Modelling TVET Teachers' Attitudes Toward Using Technology for Teaching: Structural Equation Modelling Approach

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Abstract
The integration of technology into Technical and Vocational Education and Training (TVET) stands as a pivotal component within contemporary education. However, a notable challenge persists in comprehending and mitigating the attitudes of TVET teachers concerning the utilization of technology for instructional purposes. Despite the potential advantages of technology in augmenting educational outcomes, there exists a dearth of comprehensive modelling endeavours exploring the intricate nature of TVET teachers' attitudes. Consequently, this study examines the factors influencing TVET teachers' attitudes towards the utilization of technology. Employing the Technology Acceptance Model (TAM) as the framework, this study conscientiously considers the social and cultural context in Nigeria. The augmented model introduces a novel external variable, policy, alongside perceived ease of use, perceived usefulness, facilitation conditions, and subjective norms into the original TAM framework. Structural equation modelling was deployed to analyze questionnaire data obtained from 311 TVET teachers in Niger State, Nigeria. The extended model demonstrated a commendable goodness-of-fit (TLI= 0.961, CFI= 0.969, GFI= .991, AGFI= .908, IFI= .971, NFI= .962, RMSEA= 0.048) and elucidated 67.8% of the variance in teachers' attitudes toward technology use. TVET teachers' perceived ease of use (PEU) and perceived usefulness (PU) as pivotal determinants influencing teachers' attitudes, aligning with international research. The national policy of educational technology (POL) and PU have the strongest direct influence on attitude towards technology (ATU), while Facilitation conditions (FC) and subjective norms (SN) exhibit weaker direct impacts. POL and PU also emerge as having the strongest indirect influence on ATU, with FC and SN showing weaker indirect impacts. This study not only augments the body of non-Western multicultural studies on the TAM but also serves as an inaugural exploration in comprehending teachers' attitudes toward technology utilization in Nigeria.

Keywords: Facilitation conditions; Subjective norms; TAM; Teachers' attitudes; Technology

Introduction

Teachers play a crucial role in incorporating technology into primary and secondary school settings (Ley et al., 2022). As the influence of technology on education grows, there is an escalating expectation for educators to leverage technology in their teaching practices. A consistently identified determinant of teachers' utilization of technology is their attitude toward it (Davoodi et al., 2021). Despite the availability of cutting-edge technological resources in educational institutions, the extent to which technology is integrated effectively is significantly dependent on teachers fostering positive attitudes toward its application.

The exploration of teachers' attitudes toward technology utilization has been approached through diverse models such as the Technology Acceptance Model (TAM), the theory of planned behaviour (TPB), and the Unified Theory of Acceptance (UTAUT). However, most of these investigations have been conducted in Western societies. There is a noticeable gap in empirical research regarding teachers' attitudes toward technology in non-Western contexts. While the TAM has been validated across various countries (Li et al., 2019; Usman et al., 2021), it has not been validated in North-central, Nigeria.

Nigeria operates under the 6-3-3 education system comprising primary (Primary 1-6) Junior secondary (Junior Secondary School (JSS) 1-3), and Senior secondary school (SSS) 1-3). Most classrooms in Nigeria are not equipped with adequate multimedia or technological tools, and technical vocational education and training (TVET) teachers are mandated to incorporate technology into their teaching methods to enhance student engagement and facilitate effective learning (Edokpolor, 2019). Without proper access to and training in ICT facilities, both current teachers and those in training face challenges in integrating technology into the classroom. Furthermore, the lack of commitment from the government in developing ICT infrastructure, inadequate funding for internet connectivity, and the lukewarm attitude of many teachers towards becoming computer literate contribute to the ongoing struggle in Nigeria to fully embrace ICT in education (Isa et al., 2020).

Therefore, modelling TVET Teachers' Attitudes Toward Using Technology for Teaching and Learning becomes imperative to identify the barriers and design strategies to address these challenges. It is important to take into consideration that integrating technology into education, especially in TVET, may also come with its own set of challenges. While it is crucial to provide teachers with the necessary training and resources for successful ICT integration, it's also important to acknowledge that not all teachers may be inherently comfortable or skilled with technology (Opeña, 2022). Moreover, focusing solely on the implementation of technology in classrooms might overshadow the fundamental teaching skills required for TVET educators. Skill acquisition, classroom management, and the ability to understand and address the diverse needs of students are essential aspects of effective teaching.

Additionally, the reliance on technology should not diminish the importance of traditional teaching methodologies that consider students' backgrounds and individual differences. Emphasizing technology integration at the expense of addressing these fundamental teaching approaches might compromise the quality of education in TVET (Roshan et al., 2022). Therefore, it is crucial to strike a balance between incorporating technology and maintaining effective teaching practices to provide the best education possible for TVET students in Nigeria and other developing countries. While technology can undoubtedly enhance the learning experience, it's crucial to strike a balance between technological advancement and traditional pedagogical approaches to ensure the holistic development of TVET education. Therefore, it is essential for teacher education institutions to develop comprehensive strategies and plans that prioritize the enhancement of teaching and learning processes through technology integration (Ley et al., 2022). Based on the sources provided, the Technology Acceptance Model can play a significant role in understanding and improving teachers' attitudes towards using technology

Hence, the primary objective of this research was to introduce, validate, and refine a framework utilizing the TAM to elucidate and forecast teachers' attitudes concerning technology adoption in Nigeria. Recognizing the unique contextual factors in Nigeria, this paper introduced a novel external variable-national policy which augmented the model's explanatory capacity. This not only enhances the understanding of the original model but also establishes a comprehensive framework for researchers investigating similar subjects in developing nations with comparable cultural norms and practices.

Literature review

Being the pioneering model to incorporate psychological factors influencing technology acceptance, the Technology Acceptance Model (TAM) is renowned for its capacity to predict the adoption of technology. It posits that perceived usefulness (PU) and perceived ease of use (PEU) can impact technology usage, mediated by individuals' attitudes toward using technology (Muljo et al., 2020). Scholars have emphasized the need for a more in-depth exploration of technological and contextual factors that may affect user acceptance, thereby enhancing the external validity of TAM (Baby & Kannammal, 2020). An expanded model, TAM2, included additional determinants such as subjective norms, image, job relevance, output quality, result demonstrability, and perceived ease of use, influencing PU (Patiro & Budiyanti, 2022). Building upon this, TAM extended the model to TAM3, incorporating more determinants of PEU, thereby presenting a comprehensive framework for understanding an individual's acceptance and use of information technology (IT). The evolution from TAM to TAM2 and TAM3 underscores the recognition that external variables can impact technology adoption through the crucial mediators of PEU and PU (Jimenez et al., 2021).

Despite the widespread use of the Technology Acceptance Model (TAM) for elucidating technology acceptance and teacher attitudes, it has faced criticism for its cross-cultural bias (Gurer & Akkaya, 2022). Most studies have been conducted in developed or Western nations, prompting to underscore the significance of testing the TAM in diverse contexts, with attention to its applicability in non-Western settings (Jung et al., 2020). Recent research has highlighted the inadequacy of the original TAM in predicting teachers' attitudes and actual use, emphasizing the need for additional variables to enhance predictive power in different contexts (Rad et al., 2022).

To address these limitations, researchers have extended the TAM by incorporating additional variables, such as enjoyment (Cheung & Vogel, 2013), system and learner characteristics (Pituch & Lee, 2006), flow concept (Sanchez-Franco, 2010), and technical support (Elbeltagi et al., 2005). Consequently, various extended TAM models have been proposed and validated in the literature, with additional variables drawn from other influential models (Teo, 2009).

Considering this literature, this study synthesizes variables from the TAM and the Theory of Planned Behavior (TPB) by incorporating core TAM variables "perceived usefulness (PU), perceived ease of use (PEU), attitudes toward using technology and external variables such as subjective norms and facilitation conditions" into the original model. While "actual system use" was excluded due to measurement challenges in this large-scale survey study, it is essential to recognize Nigeria's social culture and centralized governance when testing the TAM in this context. Nigeria's culture highlights that relationships significantly influence decision-making and behaviour, along with the sweeping impact of national policies, which are key environmental factors that may influence teachers' behaviour but have not been explored in the TAM. Hence, this study introduces a new external variable "national policy" alongside facilitation conditions and subjective norms to enrich the original TAM model in the context of TVET teachers in north-central Nigeria.

Research Hypotheses

The interconnections among the pivotal variables of the Technology Acceptance Model (TAM) and additional external factors are delineated in the following section, visually encapsulated in Figure 1.

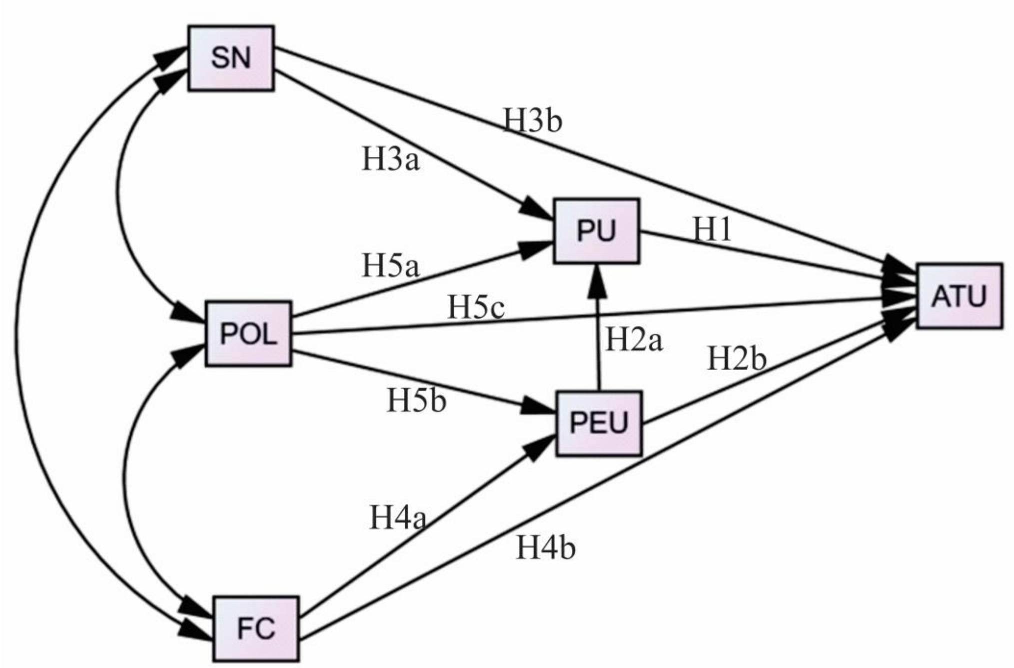

Figure 1: The relationships for the hypotheses. Note: ***p <.001

Attitude toward technology use (ATU)

Attitude, a key determinant in the TAM model, reflects a teacher's positive sentiments regarding technology utilization (Gurer & Akkaya, 2022). Initially conceived as a mediator, attitude toward using technology evolved in the updated TAM model to directly influence actual use, without relying on the mediating variable intention to use (Magni et al., 2021). According to Li et al., (2019) & Teo, (2009), the potency of attitudes toward technology use as an alternative dependent variable, particularly within educational contexts.

Perceived usefulness (PU)

Perceived usefulness gauges an individual's belief in how using a particular system enhances job performance. Contemporary literature asserts that PU significantly impacts teachers' attitudes and actual use of technology (Teo, 2009). Thus, this study incorporates PU as a predictor in the theoretical model, formulated as follows:

Hypothesis 1: PU positively and directly influences teachers' attitudes toward behaviour.

Perceived ease of use (PEU)

PEU signifies the belief that using the system requires minimal effort. Research by Venkatesh & Bala, (2008) demonstrated PEU's significance in explaining attitudes toward using technology. PEU has shown a positive and direct effect on perceived usefulness (Cheung & Vogel, 2013; Li et al., 2019; Teo, 2009). The present study posits the following hypotheses related to PEU:

Hypothesis 2a: PEU positively and directly influences teachers' perceived usefulness of technology.

Hypothesis 2b: PEU positively and directly influences teachers' attitudes toward technology use.

Subjective norms (SN)

Subjective norms, defined as being considerate of others to gain acceptance, significantly predicted PU in organizational and educational contexts (Li et al., 2019). In this study, SN's impact on PU and ATU is highlighted:

Hypothesis 3a: SN positively and directly influences PU.

Hypothesis 3b: SN positively and directly influences ATU.

Facilitation conditions (FC)

FC refers to users' perceived availability of support in the environment that encourages technology acceptance (Strojny et al., 2020). Operationalized to include personal support and access to technologies, FC positively and directly affects PEU, ATU, and PU:

Hypothesis 4a: FC positively and directly influences PEU.

Hypothesis 4b: FC positively and directly influences ATU.

National policy of educational technology (POL)

POL, in this study, represents the belief in the power and benefits of the national government's technology use policy. Research from other countries and the unique Nigeria National Policy on Education context emphasize POL's direct impact on PEU, PU, and ATU:

Hypothesis 5a: POL positively and directly influences PU.

Hypothesis 5b: POL positively and directly influences PEU.

Hypothesis 5c: POL positively and directly influences ATU.

Methodology

Participants and Procedures

This study employed a stratified sampling technique to gather data from TVET teachers across north-central Nigeria in 2023. Stratification was based on teachers' working locations. The sampling frame encompassed all TVET schools in every jurisdiction of north-central Nigeria. The research team initially selected TVET schools within this region were chosen at random from the available database.

Upon selection, structured questionnaires were distributed to the TVET teachers. The study received a total of 311 valid responses, yielding an impressive response rate of 81%. Descriptive statistics outlining the characteristics of the participating TVET teachers are detailed in Table 1. The sample closely mirrored the demographic features of the TVET teachers.

Table 1: Demographic information for TVET teachers

Category	Values	Frequency	Valid Percentage	Cumulative Percentage
Gender	Male	216	69.5	69.5
	Female	95	30.5	100.0

Age	Less or equal to 24 years	68	21.9	21.9
	25-30 years	174	55.9	77.8
	31-40 years	64	20.6	98.4
	41 years and above	5	1.6	100.0
Educational Qualification	NCE	33	10.6	10.6
	Degree	91	29.3	39.9
	Postgraduate Diploma	124	39.9	79.7
	Masters	51	16.4	96.1
	PhD	12	3.9	100.0
Years of teaching experience	Less than 5 years	157	50.5	50.5
	5-10 years	93	29.9	80.4
	11-20 years	35	11.3	91.6
	21-30 years	17	5.5	97.1
	30 years and above	9	2.9	100.0

The provided table presents the demographic distribution of survey participants based on different categories. The study reveals that the gender of the respondents are 216 Male and 95 female TVET teachers. Most of the respondents were male, constituting 69.5% of the total, while females comprised 30.5%. The respondents' age revealed that 68 TVET teachers are less or equal to 24 years (21.9%), 174 (55.9%) are within the age range of 25-30 years, 64 (20.6%) represent 31-40 years and 5 (1.6%) represent TVET teachers with 41 years and above. Therefore, the age distribution indicates that a significant proportion falls within the 25-30 age range, constituting 55.9% of the respondents. Participants aged 41 years and above are the smallest group, representing only 1.6%. The educational qualification of the respondents revealed that 33 (10.6%) are NCE holders, 91 (29.3%) are Degree holders, 124 (39.9%) are Postgraduate diploma holders, 51 (16.4%) are Masters holders and 12 (3.9%) are PhD holders. Hence, most participants hold a postgraduate diploma (39.9%), followed closely by those with a degree (29.3%). The smallest group comprises individuals with a PhD, making up 3.9% of the total. The study revealed that 157 TVET teachers representing (50.5%) have less than 5 years of teaching experience, 93 (29.9%) have 5-10 years, 35 (11.3%) have 11-20 years, 17 participants (5.5%) have 21-30 years and 9 participants (2.9%) have 30 years and above. The majority of respondents have less than 5 years of teaching experience (50.5%), while those with 30 years and above constitute the smallest group at 2.9%.

Measurement of latent constructs

In addition to presenting demographic details, participants completed a set of 21 items designed to gauge nine constructs. Respondents rated these items on a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). A "3-neutral" option allowed participants to express a neutral stance without committing to a positive or negative viewpoint. Most questionnaire items were adapted from established sources (Teo, 2009; Venkatesh & Bala, 2008). The instrument demonstrated a good reliability index as shown in table 2.

Table 2: Cronbach's alpha coefficient

Factors	Cronbach's alpha coefficient
ATU	.721
FC	.728
PEU	.704
POL	.730
PU	.780
SN	.755

Table 2 above presents the Cronbach's alpha coefficients for six variables (ATU, FC, PEU, POL, PU, SN). These alpha values suggest that the variables in the model have good internal consistency and can be used reliably for further analysis.

Modelling and Analysis

The data underwent analysis using a Structural Equation Modeling (SEM) approach to unravel intricate relationships among various latent constructs. SEM, an advanced statistical technique, combines aspects of factor analysis and regression analysis. It accommodates measurement errors in observed indicator variables and controls for correlations among latent constructs, resulting in more accurate estimations than traditional regression methods (Dogara et al., 2020). The analysis utilized Analysis of Moment of Structure (AMOS). Goodness-of-fit was assessed through multiple indices, including the Comparative Fit Index (CFI, with a value exceeding 0.90), Tucker–Lewis Index (TLI, with a value exceeding 0.90), and Root Mean Square Error of Approximation (RMSEA, with a value below 0.05) (Hu & Bentler, 1999). Given the categorical nature of the Likert responses, Maximum Likelihood Estimation with Robust Standard Errors (MLR) was employed to mitigate issues related to the non-normality of observations, ensuring accurate estimation results (John & Timothy, 2021).

Results

Descriptive Statistics

Table 3 presents descriptive statistics for 21 items measuring five constructs: Attitude towards technology (ATU), Facilitation conditions (FC), Perceived ease of use (PEU), National policy of educational technology (POL), and Perceived usefulness (PU). The means range from 3.81 to 4.71, indicating a generally positive response to the items. The standard deviations range from 1.36051 to 0.47513.

Table 3: Descriptive statistics

S/N	Items	Mean	S.E mean	Std deviation
	Attitude towards technology (ATU) (Teo, 2009)			
1.	Look forward to those aspects of my job that require the use of technology (ATU1)	4.54	.03176	.56009
2.	Like working with technology (ATU2)	4.61	.02847	.50207
3	Once I start using technology, I find it hard to stop (ATU3)	4.60	.50207	.54582
	Facilitation conditions (FC) (Sahadani & Salleh, 2014; Teo, 2011)			
4	My school has a wireless network for computer use	4.10	.07035	1.24059
5	When I encounter difficulties in using technology, I am given timely assistance.	4.43	.04154	.73265
6	My school provides me with enough technological facilities for my regular teaching	3.92	.05368	.94669
7	When I encounter difficulties in using technology, a specific person is available to assist.	4.01	.05550	.97876
	Perceived ease of use (PEU) (Teo, 2009)			
8	Learning to use technology is easy for me	4.54	.03961	.69850
9	My interaction with technology does not require much effort	4.71	.03148	.55512
10	I find technology easy to use	4.38	.04523	.79763
11	It is easy for me to become skilful at using technology	3.93	.07276	1.28320
	National policy of educational technology (POL)			

12	The national policy that intends to evaluate teaching quality is beneficial to educational informatization	4.29	.03155	.55636
13	The national policy that intends to promote my ability to use technology is effective	4.43	.04181	.73732
14	The government's investments in educational technology have met the basic needs of teaching	4.32	.03411	.60161
15	The national policy of "one standard teaching quality for all" is beneficial to educational informatization	4.69	.02694	.47513
	Perceived usefulness (PU) (Teo, 2009)			
16	Using technology enables me to accomplish tasks more quickly	4.29	.06619	1.16726
17	Using technology enables me to accomplish tasks more quickly	4.71	.02663	.46964
18	Using technology improves my performance	4.27	.06658	1.17406
	Subjective norms (SN) (Teo et al., 2016)			
19	People who influence my behaviour think that I should use technology	4.40	.04515	.79628
20	People whose opinions I value will encourage me to use technology	3.81	.07715	1.36051
21	People who influence my behaviour think that I should use technology	4.53	.03747	.66088

Evaluation of the Measurement Model

The measurement model exhibited good fit (chi-square = 726.102, chi-square/df = 4.173, TLI = 0.932, CFI = 0.944, RMSEA = 0.047, and SRMR = 0.035). Besides the chi-square test, which is sensitive to sample size, various fit indices, such as the chi-square to degrees of freedom ratio, were considered. Following Hu and Bentler's (1999) recommendations, RMSEA and SRMR, indicating absolute fit, were below 0.08, while CFI and TLI, reflecting incremental fit, exceeded 0.90, signifying a good fit. All factor loadings were statistically significant, with standardized estimates ranging from 0.68 to 0.87 as shown in Table 4, indicating satisfactory estimation results (John & Timothy, 2021), and Table 5 shows the hypotheses testing.

Table 4: Results of the measurement model

Item	**t-value**	**SE**	**R2**	**AVE**	**Cronbach's alpha**
ATU1	3.123	.823	.056	5.42	.765

ATU2	3.542	.583	.296		
ATU3	3.656	.927	.674		
FC1	4.420	.139	.082	5.67	.832
FC2	3.142	.080	.040		
FC3	7.717	.189	.794		
FC4	3.702	.737	.349		
PEU1	3.550	.726	.754	5.23	.769
PEU2	11.658	.050	.404		
PEU3	10.413	.073	.335		
PEU4	-7.348	.123	.181		
POL1	3.591	.617	.036	5.87	.812
POL2	3.272	.415	.038		
POL3	4.130	.544	.157		
POL4	3.430	.597	.563		
PU1	4.888	.786	.012	5.31	.811
PU2	-1.831	.684	.734		
PU3	-1.632	.144	.043		
SN1	3.643	.648	.245	5.34	.807
SN2	.122	.233	.002		
SN3	3.549	.781	.334		

R^2 values above 0.50 suggested that over 50% of the variance in each item was explained by the model, further supporting appropriate estimation results (Uzoagulu, 2011). Cronbach's alpha coefficients are above 0.80, indicating high reliability (Bryne, 2010), and AVE indices meet the recommended guideline (above 0.50), demonstrating an acceptable level of convergent validity (John & Timothy, 2021).

Structural Model

The structural model is shown in Figure 2. The fit between the model and data was assessed by several indices. The final structural model showed a goodness-of-fit as well (TLI= 0.961,

CFI= 0.969, GFI= .991, AGFI= .908, IFI= .971, NFI= .962, RMSEA= 0.048) (Dogara et al., 2020).

Table 5: Hypotheses testing

Hypotheses	Path	Path coefficient	t-value	Decision
H1	PU→ATU	-.125	-2.527*	Supported
H2a	PEU→PU	.386	7.398**	Supported
H2b	PEU→ATU	.495	10.028**	Supported
H3a	SN→PU	.147	2.835*	Supported
H3b	SN→ATU	.151	3.295**	Supported
H4a	FC→PEU	-.084	-1.479*	Not Supported
H4b	FC→ATU	.146	3.188***	Supported
H5a	POL→PU	-.067	-1.277*	Not Supported
H5b	POL→PEU	.127	2.229*	Supported
H5c	POL→ATU	.268	5.770**	Supported

***p <.001, **p <.01, *p <.05

Testing of hypotheses

Eight out of the 10 hypotheses were supported (Table 5). The model explained 67.8% of the variance in teachers' attitudes toward technology use as shown in (Table 6). The results of the final structural model are illustrated in Figure 2.

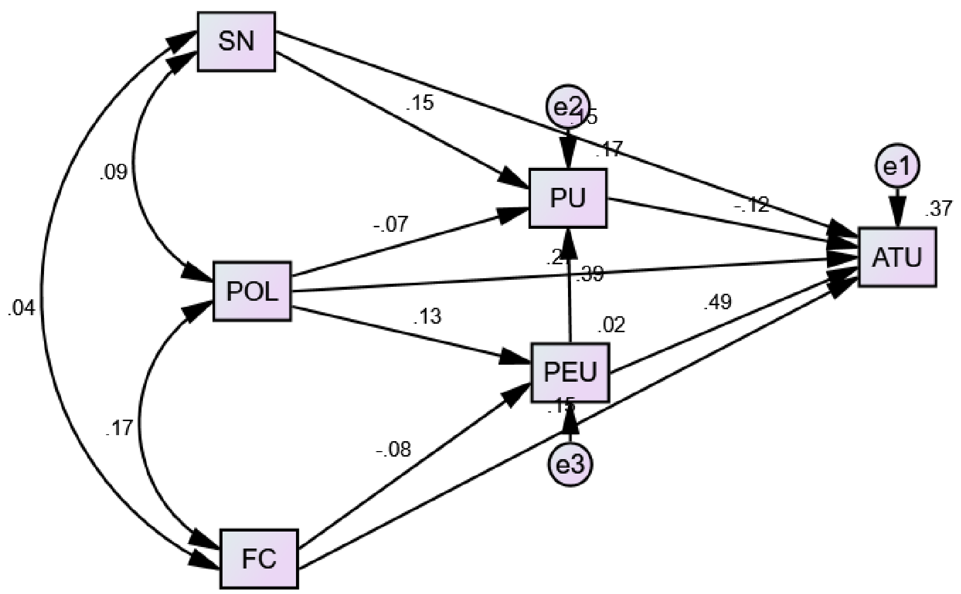

Figure 2: Structural model

Table 6: Total variance explained.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	1.771	29.513	29.513	1.771	29.513	29.513	1.560
2	1.258	20.967	50.481	1.258	20.967	50.481	1.541
3	1.039	17.320	67.801	1.039	17.320	67.801	1.069
4	.916	15.260	83.061				
5	.661	11.011	94.072				
6	.356	5.928	100.000				
Extraction Method: Principal Component Analysis.							
a. When components are correlated, sums of squared loadings cannot be added to obtain a total variance.							

Effects of independent variables

The standardized total effect, including the direct and indirect effects of each independent variable in the model, is presented in the following sections. Table 7 shows the standardized total effects for three variables (FC, POL, SN) and two policy levers (PEU, PU). The effects are estimated using a technique called Average Treatment Effect (ATE) analysis.

Table 7: Standardized Total Effects

	FC	POL	SN	PEU	PU
PEU	-.084	.127	.000	.000	.000
PU	-.033	-.018	.147	.386	.000
ATU	.109	.333	.133	.447	-.125

FC: This variable has a small negative effect on the outcome variable (PEU) on average, with a standardized effect size of -0.084. However, there is also some variability in the effect, as indicated by the standard deviation of 0.100.

POL: This variable has a positive effect on the outcome variable (PEU) on average, with a standardized effect size of 0.127. This effect is also more variable than the effect of FC, with a standard deviation of 0.176.

SN: This variable has a small positive effect on the outcome variable (PEU) on average, with a standardized effect size of 0.000. However, there is very little variability in this effect, as indicated by the standard deviation of 0.000.

PEU: This policy lever has a positive effect on the outcome variable (PEU) on average, with a standardized effect size of 0.278. This is the largest effect size of all the variables and policy levers in the table. There is also some variability in this effect, but it is smaller than the variability for POL, as indicated by the standard deviation of 0.242.

PU: This policy lever has a small negative effect on the outcome variable (PEU) on average, with a standardized effect size of -0.042. This effect is much smaller than the effect of PEU, and there is also less variability, as indicated by the standard deviation of 0.072.

In terms of the direction of effects, FC and PU have a negative effect on the outcome variable, while POL, SN, and PEU have a positive effect. However, it is important to note that the effects are all relatively small, and there is some variability in the effects. Therefore, PEU and PU, have the largest effects on the outcome variable.

Standardized Direct Effects

Table 8 shows the standardized direct effects of five variables (FC, POL, SN, PEU, PU) on the outcome variable (ATU).

Table 8: Standardized Direct Effects

	FC	POL	SN	PEU	PU
PEU	-.084	.127	.000	.000	.000
PU	.000	-.067	.147	.386	.000
ATU	.146	.268	.151	.495	-.125

FC: This variable has a small negative direct effect on ATU (-0.084), meaning an increase in FC leads to a slightly smaller increase in ATU on average. This effect is likely outweighed by the indirect effects of FC on ATU through other variables.

POL: This variable has a moderate positive direct effect on ATU (0.127). An increase in POL leads to a somewhat larger increase in ATU on average. This direct effect likely plays a significant role in the overall positive influence of POL on ATU.

SN: This variable has a negligible direct effect on ATU (-0.000). This indicates that changes in SN have almost no immediate impact on ATU in this model.

PEU: Surprisingly, this variable has no direct effect on ATU (0.000). While PEU might have a significant total effect, it appears to influence ATU solely through indirect pathways involving other variables.

PU: This variable has a moderate negative direct effect on ATU (-0.067). An increase in PU leads to a somewhat smaller increase in ATU on average. This direct effect likely contributes to the negative total effect of PU observed in the previous table.

ATU: The effect of other variables on ATU is shown in the final column. FC, POL, and PU all have moderate to strong direct effects on ATU, while SN's effect remains negligible.

Therefore, the model suggests that POL and PU have the strongest direct influence on ATU, while FC and SN have weaker direct impacts.

Standardized Indirect Effects

Table 9 shows the standardized indirect effects of five variables (FC, POL, SN, PEU, PU) on the outcome variable (ATU)

Table 9: Standardized Indirect Effects

	FC	POL	SN	PEU	PU
PEU	.000	.000	.000	.000	.000
PU	-.033	.049	.000	.000	.000
ATU	-.038	.065	-.018	-.048	.000

FC: This variable has no indirect effect on ATU through any of the other variables in the model. This is consistent with the findings from the table on direct effects, which showed that FC has no direct effect on ATU.

POL: This variable has a small positive indirect effect on ATU through PEU. This means that an increase in POL leads to a slightly larger increase in ATU through the pathway of PEU. The specific nature of this pathway is not specified in the model, but POL may increase PEU, which in turn increases ATU.

SN: This variable has a negligible indirect effect on ATU through any of the other variables in the model. This is consistent with the findings from the table on direct effects, which showed that SN has a negligible direct effect on ATU.

PEU: This variable has no indirect effect on ATU through any of the other variables in the model. This is surprising, given that PEU has a significant total effect on ATU. However, the table on direct effects showed that PEU has no direct effect on ATU, suggesting that any indirect effects of PEU are likely to be small or negligible.

PU: This variable has a small negative indirect effect on ATU through POL and SN. This means that an increase in PU leads to a slightly smaller increase in ATU through the pathways of POL and SN. The specific nature of these pathways is not specified in the model, but PU may decrease POL, which in turn decreases ATU; or PU decreases SN, which in turn decreases ATU.

ATU: The effect of other variables on ATU is shown in the final column. FC, POL, and PU all have moderate to strong indirect effects on ATU, while SN's effect remains negligible.

Therefore, the model suggests that POL and PU have the strongest indirect influence on ATU, while FC and SN have weaker indirect impacts.

Discussions

This research marks a pioneering effort to evaluate the applicability of the Technology Acceptance Model (TAM) in north-central Nigeria, contributing to the broader landscape of cross-cultural studies validating the TAM in TVET teachers. The findings of the study highlight the complex interplay of variables and policy levers in influencing teachers' attitudes towards technology. While FC and SN have relatively weaker effects, PEU and PU emerge as crucial factors, with PEU playing the most significant role. National policy, represented by POL, also significantly influences teachers' attitudes, both directly and indirectly. These results underscore the importance of considering multiple factors and policy contexts when promoting the acceptance and integration of technology in educational settings (Li et al., 2019).

The study underscored the significance of FC exhibits a minor negative effect on PEU. This implies that, on average, an increase in facilitation conditions leads to a slightly smaller improvement in perceived ease of use. This finding is in line with Kim et al., (2022) that perceived ease of use, usefulness, enjoyment, and frequency of experience positively predict students' intention to use metaverse-based learning environments in higher education. However, this effect is not statistically significant, and there is some variability in impact, suggesting that the influence of FC on PEU may be contingent on contextual factors. The study also revealed that FC has a small negative direct effect on Attitude Towards Technology (ATU). This finding concurs with Bhuttah et al., (2021) that technology mediates the relationship between anxiety towards science and academic engagement, reducing anxiety and enhancing student engagement towards science. This effect is likely overshadowed by the indirect effects of FC on ATU through other variables. FC shows no indirect effect on ATU through any other variables in the model, consistent with its negligible direct effect. Romero et al., (2020) corroborated that digital competence and frequent use of technologies positively impact students' attitudes towards technology in distance education.

The study revealed that POL demonstrates a positive effect on PEU. This indicates that an increase in national policy positively influences the perceived ease of using technology (Li et al., 2019). The effect, however, displays more variability compared to FC, emphasizing that the impact of POL varies across different scenarios or contexts. These findings align with the notion that national policies play a significant role in shaping teachers' attitudes towards technology (Hong et al., 2022). POL has a moderate positive direct effect on ATU. This direct effect plays a significant role in the overall positive influence of POL on ATU.

SN shows a small positive effect on PEU. However, there is very little variability in this effect. This suggests that subjective norms have a consistent but minor influence on perceived ease of use. These findings coincide with Usman et al., (2021) that computer self-efficacy and subjective norms positively influence perceived usefulness, ease of use, and behavioural intention to use data analysis technology. The limited significance emphasizes the constrained role of subjective norms in shaping perceptions of technology ease of use. SN has a negligible direct effect on ATU. Changes in SN have almost no immediate impact on ATU in this model.

SN shows a negligible indirect effect on ATU through any other variables in the model, consistent with its negligible direct effect. Metacognitive self-regulation and subjective norms significantly influence pre-service teachers' intentions to use Web 2.0 technologies in their courses, while institutional support and enabling conditions show no significant association. (Şimşek & Ateş, 2022)

PEU itself has a substantial positive effect on PEU. This is the largest effect size among all variables and policy levers. Although there is some variability in this effect, it is smaller than the variability for POL, emphasizing the central role of perceived ease of use in influencing teachers' attitudes. This finding coincides with the Eze et al., (2021) that perceived usefulness and ease of use positively mediate the relationship between ICT support and ICT use among teachers, with attitudes towards ICT acceptance and use predicting actual use. Surprisingly, PEU shows no direct effect on ATU. While PEU might have a significant total effect, it seems to influence ATU solely through indirect pathways involving other variables. PEU shows no indirect effect on ATU through any other variables in the model. This is surprising given its significant total effect, suggesting that any indirect effects of PEU are likely small or negligible.

Perceived Usefulness (PU) and Perceived Ease of Use (PEU) as pivotal determinants influencing teachers' attitudes, aligning with findings from prior international research (Kumar et al., 2023). PEU, acting both directly and indirectly through PU, consistently emerged as a crucial factor, echoing established trends in TAM literature and reflecting similarities with non-Western contexts (Naidoo, 2022). PU has a small negative effect on PEU. The effect is much smaller than the effect of PEU, and there is less variability, implying that perceived usefulness has a limited and slightly adverse impact on perceived ease of use (Rakhmawati et al., 2020). PU has a moderate negative direct effect on ATU. This direct effect contributes to the negative total effect of PU. PU has a small negative indirect effect on ATU through POL and SN. An increase in PU leads to a slightly smaller increase in ATU through the pathways of POL and SN.

POL has a small positive indirect effect on ATU through PEU. An increase in POL leads to a slightly larger increase in ATU through the pathway of PEU (Dessilomba & Tanaamah, 2021). Other variables' effects on ATU indicate that POL and PU have the strongest direct influence on ATU, while FC and SN have weaker direct impacts. The model suggests that POL and PU have the strongest indirect influence on ATU, while FC and SN have weaker indirect impacts.

Conclusion

This study provides valuable insights into the complex interplay of factors influencing TVET teachers' attitudes towards technology in north-central Nigeria. The findings confirm the applicability of the Technology Acceptance Model (TAM) in this context, highlighting the crucial roles of perceived ease of use (PEU) and perceived usefulness (PU) in shaping teachers' attitudes. when promoting the acceptance and integration of technology in educational settings.

Implications

These findings underscore several key implications for the effective promotion of technology acceptance and integration in TVET (Technical and Vocational Education and Training) education:

1. Prioritize Perceived Ease of Use (PEU): Emphasize strategies aimed at improving teachers' perceived ease of use. This includes implementing user-friendly software solutions, offering comprehensive training programs, and providing continuous technical support to address any challenges that may arise.
2. Leverage National Policy Support: Advocate for the development and implementation of national policies that allocate resources and infrastructure to support the integration of technology in TVET education. It is crucial to create an environment that not only

provides the necessary tools but also fosters a culture of innovation and technological adoption.

3. Address Context-Specific Challenges: Recognize the unique challenges associated with Facilitation Conditions (FC) and Subjective Norms (SN) in TVET settings. Tailor interventions to the specific needs and cultural context of TVET institutions, acknowledging that a one-size-fits-all approach may not be effective in addressing these challenges.
4. Mitigate Complexity Concerns: Tackle concerns related to the perceived complexity of technology by implementing clear and accessible instructional strategies. Simplify user interfaces, offer straightforward instructions, and align technological applications with the practical goals of teachers. By doing so, the integration of technology becomes more seamless and aligned with the objectives of TVET educators.
5. Foster a Culture of Technology Appreciation: Cultivate awareness among educators regarding the tangible benefits of technology in enhancing both teaching and learning experiences. Encourage a continuous learning mindset and provide opportunities for exploration, allowing teachers to stay updated with technological advancements and integrate them into their instructional practices.

Limitations

1. Sample size and generalizability: While the study provides valuable insights, the sample size and specific context of north-central Nigeria may limit the generalizability of the findings to other TVET settings with different cultural, technological, and policy landscapes. Further research in diverse contexts is needed to solidify the applicability of the conclusions.
2. Focus on self-reported data: The study relies primarily on self-reported data, which might be susceptible to biases such as social desirability. Future research could

incorporate additional data sources, such as observations of teachers' actual technology use or student learning outcomes, to provide a more comprehensive picture of the relationship between attitudes and behaviour.

3. Limited exploration of specific technologies: The study examines broad categories like "user-friendly software" without delving into the specific features or functionalities that teachers find most helpful or challenging. Future research could explore specific technologies and their impact on perceived ease of use and adoption.
4. Lack of longitudinal data: The study provides a snapshot of attitudes at a single point in time. Longitudinal data would be needed to understand how attitudes towards technology evolve and how interventions impact long-term technology use and integration in TVET education.

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