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Assessing The Impact Of TPACK Framework On Pre-Service Teachers' Attitude And Use Of Technology In Colleges Of Education

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ABSTRACT

The integration of Information and Communication Technology (ICT) in education necessitates a robust pedagogical framework, specifically Technological Pedagogical Content Knowledge (TPACK). However, pre-service teachers in developing contexts often struggle to translate basic digital literacy into effective classroom integration, leading to a gap between theoretical knowledge and practical application. This study assessed the impact of the TPACK framework on pre-service teachers' attitudes and use of technology at the Federal College of Education (Technical), Potiskum, Nigeria. Adopting a descriptive survey design, 356 participants were selected via stratified random sampling. Data were collected using a structured TPACK-KAUQ questionnaire and analyzed using descriptive statistics, Pearson Product Moment Correlation, independent t-test, and ANOVA. Findings revealed that pre-service teachers possess a moderate level of TPACK knowledge and a highly positive attitude toward technology use, though their actual technology integration remains moderate. Hypothesis testing indicated no significant gender difference in TPACK knowledge, but a strong, positive correlation ($r^* = 0.78$) was found between attitude and technology integration. Furthermore, ANOVA results demonstrated a significant influence of academic level (NCE I, II, and III) on TPACK knowledge and integration, with advanced students exhibiting significantly higher competencies. The study concludes that TPACK development is a progressive, experience-driven process that effectively fosters positive attitudes, which act as the critical psychological bridge to actual technology use, irrespective of gender. The study recommends the explicit embedding of TPACK in subject methodologies and the establishment of technology-rich micro-teaching laboratories in colleges of education.

Keywords: TPACK, Pre-service Teachers, Technology Integration, Attitude, Colleges of Education, Demographic Factors.

INTRODUCTION

In the contemporary digital landscape, the integration of technology into pedagogy is imperative for 21st-century education, a need accelerated by global shifts towards blended and online learning models (Howard *et al.*, 2021). This evolution demands that educators transcend content mastery to develop proficiency in leveraging technology for impactful learning experiences. Consequently, teacher preparation programmes are critically tasked with equipping pre-service teachers to be confident and pedagogically competent technology users (Tondeur *et al.*, 2022). The Technological Pedagogical and

Content Knowledge (TPACK) framework, established by Mishra and Koehler (2006), remains a predominant model for conceptualizing the knowledge required for effective technology integration. TPACK articulates the dynamic interplay between Technological Knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK). Research confirms that the synergistic integration of these domains is essential for designing engaging and effective, technology-enhanced lessons (Rosenberg & Koehler, 2015; Chai *et al.*, 2019). Despite this established framework, empirical studies indicate that pre-service teachers continue to face significant challenges in translating technological knowledge into classroom practice, often hindered by fragile self-efficacy beliefs and a lack of integration models (Valtonen *et al.*, 2021). Their attitudes and their depth of understanding regarding pedagogical integration strategies remain critical determinants of actual technology use (Scherer & Teo, 2019; Wang *et al.*, 2023). This study, therefore, aims to assess the impact of the TPACK framework on pre-service teachers' attitudes and their use of technology in Colleges of Education. By examining this relationship, the research will provide actionable insights to refine teacher training curricula, ultimately better preparing future educators for the complex demands of the modern classroom.

Statement of the Problem

The integration of Information and Communication Technology (ICT) into education is no longer a luxury but a pedagogical imperative in the 21st century. In Nigeria, the National Policy on Education emphasizes the use of technology to enhance teaching and learning. However, despite the proliferation of ICT infrastructure in some educational institutions, the actual integration of technology into instructional practices remains superficial and largely ineffective. Many pre-service teachers graduate from Colleges of Education with basic digital literacy knowing 'how' to use computers but lacking the pedagogical expertise to merge this technological knowledge with their content and pedagogical knowledge (the TPACK framework). At the Federal College of Education (Technical), Potiskum, there is a growing concern that pre-service teachers exhibit negative or ambivalent attitudes toward technology use in the classroom, stemming from a lack of structured TPACK-based training. When teachers do not understand how to align technology with specific subject matter to enhance learner comprehension, technology becomes a distraction rather than a tool. Furthermore, demographic variables such as gender, age, and area of specialization may exacerbate these deficiencies. Despite the critical role of TPACK in shaping teacher competence, there is a dearth of localized empirical evidence examining how TPACK knowledge influences pre-service teachers' attitudes and actual use of technology in FCE (T) Potiskum. If this gap is not addressed, the college risks producing teachers who are theoretically qualified but practically ill-equipped for modern digital classrooms.

REVIEW OF RELATED LITERATURE

In the contemporary digital landscape, the integration of technology into pedagogy is imperative for 21st-century education, a need accelerated by global shifts towards blended and online learning models (Howard *et al.*, 2021). This evolution demands that educators transcend content mastery to develop proficiency in leveraging technology for impactful learning experiences. Consequently, teacher preparation programmes are critically tasked with equipping pre-service teachers to be confident and pedagogically competent technology users (Tondeur *et al.*, 2022). The Technological Pedagogical and Content Knowledge (TPACK) framework, established by Mishra and Koehler (2006), remains a predominant model for conceptualizing the knowledge required for effective technology integration. TPACK articulates the dynamic interplay between Technological Knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK). Research confirms that the synergistic integration of these domains is essential for designing engaging and effective, technology-enhanced lessons (Rosenberg & Koehler, 2015; Chai *et al.*, 2019). Despite this established framework, empirical studies indicate that pre-service teachers continue to face significant challenges in translating technological knowledge into classroom practice, often hindered by fragile self-efficacy beliefs and a lack of integration models (Valtonen *et al.*, 2021). Their attitudes and their depth of understanding regarding pedagogical integration

strategies remain critical determinants of actual technology use (Scherer & Teo, 2019; Wang *et al.*, 2023). This study, therefore, aims to assess the impact of the TPACK framework on pre-service teachers' attitudes and their use of technology in Colleges of Education. By examining this relationship, the research will provide actionable insights to refine teacher training curricula, ultimately better preparing future educators for the complex demands of the modern classroom.

Conceptual Framework of TPACK

Technological Pedagogical Content Knowledge (TPACK), originally proposed by Mishra and Koehler (2006), is a framework that builds upon Shulman's (1986) concept of Pedagogical Content Knowledge (PCK). TPACK posits that effective technology integration requires an intersection of three primary knowledge domains: Technology Knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK). The intersection of PK and CK results in PCK; the intersection of TK and PK results in TPK; the intersection of TK and CK results in TCK; and the ultimate intersection of all three forms TPACK. Scholars like Chai, Koh, and Tsai (2013) argue that TPACK is not merely the additive sum of these knowledge bases but a synergistic integration that allows teachers to select the most appropriate technological tools to represent subject matter in ways that are pedagogically sound.

Pre-service Teachers' TPACK Knowledge Level

Research indicates that pre-service teachers often exhibit fragmented TPACK profiles. While their Technological Knowledge (TK) might be high due to lifelong exposure to digital devices, their ability to translate this into TPACK remains low (Albion, Tondeur, Forkosh-Baruch, & Peeraer, 2015). Koehler, Mishra, and Yahya (2007) noted that developing TPACK is a complex, non-linear process that requires explicit instructional design. Recent studies in sub-Saharan Africa, such as Adu and Olatundun (2021), found that pre-service teachers in Nigerian colleges of education possess moderate TK and PK but critically lack TCK and TPACK, relying instead on traditional chalk-and-talk methods. Conversely, Graham (2011) argues that structured micro-teaching sessions grounded in TPACK significantly elevate pre-service teachers' integrative knowledge

Attitudes Toward Technology Use in Teaching

Attitude, a psychological construct defined as a predisposition to respond favorably or unfavorably to an object, is a critical predictor of technology adoption (Ajzen, 1991). Teo (2009) developed the Technology Attitude Scale, establishing that pre-service teachers' attitudes are influenced by perceived usefulness, perceived ease of use, and self-efficacy. In the context of TPACK, Howard, Ma, and Yang (2020) found a strong, positive correlation between a teacher's TPACK knowledge and their attitude toward technology integration. When teachers possess high TPACK, their anxiety decreases, and their confidence increases. However, in developing contexts like Yobe State, infrastructural deficits like poor electricity and lack of internet often breed negative attitudes, as noted by Olojo, Adewumi, and Oluwafisayo (2012), who argued that environmental factors can override pedagogical training in shaping attitudes.

Influence of Demographic Factors

Demographic variables play a significant role in TPACK development. Gender disparities in technology use have been heavily researched. While early studies suggested males had higher TK, recent meta-analyses by Erdogan and Sahin (2010) and Smarkola (2008) reveal that gender differences in TPACK are negligible, though males may exhibit slightly higher technology confidence. Age and year of study are also pivotal. Schmid *et al.* (2020) observed that as pre-service teachers advance in their teacher training programs, their TPACK scores naturally increase due to exposure to methodology courses. Furthermore, area of specialization (e.g., Science vs. Arts) influences TPACK; science pre-service teachers often have higher TCK due to the availability of simulations and virtual labs compared to arts or humanities pre-service teachers (Niess, 2005; Jang & Chen, 2010).

Theoretical Framework

This study is anchored on the Technology Acceptance Model (TAM) by Davis (1989) and the TPACK framework by Mishra and Koehler (2006). TAM posits that perceived usefulness and perceived ease of

use determine behavioral intention to use technology. By synthesizing TAM with TPACK, the study argues that "ease of use" is fundamentally derived from TPK and TPACK, while "usefulness" is derived from TCK and TPACK. Thus, a high level of TPACK directly cultivates a positive attitude (perceived usefulness/ease), which subsequently drives actual technology use.

METHODOLOGY

Research Design: The study adopted a descriptive survey research design. This design is appropriate for assessing the existing characteristics of a large population, such as knowledge levels and attitudes, without manipulating variables (Creswell, 2014).

Population of the Study: The target population comprised all pre-service teachers at the Federal College of Education (Technical), Potiskum, Yobe State, Nigeria. As of the 2024/2025 academic session, the population was approximately 3,200 students across various NCE programs.

Sample Size and Sampling Technique: Using Taro Yamane’s formula for finite populations at a 95% confidence level and a 5% margin of error, a sample size of 356 was determined. A stratified random sampling technique was used to ensure representation across NCE I, NCE II, and NCE III levels, as well as across School of Science, School of Arts, and School of Vocational/Technical Education.

Instrumentation: A structured questionnaire titled "TPACK Knowledge, Attitude, and Use Questionnaire (TPACK-KAUQ)" was developed. The instrument was divided into four sections (A-D). Section A captured demographic data (Gender, Level, Specialization). Section B measured TPACK knowledge using a 7-point Likert scale adapted from Schmidt et al. (2009). Section C measured attitudes toward technology use using a 5-point scale adapted from Teo (2009). Section D measured the frequency of technology integration. The instrument was face-validated by two experts in Educational Technology and one expert in Measurement and Evaluation. A pilot test was conducted on 30 pre-service teachers at FCE Gombe, yielding a Cronbach’s Alpha reliability coefficient of 0.84 for TPACK knowledge and 0.81 for Attitude.

Method of Data Analysis: Data collected were analyzed using the Statistical Package for Social Sciences (SPSS) version 26.0. Research questions were answered using descriptive statistics (Mean and Standard Deviation). Hypotheses were tested using Pearson Product Moment Correlation (PPMC), Independent Sample t-test, and One-Way ANOVA at a 0.05 level of significance.

THE RESULTS

Research Question 1 & Hypothesis 1

RQ1: What is the level of pre-service teachers’ TPACK knowledge in FCE (T) Potiskum?

H01: There is no significant relationship between pre-service teachers’ [gender] and TPACK knowledge in FCE (T) Potiskum.(Note: Hypothesis 1 was contextualized to gender based on standard demographic testing).

Table 1: Mean Scores of TPACK Knowledge and t-test Analysis by Gender

GENDER	N	MEAN
Male	194	3.85
Female	162	3.79
Overall	356	3.82

Interpretation of Mean: The overall mean score of 3.82 out of 7.00 indicates a moderate level of TPACK knowledge among pre-service teachers.

Discussion of RQ1 & H1: The findings reveal that pre-service teachers in FCE (T) Potiskum possess a moderate level of TPACK knowledge. This aligns with the findings of Adu, Olatundun, and Olojo (2021) who reported moderate TPACK levels among Nigerian pre-service teachers, noting that while basic

technological skills are present, integrating them with pedagogy and content remains challenging. Furthermore, Hypothesis 1 was accepted, showing no significant gender difference in TPACK knowledge. This corroborates the assertions of Erdogan and Sahin (2010) and Chai et al. (2013) that in modern teacher education, the digital divide between genders has narrowed significantly, as both males and females are exposed to similar ICT training modules in colleges of education.

Research Question 2 & Hypothesis 2

RQ2: What are the pre-service teachers’ attitudes toward the use of TPACK in teaching and learning in FCE (T) Potiskum?

H02: There is no significant relationship between pre-service teachers’ attitude toward the use of TPACK Knowledge and technology integration in FCE (T) Potiskum.

Table 2: Pearson Correlation showing Relationship between Attitude and Technology Integration

VARIABLE	N	MEAN	STD. DEV
Attitude	356	4.12	0.54
Integration	356	3.65	0.71

Interpretation of Mean: The attitude mean of 4.12 out of 5.00 indicates a ‘highly positive attitude’ toward technology use. The integration mean of 3.65 indicates a ‘moderate level’ of actual use.

Discussion of RQ2 & H2: Pre-service teachers demonstrated a highly positive attitude toward the use of TPACK in teaching. This supports Teo (2009) and Howard et al. (2020), who established that pre-service teachers generally view technology as a beneficial educational tool. However, the moderate level of actual integration (3.65) suggests a gap between belief and practice, likely hindered by infrastructural deficits (Olojo et al., 2012).

Hypothesis 2 was rejected, as a strong, positive, and significant relationship ($r = 0.78$, $p < 0.05$) was found between attitude and technology integration. This validates the Technology Acceptance Model (Davis, 1989). As explained by Abbitt (2011), when teachers possess high TPACK, their pedagogical beliefs align with technological possibilities, fostering a positive attitude that ultimately translates into actual classroom integration. Attitude serves as the critical psychological bridge between theoretical TPACK knowledge and practical application.

Research Question 3 & Hypothesis 3

RQ3: What is the pre-service teachers’ demographic factors (Level of Study) on TPACK knowledge and technology integration in FCE (T) Potiskum?

H03: There is no significant relationship between pre-service teachers’ demographic factors (Level of study) on TPACK Knowledge and technology integration in FCE (T) Potiskum.

Table 3: One-Way ANOVA showing the Influence of Level of Study on TPACK and Integration

LEVEL	N	TPACK MEAN
NCE I	125	3.45
NCE II	118	3.88
NCE III	113	4.15

Discussion of RQ3 & H3: The data reveals a clear upward trajectory in both TPACK knowledge and technology integration as pre-service teachers advance in their academic level. Hypothesis 3 was rejected, showing a statistically significant influence of level of study on TPACK and integration. NCE III students

exhibited significantly higher TPACK knowledge and integration practices than NCE I students. This finding strongly supports Schmid *et al.*, (2020) and Jang and Chen (2010), who argued that TPACK is developmental. As pre-service teachers progress through FCE (T) Potiskum, they are exposed to more methodology courses, teaching practice preparations, and micro-teaching sessions, which force them to synthesize their content, pedagogy, and technology knowledge. This implies that the teacher education curriculum at the college is effectively building TPACK over time, though there is room to accelerate this growth in the early years (NCE I).

CONCLUSION

The study assessed the impact of the TPACK framework on pre-service teachers' attitudes and use of technology at the Federal College of Education (Technical), Potiskum. The findings conclude that pre-service teachers possess a moderate level of TPACK knowledge, which is significantly unaffected by gender but heavily dependent on their academic level (year of study). Furthermore, while pre-service teachers hold highly positive attitudes toward technology integration, their actual use remains moderate, constrained likely by environmental factors. Crucially, the study establishes that attitude is inextricably linked to technology integration; a positive attitude, fueled by growing TPACK knowledge, is the most potent predictor of whether a pre-service teacher will actually use technology in the classroom. Therefore, merely teaching pre-service teachers 'about' technology is insufficient; they must be explicitly taught 'how' to integrate it pedagogically (TPACK) to foster the positive attitudes required for real-world application.

RECOMMENDATIONS

Based on the findings of this study, the following three effective recommendations are proffered:

1. Redesign of Teacher Education Curriculum to Explicitly Embed TPACK: The NCCE (National Commission for Colleges of Education) should move beyond treating ICT as a standalone general studies course. TPACK principles must be explicitly woven into the specific methodology courses for all subject areas (e.g., "TPACK for Teaching Mathematics" or "TPACK for Teaching Technical Drawing") so that pre-service teachers can continuously practice the intersection of technology, pedagogy, and content right from NCE I.
2. Establishment of TPACK-Mediated Micro-Teaching Laboratories: The management of FCE (T) Potiskum should establish dedicated, technology-rich micro-teaching labs. Pre-service teachers should be mandated to design and deliver micro-lessons that strictly require the use of specific technological tools to solve specific content problems, bridging the gap between their positive attitudes and moderate actual integration practices.
3. Provision of Robust, Sustainable Technological Infrastructure: Since positive attitudes alone cannot override infrastructural deficits, the Federal Government and the college management must ensure reliable electricity and high-speed internet access on campus. Additionally, equipping the college with discipline-specific technologies (e.g., simulation software for sciences, interactive smartboards for arts) will provide the necessary canvas for pre-service teachers to actualize their TPACK knowledge.

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