVET. Therefore, it is essential to provide pedagogical assistance and incorporate technology into all subject areas. **H3:** *There is a significant relationship between technology and the teachers' technical knowledge and skills in a TVET discipline.*

It could be deduced from the above discussion that there is a significant relationship between technological tool mastery, teachers' teaching approach, and the teachers' technical knowledge and skills in the effective integration of technology in the classroom. To ascertain the extent of such a relationship and determine its impact on TVET education, there is a need to test the hypothesis and the conceptual framework as presented in figure 2.0.

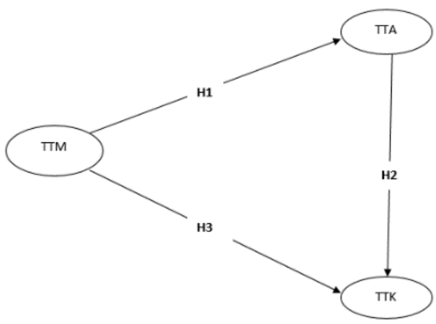

Fig. 2 - Conceptual framework for the study (Authors construct, 2023)

1. **TTM**- represents technological tools mastery and integration in TVET with hypothesis 1 measuring the significant relationship between TTM and TTA.
2. **TTA**- represents technology and teaching approaches in a TVET subject with hypothesis 2 measuring the significant relationship between TTA and TTK.
3. **TTK**- represents technology and teachers' technical knowledge and skills in a TVET discipline with hypothesis 3 measuring the significant relationship between TTK and TTM.

3. Method

3.1 Research Design

This study involved teachers teaching various art-related subjects in TVET learning institutions in Ghana. The teachers were at the secondary and tertiary school levels and ran various TVET art subjects. With the adoption of a quantitative data approach, an online survey questionnaire was developed consisting of 36 items and 5 constructs on a five-point Likert scale. This was presented on Google Forms and distributed via email and social media. The Structural Equation Modelling (SEM) analysis technique was employed to measure the path coefficients of direct or indirect influence between exogenous and endogenous variables. SPSS was used for the exploratory factor analysis, while Smart PLS-3 software was used for the confirmatory factor analysis and modelling sections. Literature has established that PLS-SEM represents a well-substantiated method for estimating complex cause-and-effect relationship models in management research (Gudergan et al., 2008).

3.2 Population and Sampling

The population for the study comprised art teachers from the various secondary and tertiary public educational institutions in Ghana. The schools include senior high schools, TVET institutions, and Technical Universities. The subjects taught in these schools by art teachers include graphic/communication design, textile technology/design, ceramic technology/design, painting/picture making, sculpture/metal fabrication, and leather/basketry. Participation was voluntary, and participants were assured of utmost confidentiality.

A cross-sectional survey approach was adopted. The sampling technique employed in reaching the respondents was convenience sampling. A total of 152 art teachers, composed of 92 males and 28 females, participated in the study by responding to the online survey. The sample size used was appropriate for the study because, according to Hair et al. (2019), a minimum sample size should be 150 or less when the model with seven constructs or less is used at least modest commonalities (.5) and no under identified constructs (Hair et al., 2019).

3.3 Demographic Characteristics

The demographic characteristics of respondents are presented in Table 1.0. Most respondents (65.8%) were males, while 43.2% were females. Most of the respondents who participated in the study were Masters/MPhil degree holders (n = 70), while the least participants were HND holders (n = 4). The results showed that participants who teach at Technical Universities were in the majority, representing 63.2% of the respondents. However, participants from the Teacher Training Colleges were in the minority, representing 2.6% of the respondents.

Table 1 - Demographic characteristics of respondents

Variables	Category	Frequency	Percentage
Gender	Male	100	65.8
	Female	52	34.2
Educational level	HND	4	2.6
	Degree	52	34.2
	Masters/MPhil	70	46.1
	PhD	26	17.1
Current Level of Teaching	Senior High school level	38	25.0
	Senior High Technical School level	14	9.5
	Technical University level	96	63.2
	Teacher Training College level	4	2.6

Source: Field Survey, 2023.

3.4 Instrumentation

The instrument for the study was based on the TPACK model, initially developed by Mishra and Koehler (2009). This assumed that quality TVET practices could be achieved if TVET art teachers understood their subject matter, pedagogical procedures and knowledge about how to employ technological tools. Against this background, the questionnaire design was in two sections. The first section represented the demographic characteristics of the respondents. It contained six (6) items: gender, age, highest educational qualification, subject area of specialisation, and the level at which he or she was now teaching. The second section had seven (7) constructs, namely: Pedagogical Content Knowledge (PCK), Content Knowledge (CK), Pedagogical Knowledge (PK), Technological Knowledge (TK), Technological Content Knowledge (CK), Technological Pedagogical Knowledge (TPK), and Technological Pedagogical and Content Knowledge (TPACK). Each construct contained a minimum of five (5) and a maximum of six (6) items, respectively. In total, 36 items measured all the constructs using a five-point Likert scale response format with answer options: 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree. Before administering the questionnaire, a pilot survey involving 20 art teachers was conducted to validate the appropriateness of the instrument.

3.5 Exploratory Factor Analysis (EFA)

An Exploratory Factor Analysis (EFA) was performed to assign indicators to the appropriate constructs properly. As shown in Table 2 the mean ratings of the indicators as to the respondent's level of agreement or disagreement concerning PCK, CK, PK, TK, TCK, TPK, and TPACK is displayed, with 1 being the lowest value for those who strongly disagree and 5 for those who strongly agree. The mean rating shows that the indicators are highly rated (approximately 3 or more) as major factors that affect teachers' ability to integrate technology in a TVET subject. However, the standard deviations were quite high (above 0.85).

Table 2 - Descriptive statistics of measurement instrument

Items	Mean	Std. Deviation
PCK1	4.30	1.163
PCK2	3.95	.961
PCK3	3.97	1.079
PCK5	4.09	.909
CK6	3.92	1.052
CK7	3.82	.945
PK8	4.12	.935
PK9	3.37	.988
TK10	3.85	.995
TK11	3.64	1.112
TK12	3.75	1.005
TK13	3.96	.927
TCK14	4.07	.940
TCK15	3.89	.870
TCK16	3.68	1.130
TCK17	3.75	1.141
TPK18	3.76	1.053
TPK19	3.71	.946
TPK20	3.82	.931
TPK21	3.87	.954
TPK22	3.82	1.038
TPACK23	4.57	.882
TPACK24	4.32	.938
TPACK25	4.13	.851
TPACK26	3.91	.937

TPACK27	3.62	1.091

Source: Field Survey, 2023.

3.5.1Reliability and Validity of Instrument

Reliability refers to the consistency of the item-level errors within a single factor. Cronbach's alpha should be above 0.7 (Hair et al., 2019). As shown in Table 3.0, the Cronbach alpha for the study is 0.964. Bartlett's test provides statistical significance, indicating that the correlation matrix should have significant correlations among at least some variables. Bartlett's test results for the study were significant (<0.05). Also, the Kaiser-Meyer-Olkin (KMO) test, which measures how suitable the data is for factor analysis, was conducted. KMO values between 0.8 and 1 indicate adequate sampling, as shown in Table 3.

Table 3 - Reliability, KMO and Bartlett's test output

Measure	Value
Cronbach Alpha	0.964
KMO Measure of Sampling Adequacy	0.896
Bartlett's Test Critical Value	4058.270
Bartlett's Test degree of freedom	630
Bartlett's Test significant value	<0.001

Source: Field Survey, 2023.

The degree to which an item correlates with all other items is known as its commonality. Higher communalities are preferable. It may be difficult for a given variable to load considerably on any factor if its commonalities are low (between 0.0-0.4). Table 4 provides the commonalities of the study's output.

Table 4 - Communalities output

	Initial	Extraction
PCK1	1.000	.571
PCK2	1.000	.586
PCK3	1.000	.705
PCK5	1.000	.788
CK6	1.000	.805
CK7	1.000	.822
PK8	1.000	.727
PK9	1.000	.713
TK10	1.000	.712
TK11	1.000	.831
TK12	1.000	.672
TK13	1.000	.773
TCK14	1.000	.700
TCK15	1.000	.810
TCK16	1.000	.619
TCK17	1.000	.741
TPK18	1.000	.800
TPK19	1.000	.746
TPK20	1.000	.655
TPK21	1.000	.753
TPK22	1.000	.808
TPACK23	1.000	.806
TPACK24	1.000	.658
TPACK25	1.000	.742

TPACK26	1.000	.776
TPACK27	1.000	.760

Source: Field Survey, 2023

The output of Initial Eigenvalues and Extracted Sums of Squared Loadings was analysed. The requirement for identifying the number of components or factors stated by selected variables is the presence of eigenvalues of more than 1. Table 5 shows that four components have eigenvalues greater than 1, which explains 73.38% of the variance. This is confirmed pictorially in the screen plot in Figure 3.

Table 5 - Total variance extracted output

	Initial Eigenvalues			Extraction Sum of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	14.008	53.875	53.875	14.008	53.875	53.875
2	2.304	8.863	62.738	2.304	8.863	62.738
3	1.709	6.573	69.311	1.709	6.573	69.311
4	1.057	4.066	73.377	1.057	4.066	73.377
5	.976	3.754	77.131			
6	.760	2.925	80.056			
7	.755	2.904	82.960			
8	.577	2.220	85.180			

Extraction Method: Principal Component Analysis

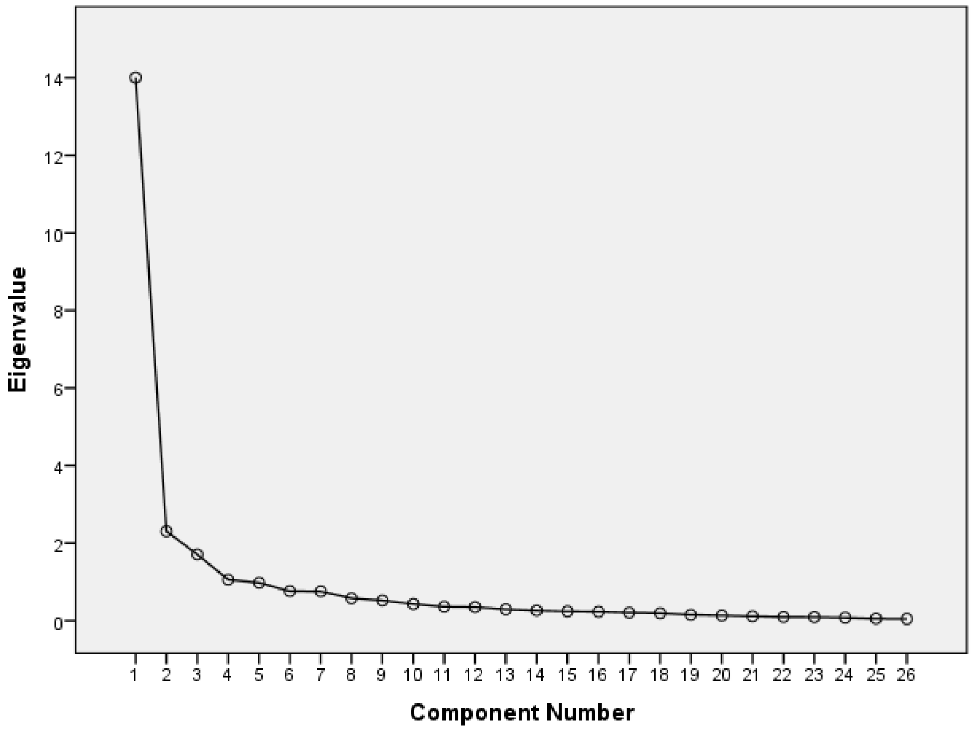

Fig. 3 - Scree plot

Factor structure refers to the inter-correlations among the variables being tested in the EFA. Using the pattern matrix in Table 6 below, we can observe that variables are grouped into factors. Although four components emerged from the EFA, the Confirmatory Factor Analysis (CFA) considered only three (TTA, TTK, and TTM).

Table 6 - Pattern matrix

	Component			
	1	2	3	4
TPK18	.800			
TPK22	.797			
TPK19	.772			
TPACK27	.756			
TPK21	.751			
TCK15	.744			
TCK17	.731			
TPK20	.720			
TCK16	.658			
TPACK26	.613			
TPACK23		.837		
TPACK25		.770		
PCK1		.733		
TCK14		.728		
PCK5		.715		
TPACK24		.678		
PK8		.667		
PCK2		.604		
CK6			.823	
CK7			.777	
TK11			.768	
TK10			.574	
TK12			.487	
PK9				.794
PCK3				.583
TK13				.537

Source: Field Survey, 2023

3.6 Confirmatory Factor Analysis (CFA)

The reliability of the variables was tested using Cronbach's Alpha and Composite Reliability (CR). At the outset, the overall sample was assessed and items having factor loadings that were smaller than 0.600 were discarded except for two indicators which had values approximately equal to 0.600. The results for reliability and validity along with the factor loadings for the remaining items are presented in table 7.0. All the Alpha values and CRs were higher than the recommended value of 0.600. The Average Variance Extracted (AVE) and CRs were all higher or close to 0.500 and 0.700, respectively, which corroborates convergent validity. In all 21 items and 3 constructs constitute the variables for the study, as shown in table 7.

3.7 Discriminant Validity

Discriminant validity was evaluated using Fornell & Larcker and Heterotrait-Monotrait Method (HTMT) criteria. According to Hair et al. (2017), the Fornell-Larker criterion for determining the discriminant validity of a measurement model requires that the square root of the AVE of a construct be greater than the correlations of other constructs below that construct (Fornell & Larcker, 1981). The Heterotriat-Monotrait ratio (HtMt) Method, according to Hair et al. (2019), is an alternative procedure for assessing discriminant validity; it estimates the true correlation between two constructs if they were perfectly measured (i.e., if they were perfectly reliable). The HTMT has a cut-off threshold for severe discriminant validity of 0.850 and for liberal discriminant validity of 0.900. The results displayed in Table 8 prove that the proposed model's discriminant validity is established.

Table 7 - Item loadings, reliability and validity

		Factor Loadings	Alpha	rho_A	CR	AVE
TTA	PCK2	0.765	0.921	0.922	0.936	0.679
	PCK5	0.838				
	PK8	0.846				
	TCK14	0.794				
	TPACK23	0.857				
	TPACK24	0.786				
	TPACK25	0.874				
TTK	CK6	0.829	0.911	0.916	0.933	0.737
	CK7	0.856				
	TK10	0.873				
	TK11	0.9				
	TK12	0.833				
TTM	TCK16	0.756	0.945	0.947	0.953	0.694
	TCK17	0.841				
	TPACK26	0.839				
	TPACK27	0.856				
	TPK18	0.868				
	TPK19	0.839				
	TPK20	0.776				
	TPK21	0.816				
	TPK22	0.9				

Source: Field Survey, 2023

Table 8 - Discriminant validity using the criterion by Fornell & Larcker & HTMT

	TTA	TTK	TTM
TTA	***0.824***	0.723	0.704
TTK	0.671	***0.858***	0.818
TTM	0.66	0.768	***0.833***

Note: Diagonal and italicized elements are the square roots of the AVE (average variance extracted). Below the diagonal, elements are the correlations between the constructs. Above the diagonal, elements are the HTMT values.

Source: Field Survey, 2023

3.8 Data Analysis

Using a Structural Equation Modelling (SEM) analysis technique, the test of hypothesis of the study was conducted to determine the influence between variables, both direct and indirect effects of exogenous variables on endogenous variables. Path analysis was used to measure the direct effect of exogenous variables on endogenous variables. Bootstrapping method was used to measure the level of technology integration in mediating the indirect effect of technological tool mastery and technical knowledge and skills on art teachers training in a TVET discipline. Data analysis was done with SmartPLS 3.0 software. The relevant theories that support the formulation of the research hypothesis in line with influence of exogenous variables on endogenous variables directly or using mediation were proposed in the review of related literature.

4. Findings

4.1 Validities and Reliabilities

Before the model was tested using SEM analysis, two tests were conducted to ensure the validity and reliability of variables and instruments. These included confirmatory factor analysis and Cronbach's alpha. The validity and reliability of instruments were tested using confirmatory factor analysis, while the feasibility and consistency of all indicators in the variables studied were evaluated using Cronbach's alpha. The validity test results indicate that out of the 36 indicators and items on all the research variables, only 21 have an outer loading value exceeding 0.70. As a result, 15 indicators or items were dropped. Therefore, 21 indicators on all instruments have met the criteria for validity and are ready to be used for research (Johnson & Wichern, 2007; Kholifah et al., 2022). Moreover, the reliability test disclosed that the Cronbach alpha number was included in the reliable criteria on all instruments (Reid, 2014; Kholifah et al., 2022), a clear demonstration that the instruments have a good level of consistency for collecting data on each variable.

4.2 Model Fit Index

The model suitability test is used to measure the structural model's conformity level. That is the overall fit index of the research model. Model fit refers to how well our proposed model accounts for the correlations between variables in the dataset. Standardised Root Mean Square Residual (SRMR) is a measure of absolute fit and standard differences between observed and predicted correlations (<0.08) between 0 and 1, with Bentler and Bonnet (1980) recommending.
values greater than 0.90, indicating a good fit. More recent suggestions state that the cut-off criteria should be NFI ≥.95 (Hu and Bentler, 1999). Therefore, the model is appropriate for carrying out structural model analysis based on the acquisition of values contained in the goodness of fit category (Johnson & Wichern, 2007). Moreover, table 9.0 indicates the model fit indices, while figure 4.0 represents the structural analysis model results.

Table 9 - Model fit indices

Goodness of fit indices	Result	Desired levels	Explanation
SRMR	0.07	<0.08	Supported
NFI	0.7	>0.95	Supported*

* *NFI (Normed Fit Index) is sensitive to sample size such that it underestimates fits for samples less than 200 (Kline, 2005) and the sample size used is 152.*

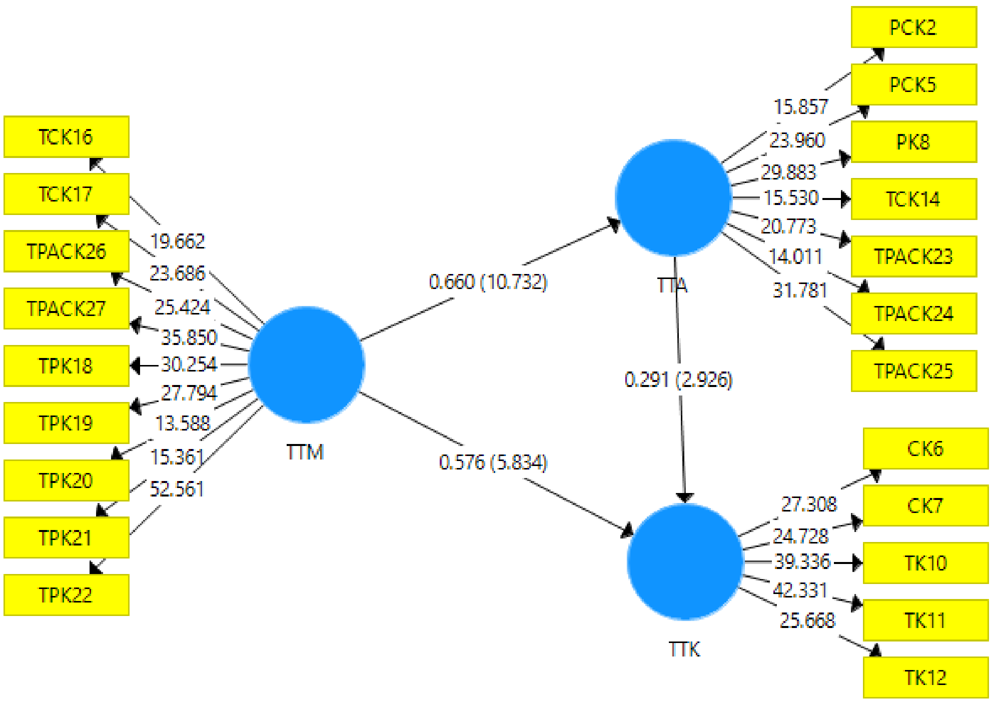

Fig. 4 - The Results of the structural model analysis

5. Results and Discussion

5.1 The Relationship Between TTM (Technological Tools Mastery) and the Ability of the Art Teacher to Effectively Integrate Technology into a TVET Subject

The hypothesis was to determine how well the art teacher can seamlessly incorporate technology into a TVET subject. The results from the Structural Equation Model analysis (Fig. 4.0) revealed a strong positive and significant relationship between technological tool mastery and the ability of the art teacher to effectively integrate technology in the teaching and learning a TVET subject. This implies that the art teacher with high technical competence and proficiency in various technological tools is likelier to use technology to deliver lessons in TVET. The positive relationship suggests that art teachers with a high level of knowledge about technological tools will be proficient in incorporating technology into teaching TVET subjects more professionally, which aligns with the learning outcomes of TVET subjects. With this, the art teacher is better positioned to incorporate these tools to create an interactive and innovative learning environment and enhance the overall learning experience of TVET. These findings support the scholarly works of Mudau, Patience K., and Van Wyk (2021); Legg-Jack and Ndebele (2022); Mohammad Yunus and Mohamad (2022) and Shahroni, Mingha, and Mustakim (2022), who corroborated that the extent to which art teachers master and apply technological tools in the classroom influences how much they can incorporate technology into a TVET course.

However, these results oppose the prevailing conditions in the study area, where art teachers and instructors in TVET institutions have weak competency in using these technological tools. As a result, they cannot inculcate technology into their teaching and learning of TVET subjects. Additionally, there is poor funding for TVET education in Ghana, which has resulted in outdated training equipment, insufficient training materials, and, in some cases, curricula that have not been designed to integrate technological tools and procedures. These constraints have contributed to a situation where theoretical instruction receives greater emphasis, often neglecting the acquisition of practical skills crucial for developing a skilled workforce and promoting productivity. Consequently, the TVET system produces graduates well-versed in theory but lacking proficiency in practical skills in the use of technology.

The interplay between the results stated above, and the prevailing situations in the study area strongly suggest the need for stakeholders in the TVET subsector to prioritise the provision of infrastructure, technology-based equipment, and training of art teachers and instructors to use technological tools and procedures effectively to deliver quality education to students offering TVET subjects. The conclusion, therefore, is that teachers who master the use of technological tools can better equip their students with the skills and knowledge needed in Industrial Revolution 4.0.

5.2.1 The Influence of a Technologically Driven Teaching Approach (TTA) on a TVET Subject

The hypothesis aimed to determine whether technology significantly affects the teaching strategies art teachers employ in their instruction. It emerged from the Structural Equation Model (Fig. 4.0) that technology significantly influences the teaching approaches art teachers employ to teach TVET subjects. This implies that an art teacher's technological knowledge and skills will play a crucial role in the quality of teaching and learning in a TVET subject. The study underscores the need to consider technology as a key element in effectively delivering Technical and Vocational Education and Training (TVET) subjects. In the TVET education sub-sector, where practical skills are crucial, a technologically driven teaching approach would enhance the effectiveness of skill development and better prepare students for real-world applications. Anthony and Abubakar (2021) posit that technology-based teaching devices, such as computers, digital cameras, and video recorders, are crucial for preparing students within the TVET ecosystem to meet the demands of the modern workforce.

The information gathered from the sample population points to the fact that teachers need to be proficient in using various technological tools and procedures to effectively incorporate them into their instructional methods. This result is consistent with previous studies that identified technology as an integral part of modern education and instructional methods (Basilotta-Gómez-Pablos et al., 2022; Cabero-Almenara et al., 2022). Paradoxically, preliminary information obtained from the sample population before the administration of the research instrument revealed that most art teachers in Ghana do not have adequate competencies in the manipulation of technology tools, and this affects their teaching delivery. This is consistent with the submission of Kissi et al. (2020) that most art teachers and instructors in Ghana cannot keep up with the rapid technological improvements and changes. As a result, they lack the necessary technological tools and adaptations to facilitate effective instructional delivery of TVET subjects.

The gap between the conditions that prevail in the study area and what the ideal situation should be, as espoused by the results of this study, buttresses the need for art teachers and instructors to be given adequate training on the efficient application of technology tools to teach students to draw, design, manipulate images, and produce competitive art products for the ever-increasing market. The technological skills acquired by the teachers will enable them to sufficiently train the students to fit into the increasingly evolving labour market. Thus, various stakeholders in the TVET ecosystem, including curriculum developers, training institutions, teachers, and instructors, should adopt and apply technology-based teaching methods in the teaching and learning delivery of TVET subjects. In conclusion, the technological skills possessed by an art teacher affect his or her teaching approach and delivery.

5.2.2 The Relationship Between Technology and the Teacher's Technical Knowledge and Skills (TTK) in a TVET Discipline

The hypothesis aims to investigate the influence of the application of technology on a teacher's technical knowledge and skills in teaching art subjects in Technical and Vocational Education and Training (TVET). The results from the structural equation model (Fig. 4.0) confirmed a significant relationship between technology and art teachers' technical knowledge and skills in a TVET discipline. The results further affirmed that using technological tools such as computers, software, and digital devices substantially impacts teaching and learning. Teachers who incorporate these tools into their instructional methods exhibit a distinct set of knowledge, skills, abilities, and attitudes compared to those who do not. This implies that integrating technology enhances the teacher's technical proficiency and contributes to a potentially more advanced skill in the teacher's subject area. This was corroborated by the scholarly works of Basilotta-Gomez-Pablos et al. (2022), asserting that a teacher who uses technology effectively in the classroom must possess a combination of knowledge, abilities, and attitudes. However, Cabero-Almenara et al. (2022) posit that how each teacher readily accepts technology use, integration, and adaptation in TVET will impact their competency development.

Art teachers form part of the TVET education delivery system. They are expected to possess competencies for effectively using technology tools to impart knowledge to students. Their technological competence positively affects the knowledge and skill with which they deliver their lessons. In the study area of Ghana, it has been observed that art teachers and instructors who use technology tools to instruct students in senior high schools and technical and vocational schools across the country possess excellent knowledge and skills compared to those who use the traditional way of teaching. It can be concluded that the situation in the study area is linked with the results obtained for this study.

It is, therefore, imperative for TVET educators, including training institutions and policymakers, to develop and engage teachers with high competency in the practical application of technical knowledge and skills in their respective disciplines using technological tools and procedures. This will enhance TVET and promote technology inclusion in all TVET programs. Moreover, the quality of TVET education, characterised by its ability to provide technical knowledge and skills, will be improved. This study is an eye-opener for international researchers to conduct further research into integrating technology into TVET education delivery, with a particular reference to art. It is hoped that attention will be paid to how logistical problems, infrastructural challenges, and human capital deficits can be addressed for effective technology integration.

6. Conclusion

TVET has been recognised as a critical strategy for achieving rapid socio-economic and industrial growth in Ghana. As a result, the government and other stakeholders have implemented several reforms and policies to improve TVET delivery. These include curriculum diversification, increased opportunities for the youth, and the expansion and improvement of institutions delivering TVET. Ghana has existing laws and legislative instruments that provide a framework for regulating and enhancing TVET delivery. These include the National Vocational Training Institute (NVTI) Act of 1970, the National Board for Professional and Technician Examination (NABPTEX) Act of 1994, the Council for Technical and Vocational Education and Training (COTVET) Act of 2006, the Polytechnic Act of 2007, and the Technical University Act of 2016 (Act 922). These reforms have transformed the TVET subsector by making it more responsive and aligned with the evolving needs of local, national, and global trends.

This study demonstrates that the future of Technical and Vocational Education (TVET) in Ghana will be significantly influenced by two key factors: mastery of technological tools using technologically driven instructional approaches and teachers' technological knowledge and abilities. In other words, the effective integration of technology and teachers' proficiency in technological skills will play a pivotal role in shaping the trajectory of TVET in Ghana and other developing nations such as Malaysia, Jamaica, and Bangladesh. Art teachers should be equipped with these technological factors to effectively incorporate technology into teaching TVET art subjects. The results show that a technologically focused teaching strategy would outperform conventional teaching techniques in terms of helping students develop their skills and better meet the expectations of the present generation of youngsters. The study calls on art teachers to master and apply technological tools in their lesson delivery. This will enhance Technical and Vocational Education and Training (TVET) delivery and promote technology-inclusive TVET across all TVET disciplines. It is anticipated that the results of this study will serve as a guide for further empirical research into effective ways of integrating technology into TVET subjects. It is also the expectation of the researchers that the study results will stimulate further empirical studies by the international body of knowledge into the untapped areas of TVET education delivery in other parts of the world.

Declaration of Conflict of Interest

We, the authors, declare no conflict of interest in carrying out this research.

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