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Gender Influence on Student Teachers' Perceptions of the Constructs of Technological Pedagogical Content Knowledge (TPACK) in Nigerian Universities

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Abstract: This study investigated whether gender influences the perceptions of TPACK constructs among male and female student teachers in public universities in north-central Nigeria. The study adopted the cross-sectional survey design carried out using the TPACK questionnaire across the study's sample. Sample selection for the study was based on a multi-stage sampling technique. Accordingly, a questionnaire was distributed to a sample of 529 male and female student teachers in their final year enrolled in three universities in Kwara State, Nigeria. They responded to the study tool that was accessed after the validity and reliability of the tool had been verified using Cronbach's Alpha. The data were analysed using statistical mean and Mann-Whitney U test. The findings revealed that gender differences in student teachers' perceptions of their Technological Knowledge (TK) and Technological Content Knowledge (TCK) favouring male respondents. However, the results showed no statistically significant differences between male and female student teachers in technological pedagogical knowledge (TPK) and technological pedagogical content knowledge (TPACK). The study's conclusions, recommendations, implications, and limitations are based on the research findings.

Keywords: Gender; Perceptions; Student Teachers; Constructs of Technological Pedagogical Content Knowledge (TPACK); Nigerian Universities

تأثير النوع الاجتماعي على تصورات الطلاب المعلمين لأبعاد معرفة المحتوى التربوي التكنولوجي في الجامعات النيجيرية

موداسيرو ولاليري يوسف[1] وطلعت فضيلات أحمد[2] وسيث داد أنساه[3] وحمدلات تايو يوسف[4]

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بحثت الدراسة الحالية تأثير النوع الاجتماعي على تصورات الطلبة المعلمين لأبعاد معرفة المحتوى التربوي التكنولوجي (TPACK) في الجامعات الحكومية في شمال وسط نيجيريا. تكونت عينة الدراسة من 529 طالبًا وطالبة من طلبة السنة الأخيرة، والمسجلين في ثلاث جامعات في ولاية كوارا بنيجيريا، وقد استجابوا لأداة الدراسة بعد التحقق من الصدق والثبات. تم تحليل بيانات الدراسة باستخدام المتوسطاتالحسابية، واختبار مان ويتني، كشفت النتائج عن اختلافات بين الجنسين في تصور الطلاب المعلمين لمعرفتهم التكنولوجية (TK) ومعرفة المحتوى التكنولوجي (TCK) لصالح الذكور، كما أظهرت النتائج عدم وجود فروق ذات دلالة إحصائية بين الطلاب والطالبات المعلمين في المعرفة التربوية التكنولوجية (TPK)، ومعرفة المحتوى التربوي التكنولوجي (TPACK).

الكلمات المفتاحية: النوع الاجتماعي؛ تصورات الطلاب المعلمين، المحتوى التربوي التكنولوجي (TPACK)، الجامعات النيجيرية

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Introduction

Technology is an indispensable component of the 21st-century educational system. Contemporary education is dependent on information and communication technology for students' enrolment, institutional administration, instructional delivery, learning assessment and evaluation, collaboration with stakeholders, among others. ICT has become the oxygen through which school and corporate education life depends on. Empirical studies demonstrated that teachers' instructional delivery quality is the most significant contributing factor to learners' learning outcomes. Therefore, teachers' versatility in integrating ICT tools and resources would go a long way in ensuring the quality of learning among students (Mizell, 2010). However, the surfeit of ICT resources in the 21st century has presented teachers with new challenges owing to the endless potentials of ICT in every aspect of education (Albion et al., 2015). Hence, it is important to examine how teacher education programs influence the use of technology by student teachers.

In the developed world, student teachers, like other students, are digital natives. These students have been using technologies in their daily lives and are comfortable and knowledgeable with various types of technology. They would navigate various obstacles and use technology with ease (Corey, 2012). However, digital penetration is lower in developing nations, where ICT resources are not readily available. Despite the low penetration of ICT resources in developing nations, teachers and students need to integrate ICT in their instruction.

Student teachers or pre-service teachers are prepared for academic leadership roles through professional teacher education courses and practical in teacher education institutions. Such institutions provide student teachers with information in four specific components of teacher education. These components are general education (psychology, educational administration, testing, and measurement, among others); subject-specific mastery (physics, mathematics, geography, among others), pedagogy, which is the methodology of teaching; and applied education or teaching practice (Manasia et al., 2019). Teachers must model good use of technology in their instruction to encourage students' adoption of technology in the work environment. Teacher education institutions must prepare student teachers to make good use of technology. Teachers' use of ICT will help them motivate students and grow their interest in learning activities. It provides teachers with preconditions in vision, policy, and institutional culture. ICT can assist the teacher in providing the enabling environment for personnel support (Bhattacharjee & Deb, 2016).

The Nigerian national policy in education (Federal Republic of Nigeria, 2013) recognizes the importance of quality teachers in providing quality education; thus, the emphasis on planning for quality teacher education at tertiary education level, at the college of education and universities. In addition, pre-service and in-service teachers' education programs produce contemporary teachers for the 21st-century classroom. However, studies in Nigeria showed that pre-service and in-service teachers' education programs fall below the requirements of the contemporary knowledge economy. This is due to inadequate coverage and mastery of content knowledge, the prevalence of memorization of content due to overuse of the lecture method, and a low level of technology penetration and utilization for teaching and learning (Federal Ministry of Education, 2014). Centralized national bodies regulate teacher education in Nigeria. For example, the National Commission for Colleges of Education (NCCE) provides the document (Academic Standard) on basic requirements for students or pre-service teachers in the 3-year programs leading to the award of the National Certificate in Education (NCE).

The National Universities Commission (NUC) regulates teacher education in the universities through the Basic Minimum Academic Standard (BMAS) for the 3-5 years programs leading to the award of a Bachelor of Education, or a Bachelor of Arts or Science in education, or a Bachelor of Technology in Education. However, it should be noted that the BMAS contains only two courses, each of 2 credits/units, related to technology integration in teaching and learning. Introduction to Educational Technology (2 credits); and Information and Communication Technology in Education (2 credits) (National Universities Commission, 2007). These two courses are insufficient to provide student teachers with the needed knowledge and skills to promote technology infusion in teaching and learning.

Effective technology implementation in the classroom requires acknowledging the relationship among the content, pedagogy, and technology elements. The relationships are dynamic and transactional within the institutional, classrooms, and different cultural contexts. Such factors are the individual educator, grade level, and class demographics. Therefore, each situation requires a slightly different approach to technology integration. Specific technological tools (hardware, software, and associated information literacy practices) can potentially instruct and guide students toward a better and more robust understanding of the subject matter. The three types of knowledge required by pre-service or in-service teachers are Content Knowledge (CK), Technology Knowledge (TK), and Pedagogical Knowledge (PK), which are combined and recombined with various intersections within the TPACK framework (Koehler & Mishra, 2009). The interactive influence of teachers' variables has been an issue of concern in educational research. Similarly, the area of TPACK has been explored based on variables like gender, age, subject specialization, among others.

A study in Singapore explored pre-service teachers' perceptions of TPACK seven constructs as related to age and gender. Findings indicated that the TPACK constructs significantly impacted pre-service teachers' TPACK perceptions; however, age and gender were insignificant. Specifically, only technological pedagogical knowledge (TPK) and technological content knowledge (TCK) significantly predicted TPACK (Koh & Sing, 2011). Another study investigated TPACK of secondary school science teachers using a new contextualized TPACK. The model also examined the associations between in-service teachers' experience, gender and TPACK. The results revealed that gender and teaching experience statistically influenced secondary science teachers' TPACK. Male science teachers rated their TPACK knowledge significantly higher than their female counterparts. Also, experienced science teachers rated their in-context content knowledge (CK) and pedagogical content knowledge (PCK) significantly higher than novice science teachers. However, science teachers with less teaching experience rated their in-context technology knowledge and technological content knowledge (TPCKC) significantly higher than experienced teachers. The study indicated that gender and teaching experience influenced secondary school science teachers' TPACK (Jang & Tsai, 2013).

Aslan and Zhu (2016) investigated pre-service and new serving teachers' perceptions for ICT-related eight variables, considered along with gender, subject, and university. The results indicated that pre-service and serving teachers' integration of ICT was at a basic level. Also, the gender variable did not significantly predict the pre-service teachers' ICT integration into teaching practices. Altun and Akyildiz (2017) investigated the TPACK of final year student-teachers in five different subject areas in a Turkish university. They also examined the relationships between sub-factors of TPACK and gender, program, personal computer ownership, and Internet connection. The results revealed that participants had good TPACK knowledge levels and showed meaningful relationships and significant differences between gender, program, personal computer, and Internet connection.

Similarly, Karakaya and Yazici (2017) investigated the TPACK self-efficacy for science student teachers on material development in a university in Turkey. The study also explored the variables of grade level, gender and teaching technologies. Findings indicated that gender is not a factor in pre-service science teachers' technological pedagogical content knowledge (TPACK) self-efficacy on material development.

Irmak and Tüzün (2019) studied pre-service teachers' TPACK on knowledge of genetics. Also, gender and grade level differences in the perceived TPACK were examined. The pre-service science teachers perceived themselves as knowledgeable on pedagogical knowledge (PK) and not knowledgeable on Project Specific Technology Knowledge (PSTK) dimensions. They perceived that content related TPACK dimensions significantly contributed to their knowledge of genetics. Gender of pre-service science teachers showed a statistically significant difference in Project Specific Technology Knowledge (PSTK), Pedagogical Knowledge (PK), Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK) and TPACK dimension. Pre-service female teachers had better perceived TPACK than their male counterparts. Ergen et al., (2019) did a meta-analysis of studies on gender influence on the effect size of the Technological Pedagogical Content Knowledge (TPACK) of 29 studies conducted in Turkey and other nations between 2007 and 2017. The results of the meta-analysis indicated a significant TPACK difference by gender. The sub-group analysis, technology knowledge (TK), technological pedagogical knowledge (TPK) and technological pedagogical content knowledge (TPCK) indicated a significant effect in favor of males. In contrast, content knowledge (CK), pedagogical content knowledge (PCK), and technological content knowledge (TCK) have a nominal effect size in favor of male respondents, and pedagogical knowledge (PK) has a marginal effect size in favor of female respondents.

Ma and Baek (2020) analyzed the TPACK differences between pre-service and in-service teachers in China and determined teacher division and gender influence variables on their differences. The results indicated that in-service teachers scored higher than pre-service teachers in the seven TPACK thematic components. Furthermore, teacher division and gender had an interactive effect on TK, with the male student-teachers having higher TPACK abilities than the females. Wang et al., (2020) explored the relationships between every two levels of TPACK of pre-service teachers at Nanjing Normal University in China. Their results indicated that pre-service teachers had high scores on the PCK and PK subscales while they had relatively low scores on the TPCK subscale. There was also a positive correlation between every two levels of pre-service teachers' TPACK. In addition, there were gender level differences for the CK knowledge, with female student-teachers having better subject teaching knowledge than their male counterparts. Thinzarkyaw (2020) examined the practical application of technological pedagogical content knowledge (TPACK) among teacher educators in three Education Colleges in Myanmar using a set of questionnaire. The results showed that variables of teacher educators' gender, college, experience, among others, indicated no significant differences in their TPACK-based practices.

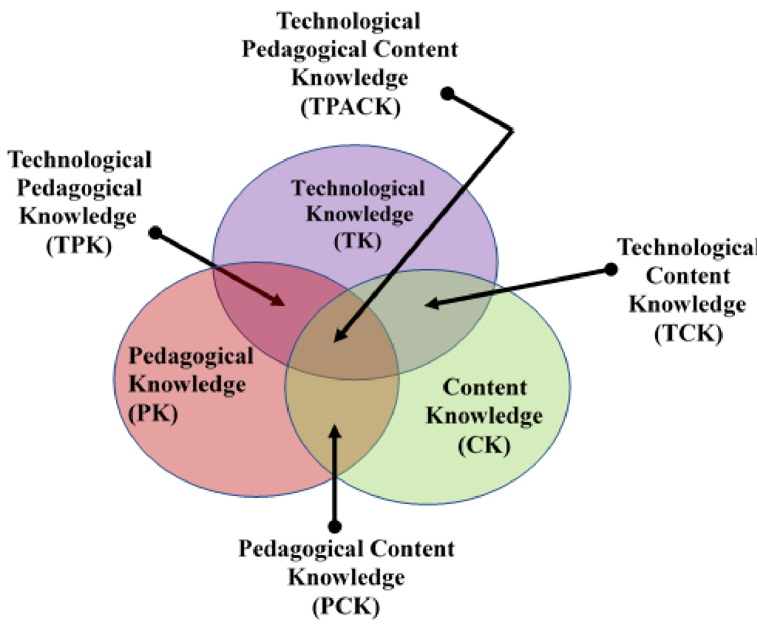
Review of Literature

The TPACK is a framework on how specific technological tools and resources are best used to facilitate students' understanding of the subject matter and enhance their performance. The framework is a miscegenation of ideas of educators desirous to ensure effective and efficient infusion of technology for teaching and learning. Prasojo et al., (2020) established the antecedent’s culmination in the TPACK framework. According to their review, Shulman (1986) introduced a framework that linked the teacher's content and pedagogy knowledge, known as Pedagogical and Content Knowledge (PCK). Shulman framework had three focused areas: pedagogical knowledge (PK), content knowledge (CK) and pedagogical content knowledge (PCK). Mishra and Koehler (2006) expanded Shulman's (1986) model to incorporate technology into content and pedagogy. Mishra and Koehler (2006) emphasized that using technology to teach content pedagogically is important for the 21st -century education. Therefore, their framework expanded on the previous PCK to seven domains of TPACK. Koehler et al., (2014) further affirmed that the TPACK design model is based on Cochran et al., (1993) and Shulman's (1986) conceptualization of PCK as an integrated understanding of pedagogy, subject matter content, students' characteristics, and the learning environment or context.

The TPACK model refers to the essential basic skills for serving or pre-service teachers' quality instruction. The model contains content knowledge (CK), pedagogy knowledge (PK), and technology knowledge (TK). The TPACK sequence of bilateral combinations and intersections results in three broad areas. These areas are pedagogical content knowledge (PCK), technological content knowledge (TCK), and technological pedagogical knowledge (TPK) components (Koehler & Mishra, 2009). The TPACK theoretical framework succinctly captures the knowledge and skills needed by teachers to create ICT-compliant teaching and learning environment. The TPACK framework is as depicted in Figure 1.

The Technological Pedagogical Content Knowledge (TPACK) framework details what teachers need to know for technology integration. The TPACK contains seven critical knowledge domains a teacher needs to excel in technology infusion for teaching and learning. These domains are content knowledge (CK), dealing with knowledge of the subject matter to be learned or taught; pedagogical knowledge (PK) related to knowledge about teaching and learning the processes, practices, or strategies; and technological knowledge (TK) dealing with digital technologies knowledge. Other domains are products of the intersection of the CK, PK, and TK. The pedagogical content knowledge (PCK) deals with the knowledge on the interaction of PK and CK to transform the subject content to promote student learning. PCK distinguishes teachers of subject matter from ordinary subject matter experts. Technological content knowledge (TCK) entails knowledge of TK and CK relations, technological pedagogical knowledge (TPK) relates to knowledge on the interface between TK and PK. TPK covers teachers' knowledge of how specific technologies can enhance the teaching and learning experiences. It deals with understanding the appropriate deployment of technological tools alongside pedagogy to instructional settings.

Figure 1: Technological Pedagogical Content Knowledge (TPACK)
Source: Koehler and Mishra (2006)



The technological pedagogical content knowledge (TPACK) results from the combinations drawn from the three foundational areas of content, pedagogy, and technology (Mishra & Koehler, 2006). The TPACK framework provides a way to measure how an instructor can integrate technology for teaching and learning, impacting teacher education training and professional development offerings (Angeli et al., 2016, Kurt, 2018).

The TPACK underscores that technology needs to interact with content knowledge using the right pedagogical knowledge for meaningful infusion in teaching and learning. Thus, technological content knowledge (TCK) ensures how technology and content influence and constrain one another during instructional activities. Therefore, apart from understanding the subject matter, teachers must understand the technologies best suited to address the subject matter to ensure that students achieve the content learning outcomes. Then TPK implies understanding of how to use specific technologies to ensure changes in teaching and learning. In this context, technology tools and resources facilitate students' learning through collaboration with peers, scaffolded learning opportunities, and problem-solving problem sets. Technology, pedagogy, and content knowledge (TPACK) relate to understanding the interactions between content pedagogy and technology knowledge (Koehler et al., 2013). Thus, the TPACK framework emphasizes that quality teaching and learning is impossible when three knowledge bases of content, pedagogy, and technology exist separately; only the interplay and relationship among them bring about meaningful, interactive, and engaged students' learning (Nelson et al., 2009). The TPACK framework posits that effective infusion of technology for pedagogy in specific subject matter requires the understanding of sensitivity to the dynamic, transactional relationship among Content (CK), Pedagogy (PK), and Technology (TK) forms of knowledge. A teacher capable of understanding and applying the relationships is an expert compared to just a disciplinary expert (content), a technology expert (technology), or a pedagogical expert (educator). A TPACK expert is an eclectic educator capable of using the right technological tools and resources to facilitate learning content using appropriate pedagogical skills.

Angeli et al., (2016) systematic chronological review of research on TPACK established that researchers have been working toward the goal of integrating technology skills into teaching and learning. They identified major issues of non-consensus regarding the transformative or integrative and the domain-general or domain-specific nature of TPACK. Nevertheless, they concluded that their research evidence indicates that TPACK is transformative. They also suggested that research efforts must focus on empirical and qualitative investigations of TPACK manifestation in real practice, which this study seeks to do.

Educators can understand TPACK from three complementary theoretical perspectives: philosophy of technology, theory of situated cognition, and positioning teaching as a design science. The insight from the philosophy of technology enhances understanding technological knowledge about the relationship between technology, humans, and the world, thus through technological mediation, teachers and technology co-shape educational practice. Insights from the theory of situated cognition allow the understanding of TPACK as a form of teacher knowledge, as teachers actively construct TPACK through formal knowledge and practical experiences. Finally, positioning teaching as a design science, we understand teachers' learning of TPACK by design as teachers assume the role of designer of technology-enhanced learning (Voogt et al., 2016).

The TPACK framework offers a productive approach to many challenges teachers face in implementing educational technology in their daily classroom activities. It outlines how content (what the teacher teaches) and pedagogy (how the teacher imparts that content) must form the foundation for any effective educational technology integration (Kurt, 2018). This is important because the technology implementation must communicate the content and support the pedagogy to enhance students' learning experience.

Operational Definitions of Terms

The following terms and variables are operationally defined as used in this study:

Student Teacher: a student studying in a university to qualify as a teacher

Gender: male and female student teachers

TPACK: This is an acronym for Technological Pedagogical Content Knowledge that captures teachers' knowledge for quality technology infusion in teaching.

The Study Problem

Studies have established the poor implementation of teacher education programs in Nigerian universities. Researchers have identified poor course contents /delivery, inadequate instructional facilities, the short period of teaching practice, examination malpractices, poor funding, lack of competence in information and communication technology (ICT) integration, and poor public attitude towards teaching as some of the challenges affecting teacher education in Nigeria (Akpa et al., 2009; Okoli et al., 2015). In addition, males and females do not have equal access to teacher education. As a result, there is a disparity in professional growth, and there are no school policies against gender discrimination in teacher education (Patrick, 2010). Furthermore, the only two courses related to technology in education in Nigerian teacher education programs are insufficient to provide student teachers with the needed knowledge and skills to promote technology infusion in teaching and learning. The TPACK framework provides a clear framework for teacher education programs. However, technology is highly dynamic and, thus, requires a re-evaluation of teacher education programs to ensure effective technology integration.

Few studies have been conducted within the Nigerian school context on TPACK, particularly examining the issue of gender in technology infusion for instruction. Additionally, the non-conclusive findings on gender influence on the TPACK of pre-service and serving teachers underscore the need for further studies on technology integration in instruction, particularly in the Nigerian university context. Such studies become imperative in developing nations where ICT integration is just getting a foothold in educational institutions. It is necessary to understand the relationship between TPACK and its constructs and the possible interactions with serving or pre-service teachers' gender variable.

Research Purpose and Questions

The present study aimed to determine whether student teachers' gender would influence their technological components of TPACK in universities in Kwara State, north-central Nigeria. The four technological constructs of the TPACK that is TK, TCK, TPK, and TPACK, were analyzed on the student teachers. Based on the main purpose, the study addressed the following research questions.

1. What is the influence of undergraduate student teachers' gender on their technological knowledge?
2. What is the influence of undergraduate student teachers' gender on their technological pedagogical knowledge?

3. How does undergraduate student teachers' gender influence their technological content knowledge?
4. What is the influence of undergraduate student teachers' gender on their technological pedagogical content knowledge?

Research Hypotheses

The following hypotheses were formulated and tested at a 0.05 level of significance.

Ho_1: There is no significant difference between male and female undergraduate student teachers' Technological Knowledge (TK).

Ho_2: There is no significant difference between male and female undergraduate student teachers' Technological Pedagogical Knowledge (TPK).

Ho_3: There is no significant difference between male and female undergraduate student teachers' Technological Content Knowledge (TCK).

Ho_4: There is no significant difference between male and female undergraduate student teachers' Technological Pedagogical Content Knowledge (TPCK).

Method and Procedures

***Research Design*:** This study adopted the cross-sectional survey design, which involved using a self-reporting questionnaire one point in time on the respondents.

Population: The study population comprised all student teachers in universities in Kwara State, a state in the North-Central region of Nigeria. All final year student teachers in the sampled universities formed the target population for the study because they have gone through all the requisite courses in their teacher education programs. School A, a federally owned university with a student-teacher population of 8473, and School B, a state-owned university, had a population of 2530 student-teachers. In addition, School C, a privately-owned university, had a population of 812 student-teachers, making a total population of 11,815 student-teachers in the study area.

Sample: The study adopted a multi-stage sampling method. First, the researchers selected the institutions with teacher education programs using the purposive sampling technique. Second, the proportional sampling technique was used to determine the number of samples required from each institution. Third, the stratified sampling technique was used to categories respondents based on student teachers' gender. Fourth, the sample had offered two courses on technology integration. They had partaken in the teaching practices where they were required to integrate technology in their instruction, and their technology integration practices were exhibited during those exercises. Finally, a total of 900 student teachers was sampled to partake as respondents to the questionnaire items used for data collection.

Tools, Instrument Reliability, and Validity: The instrument used for this study was a self-reporting questionnaire adapted by the researchers from Schmidt et al. (2009) items. The questionnaire items modification was hinged on the research objectives. The introductory section of the questionnaire explained the study's objective, sought the respondents' cooperation and appreciated them for their anticipated participation. The first sub-section of the questionnaire elicited information on the respondents' demography. This sub-section confidentially requested information on respondents' institution, academic program, and gender.

The other four sub-sections focused on Technological Knowledge (TK) with ten items; Technological Content Knowledge (TCK) with four items; Technological Pedagogical Knowledge (TPK) with ten items; and the main intersection, Technological Pedagogical Content Knowledge (TPACK), with four items. The technological items (TK, TCK, TPK and TPACK) sub-section had the response mode structured using a four-point Likert scale of Strongly Agree (SA = 4), Agree (A = 3), Disagree (D = 2) and Strongly Disagree (SD = 1).

The instrument was validated and tested for reliability through its administration on a sample of 30 final year student teachers at a university in a neighboring state. The reliability of the research instrument was determined using the Cronbach Alpha formula and found reliable ranges from 0.62 to 0.73, as depicted in Table 1.

Table (1) Summary of the items and reliability in the survey instrument

Construct	Exemplary item	# of items	Cronbach's α
TK	I keep up with important new technologies	10	0.73
TPK	I can facilitate my students to collaborate using technology	10	0.68
TCK	I know about the technologies I can use to search for the content of my first teaching subject	4	0.62
TPACK	I can select technologies to use in my classroom that enhance what I teach, how I teach and what students learn.	4	0.70

Study Procedures: The researcher had the consent of the appropriate authorities in the selected institutions. The respondents were encouraged to be objective in their responses. The researchers collected the already completed questionnaire copies with the help of the research assistants. The research assistants distributed 900 copies of the questionnaire to respondents, and some were collected back on the spot, while the remaining were retrieved after two days in January 2020 before the nationwide COVID-19 lockdown in March 2020. Although 811 copies were retrieved from the respondents, only 529 copies were useful for data analysis, indicating a return rate of 58.78%. The researchers paid attention to ethical issues during the research design and processes. First, the respondents had informed consent with the clearly stated objectives, and they voluntarily participated without being forced. Furthermore, participants had the liberty to withdraw at any point of the research data collection. Second, the information gathered was handled with utmost reasonability so that participants' identities and responses were kept confidential. Finally, all cited works were referenced and acknowledged to avoid plagiarism.

Data Analysis Method: The data collected were collated and subjected to statistical analysis. Descriptive statistics frequency and percentage were used for the demographic data in the data analysis. In addition, the non-parametric inferential statistics, the Mann-Whitney U test, was used to test the four research hypotheses. All hypotheses were tested at a 0.05 level of significance.

Results and Findings

The results and findings from the analyzed data are presented in Tables 2 to 6. Table 2 presents the student teachers' gender demographic information, while Tables 3 – 6 focused on the results to address the four research questions addressed through their corresponding hypotheses.

Table (2) Frequency and Percentage Distribution of Respondents by Gender

Gender	Frequency	Percentage
Male	221	41.8
Female	308	58.2
Total	529	100

Results in Table 2 show that 221 (41.8%) of the respondents were male, while 308 (58.2%) were female. The results imply that more female student teachers were respondents than males in this study.

To address the research questions corresponding null hypotheses were used on the student teachers' TK, TCK, TPK and TPACK knowledge. The Man-Whitney U test, a non-parametric inferential statistics, was used to test each hypothesis. The results are as indicated for each of the hypotheses

Hypothesis One

There is no significant difference between male and female undergraduate student teachers' Technological Knowledge (TK).

The results related to this hypothesis are presented in Table 3.

Table (3) Man-Whitney U test of significant difference between male and female student teachers' technological knowledge

Gender	#	Mean Rank	Sum of Ranks	Z	Asymp. sig. (2-tailed)
Male	221	291.82	64492.00	-3.428	0.00
Female	308	245.76	75693.00		
Total	529				

Table 3 indicates the value U (529) = -3.428, $p < 0.05$, which means that the stated null hypothesis was rejected. The U-value of -3.428, resulting in a 0.00 significance value, was less than 0.05 alpha value with a mean rank score of 291.82 for males and 245.76 for females. By implication, the null hypothesis was rejected; thus, there was a significant difference between male and female student teachers in their technological knowledge in universities. This was because the male student teachers had favored male student teachers.

Hypothesis Two

There is no significant difference between male and female undergraduate student teachers' Technological Pedagogical Knowledge (TPK).

Table 4 presents the results related to hypothesis two.

Table (4) Mann-Whitney U test of significance between Male and Female Student Teachers' Technological Pedagogical Knowledge

Gender	#	Mean Rank	Sum of Ranks	Z	Asymp. sig. (2-tailed)
Male	221	267.87	59198.50	-0.367	0.713
Female	308	262.94	80986.50		
Total	529				

Table 4 shows the results U (529) = -0.367, $p > 0.05$, which means that the stated null hypothesis was not rejected. This was because the U-value of -0.367 resulted in a 0.713 significance value, greater than 0.05 alpha value with a mean rank score of 267.87 for males and 262.94 for females. By implication, the stated null hypothesis was established that there was no significant difference between male and female student teachers in their technological pedagogical knowledge in universities.

Hypothesis Three

There is no significant difference between male and female undergraduate student teachers' Technological Content Knowledge (TCK).

Table 5 shows the results related to hypothesis three.

Table (5) Mann-Whitney U test of significance between Male and Female Student Teachers' Technological Content Knowledge

Gender	#	Mean Rank	Sum of Ranks	Z	Asymp. sig. (2-tailed)
Male	221	283.24	62597.00	-2.351	0.019
Female	308	251.91	77588.00		
Total	529				

Table 5 shows the results of U (529) = -2.351, $p < 0.05$, which means that the stated null hypothesis was rejected. This was because of the U-value of -2.351, resulting in a 0.019 significance value, which was less than 0.05 alpha value with a mean rank score of 283.24 for males and 251.91 for females. By implication, the stated null hypothesis was not established that there was a significant difference between male and female student teachers in their technological content knowledge in universities. This was in favor of male student teachers.

Hypothesis Four

There is no significant difference between male and female undergraduate student teachers' Technological Pedagogical Content Knowledge (TPCK).

The results of the hypothesis are presented in Table 6.

Table (6) Mann-Whitney U test of significance between male and female Student Teachers' Technological Pedagogical and Content Knowledge

Gender	#	Mean Rank	Sum of Ranks	Z	Asymp. sig. (2-tailed)
Male	221	270.83	59854.50	-0.753	0.452
Female	308	260.81	80330.50		
Total	529				

Table 6 indicates that U (529) = -0.753, $p > 0.05$ results mean that the stated null hypothesis was not rejected. This was because the U-value of -0.753 resulted in a 0.452 significance value, greater than 0.05 alpha value with a mean rank score of 270.83 for males and 260.81 for females. By implication, the stated null hypothesis was established that there was no significant difference between male and female student teachers in their technological pedagogical and content knowledge in universities.

From the analysis related to the four hypotheses, two indicated no significant difference, while two indicated a significant difference with the male having a higher rating. Specifically,

1. There was a significant difference between male and female undergraduate student teachers' Technological Knowledge (TK), with male students having a higher mean rating;
2. There was no significant difference between male and female undergraduate student teachers' Technological Pedagogical Knowledge (TPK);
3. There was a significant difference between male and female undergraduate student

teachers' Technological Content Knowledge (TCK); and

4. There was no significant difference between male and female undergraduate student teachers' Technological Pedagogical Content Knowledge (TPACK).

Discussion

The study revealed a significant difference between male and female student teachers' technological knowledge. The findings agree with earlier findings (Altun & Akyildiz, 2017, Irmak & Tüzün, 2019, Jang & Tsai 2013, Koh & Sing, 2011), which indicated that a significant difference was established in favor of males in the technological constructs of TPACK. However, the finding is in contradiction from the findings, which find significant gender differences in favor of female pedagogical knowledge (PK) in favor of females (Ergen et al., 2019) and content knowledge (CK) in favor of females in a meta-analysis of 29 studies. Also, the finding does not agree with the outcome of research by Karakaya and Yazici (2017), which indicated that gender did not affect the pre-service science teachers TPACK self-efficacy on material development in Turkey.

Results on gender influence on technological pedagogical knowledge showed no significant difference in student teachers' knowledge. This finding agrees with Aslan and Zhu (2016), who found no significant difference in student teachers' technological pedagogical knowledge. The influence of student teachers' gender on technological content knowledge revealed a significant difference in student teachers' technological content knowledge favoring male student teachers. The finding supports the earlier result of Jang and Tsai (2013), which revealed that males scored higher than females in TPACK dimensions. However, it contradicts the findings of Koh and Sing (2011), which revealed that gender does not have a significant influence on TCK using the exploratory factor analysis. Similarly, it contradicts the findings of Irmak and Tüzün (2019), which revealed that female pre-service teachers had better perceived TPACK than their male counterparts.

Results also revealed no significant difference in student teachers' technological pedagogical and content knowledge. The findings agree with Jang and Tsai (2013) that no significant difference in student teachers' technological pedagogical and content knowledge based on gender. It also aligned with Thinzarkyaw (2020) finding, which indicated no gender difference in the TPACK practices of teacher educators in three Education Colleges in Myanmar. The results indicated that no significant differences exist in the TPACK-based practices of teacher educators based on their gender. However, the findings negate the earlier findings of Ergen et al., (2019) which revealed considerable differences between male and female self-assessment of their TPACK components of technology knowledge (TK) and technological pedagogical knowledge (TPK) in favor of males.

Conclusions, Implications, and Recommendations

This paper explored the moderating effect of gender on the self-perceived TPACK knowledge of final year student teachers in pre-service teacher education programs at three Nigerian universities in Kwara State.

The findings from this study suggest that there are differences in how male and female student teachers assess their knowledge of the TPACK framework in two areas, Technological Knowledge (TK) and Technological Content Knowledge (TCK), in favor of male respondents. However, there were no significant differences between male and female student teachers in Technological Pedagogical Knowledge (TPK) and Technological Pedagogical Content Knowledge (TPACK). These varied findings align with previous studies that have reported inconsistent findings in gender.

This study measured four dimensions of TPACK using a valid instrument. The findings have drawn attention to the need for teacher education institutions to improve their program and reduce the gender gaps established in two TPACK components. Such teacher education curriculum improvement can ensure that graduates from the teacher education institutions have the required knowledge and skills (TK, TPK, TCK, and TPACK), thereby improve their confidence to integrate ICT in instruction. In addition, it is important to bring the pre-service teacher up in line with the changing knowledge and skill brought about by the ever-emerging digital technologies relevant to teaching and learning.

Finally, it is recommended that researchers should explore integrated instruments to measure future TPACK knowledge and skills. Also, the research design should explore in-class observations or recorded classroom experiences to confirm student-teacher TPACK knowledge and skills before graduation.

Limitations

The findings in this study should be considered within some limitations. First is the sample size involving only 529 student teachers in three universities in Kwara State. Therefore, the generalization and the generalizability of the findings to pre-service teachers or in-service teachers may be limited. Furthermore, a self-report questionnaire used for data collection can provide invalid information as some respondents may not answer truthfully. With a self-report, some respondents may not assess themselves accurately, and sometimes wording of the questions might be confusing or open to different interpretations.

Despite the possible limitations, the findings of this study are unique; they shed more light on the pre-service teacher TPACK knowledge. The findings also opened important vistas for the urgent need for reform in teacher education, particularly in technology integration in instruction.

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