



Tpack Level and Tpack Self-Efficacy of Pre-Service Teachers: Implications For An Sdg-Aligned Professional Development Plan

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ABSTRACT

In response to the growing demand for technology-integrated and sustainable education, this study examined the Technological Pedagogical Content Knowledge (TPACK) level and TPACK self-efficacy of pre-service teachers majoring in Bachelor of Technology and Livelihood Education (BTLED) in the Province of Tarlac, Philippines. The study was grounded in the TPACK Framework by Mishra and Koehler and Bandura's Self-Efficacy Theory, which explains the integration of technology, pedagogy, and content knowledge, as well as the role of teachers' confidence in effective teaching. A descriptive design with survey questionnaires was used. Data were analyzed using Pearson correlation. Results revealed a strong positive correlation between overall TPACK and TPACK self-efficacy ($r = .828$, $p < .001$, $N = 89$), indicating that higher TPACK levels are significantly associated with stronger teaching confidence. These findings indicate that higher levels of TPACK are associated with greater confidence in teaching, lesson design, addressing diverse learners, and technology-based assessment. However, specific areas of weakness were identified in both TPACK and self-efficacy, particularly in advanced technology integration and sustained classroom application. Identified gaps guided the development of an SDG-aligned professional development plan to strengthen teacher competence and advance SDG 4. The findings highlight the need for targeted training to enhance pre-service teachers' TPACK and self-efficacy.

Keywords: *technological pedagogical content knowledge (TPACK), TPACK self-efficacy, pre-service teachers, technology integration, sustainable development goals (SDGs), professional development plan*

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INTRODUCTION

Pre-service teachers are individuals who are undergoing formal education and training to become professional educators (Rusznyak et al., 2022). They are enrolled in teacher education programs at colleges or universities, where they gain academic knowledge and practical teaching experience through internships and student teaching. Despite this training, many pre-service teachers experience anxiety and difficulty when applying theoretical knowledge to real classroom situations (Khateeb, 2017). One major challenge pre-service teachers face is classroom management. In line with this, pre-service teachers struggled to manage classroom environments, citing difficulties in controlling student behavior and a lack of confidence in their management skills during practicum (Mkhasibe & Mncube, 2020). Many believe they may struggle to maintain discipline and create a positive learning environment, both of which are essential for effective learning (Lazarides, Buchholz, & Rubach, 2018). This concern is often linked to limited exposure to real classroom situations during training, which affects their confidence and readiness to teach.

Pre-service teachers also face challenges in addressing diverse learners in inclusive and multicultural classrooms. Many feel unprepared to adjust teaching strategies to meet the needs of students with different abilities, learning styles, and cultural backgrounds. In addition, the growing demand for technology integration in education adds another difficulty. Many pre-service teachers struggle to use technology effectively, especially with the rapid shift to digital learning caused by the COVID-19 pandemic (Li et al., 2022; Sepulveda, 2022). This situation increases their concern about meeting educational standards and stakeholder expectations (Abdul, 2021). To address these challenges, studies emphasize the importance of

the Technological Pedagogical Content Knowledge (TPACK) framework in teacher education (Li et al., 2022). TPACK integrates three key knowledge areas: content knowledge, pedagogical knowledge, and technological knowledge, allowing teachers to use technology meaningfully in instruction (Stockless, Villeneuve, Bisaillon, Fournier & Venant, 2022). This framework helps pre-service teachers design lessons that not only deliver subject content but also engage students using appropriate digital tools and innovative strategies (Abdul, 2021). Effective teaching requires understanding how technology, pedagogy, and content interact rather than treating them as separate components Kaleli Yilmaz, G. (2015).

Research indicates that educators with strong TPACK skills are more likely to use technology to promote critical thinking, collaboration, and creativity among students (Duff, 2018). TPACK also prepares pre-service teachers to meet the demands of 21st century education, where technology plays a vital role in the classroom (Lee, 2019). Moreover, the TPACK framework aligns with the United Nations Sustainable Development Goals, particularly SDG 4, which focuses on inclusive, equitable, and quality education for all (Khine, Afari, & Ali, 2019; Falloon, 2020). Through effective technology integration, teachers can help reduce educational gaps and provide equal learning opportunities to students from different socioeconomic backgrounds (Mangubat et al., 2022). Further studies indicate that TPACK also aligns with SDG 9 and SDG 10 by promoting innovation and reducing educational inequalities (Lye, 2013). Technology-supported instruction allows learning experiences to be adapted and scaled across different contexts (Yerdelen-Damar, Boz, & Aydın-Günbatır, 2017). When teachers use technology to differentiate instruction, they can better address individual student needs and help reduce educational disparities within and between countries (Tovar-Viera, 2020). This approach supports problem-solving and innovation-based learning, which are essential for education systems facing future challenges (Credé, et al., 2011).

Despite extensive research on TPACK and teacher self-efficacy, limited empirical studies have examined their interrelationship within the context of Sustainable Development Goal (SDG) alignment, particularly among pre-service TLE teachers in Philippine higher education institutions. This gap underscores the need to investigate how TPACK competencies relate to self-efficacy beliefs in promoting SDG-oriented teaching practices.

Several studies also emphasize the role of pre-service teachers as future nation builders and agents of change. Integrating TPACK into teacher education equips them to address social issues such as inequality, climate change, and social justice, which are central to the Sustainable Development Goals (Gunuc, 2017). When teacher preparation is aligned with TPACK and the SDGs, pre-service teachers not only improve their professional competence but also contribute to building a more sustainable and just society (Birch & Miller, 2007; Sepulveda, 2022). Despite existing research on TPACK and sustainable education, there is dearth on those examining the levels of TPACK and TPACK self-efficacy among pre-service teachers in relation to the Sustainable Development Goals. This gap highlights the need to assess how well future teachers are prepared to integrate technology, pedagogy, and content to support inclusive, high-quality education. Therefore, the purpose of this study is to assess the TPACK levels and TPACK self-efficacy of pre-service teachers and determine their alignment with the Sustainable Development Goals, particularly SDG 4. The findings of this study are significant as they can help identify gaps in teacher preparation programs and guide the development of SDG-aligned professional development initiatives. Ultimately, this study aims to strengthen future teachers' readiness to meet the demands of 21st century classrooms and contribute to the global goal of quality education for all.

METHOD

Research Design

The study employed a descriptive survey design to examine the levels of TPACK and self-efficacy among pre-service teachers. (A research strategy known as the descriptive method seeks to systematically describe a phenomenon, event, or condition as it currently exists. This approach is beneficial for gathering comprehensive data on present practices and conditions in educational research). Using a descriptive approach,

this study aims to accurately depict the TPACK and self-efficacy levels of pre-service TLE teachers in order to identify areas that may require further training. (According to Creswell (1994), the descriptive research method is intended to gather information about current conditions. In this context, this involves assessing pre-service teachers' technological, pedagogical, and content knowledge, as well as their level of confidence in using these skills in the classroom). This method enables the collection of quantitative data, providing a comprehensive understanding of respondents' current TPACK status. By examining these existing conditions, the study aims to generate meaningful insights that can guide the development of targeted professional development programs aligned with the Sustainable Development Goals (SDGs), ultimately enhancing the effectiveness and preparedness of future TLE educators.

Research Locale

The study was conducted at Tarlac Agricultural University and Tarlac State University, the only HEIs offering the BTLEd program in the province of Tarlac (Commission on Higher Education, Regional Office III, 2024).

Research Participants

The respondents of the study consisted of eighty-nine (89) pre-service teachers, specifically third-year Education students enrolled in the Bachelor of Technology and Livelihood Education (BTLEd) program at Tarlac Agricultural University (TAU) and Tarlac State University (TSU). These students were selected because they had not yet undergone practice teaching, ensuring that prior teaching experience would not influence the results of the study. The sample size was determined using Slovin's formula. A simple random sampling technique was employed to select the respondents. The list of eligible third-year BTLEd students from both universities served as the sampling frame, and respondents were randomly selected to ensure that each student had an equal chance of being included in the study.

Research Instrument

The study utilized two research instruments for pre-service teachers: a TPACK Level questionnaire and a TPACK Self-efficacy questionnaire. The questionnaires were adapted from the study by Schmidt et al. (2009), which examined TPACK levels among pre-service teachers, and from the study by Kiray, S. A. (2016), which measured TPACK self-efficacy.

The research instrument adapted has undergone face and content validity by the experts. Expert review ensured content and face validity, confirming the clarity, relevance, and appropriateness of the items. Construct validity was established by mapping the items to the TPACK domains Technological Knowledge, Pedagogical Knowledge, Content Knowledge, and Technological Pedagogical Content Knowledge as well as to TPACK self-efficacy.

Data Gathering Procedure

The initial step in the data-gathering process involved securing the necessary permissions to conduct the study. A formal letter of request was sent to the Deans of the Colleges of Education of both Tarlac Agricultural University and Tarlac State University, seeking approval to conduct the research among third-year Bachelor of Technology and Livelihood Education (BTLEd) students. Once approval was granted, the researcher prepared and sent letters of communication to the heads of the Higher Education Institutions (HEIs) involved in the study. These letters explained the purpose of the research and requested permission to administer the survey questionnaires to the identified respondents. Upon receiving approval from the HEIs, the researcher proceeded with the actual data collection. A modified survey questionnaire designed to assess pre-service TLE teachers' self-efficacy and TPACK levels served as the primary data-gathering instrument. Depending on what was most practical and appropriate given each institution's circumstances, the questionnaires were distributed to respondents either in person or via online platforms. The researcher

remained available to address any questions or concerns from the respondents and provided clear instructions for completing the questionnaire. The respondents were given sufficient time to complete the questionnaires, ensuring that the collected data accurately reflected their actual attitudes and competencies. After the data were gathered, the researcher organized and systematically analyzed them. The results were carefully reviewed and interpreted, with emphasis on identifying the respondents' strengths and areas for improvement. The findings of the data analysis served as the basis for developing a professional development plan to enhance the respondents' TPACK competencies. Aligned with the Sustainable Development Goals (SDGs), this plan was designed to address the specific needs identified in the study and ensure that pre-service TLE teachers are well-equipped to integrate technology into lesson planning effectively.

Data Analysis Procedure

The unit of analysis consisted of eighty-nine (89) third-year TLE pre-service teachers from Tarlac Agricultural University and Tarlac State University enrolled during the first semester of Academic Year 2024 2025. The data collected in this study were analyzed using appropriate statistical tools. Pearson product moment correlation was employed to determine the significant relationship between the variables. The research instrument underwent content and face validation by experts to ensure the relevance, clarity, and appropriateness of the questionnaire items. The responses of the participants were measured using a four-point Likert scale with the following values: 4-Distinguished Knowledge, 3-Highly Proficient Knowledge, 2-Proficient Knowledge, 1- Beginning Knowledge.

RESULTS AND DISCUSSION

TPACK Level of Pre-service Teachers

TPACK integrates technology, pedagogy, and content knowledge to ensure the effective use of technology in classroom instruction (Stockless, et.al., 2022), the mastery among pre-service teachers is essential for promoting high student engagement through technology-enhanced teaching (Abdul, 2021). Table 1 presents the TPACK levels of pre-service teachers, reflecting their understanding of technology integration, mastery of TLE content and skills, and pedagogical ability to deliver engaging, practical lessons in future classrooms.

Table 1. TPACK Level of Pre-service Teachers

Indicators	Mean	Interpretation
a. Technological Knowledge (TK)	2.86	Highly Proficient Knowledge
b. Pedagogical Knowledge (PK)	2.74	Highly Proficient Knowledge
c. Content Knowledge (CK)	2.69	Highly Proficient Knowledge
d. Technological Pedagogical Content Knowledge (TPACK)	2.76	Highly Proficient Knowledge
Grand Mean	2.76	Highly Proficient Knowledge

Legend: 3.25 – 4.00 Distinguished Knowledge, 2.51 – 3.24 Highly Proficient Knowledge, 1.75 – 2.50 Proficient Knowledge, 1.00 – 1.74 Beginning Knowledge

All component areas and the overall grand mean fall within the range of 2.51–3.24, corresponding to Highly Proficient Knowledge. This indicates that, as a group, the pre-service teachers demonstrate solid foundational knowledge across all domains and have the capacity to consistently demonstrate and share their knowledge in collaborative contexts (Ramos et al., 2020). However, the results also highlight areas that would benefit from further enhancement, particularly in reinforcing TPACK integration. In terms of Technological Knowledge (TK), pre-service teachers obtained a mean of 2.86, which is verbally described as Highly Proficient. This indicates a firm grasp of digital tools and technologies relevant to teaching. While they are confident in using technology, they would benefit from additional support in selecting and applying technology in pedagogically sound ways. The mean rating for Pedagogical Knowledge (PK) is 2.74, also described as Highly Proficient. The respondents exhibit a strong understanding of teaching strategies, classroom

management, and student learning processes. This level of competence suggests readiness for classroom practice, though continued development is encouraged to integrate technological tools further.

For Content Knowledge (CK), the mean rating was 2.69, which falls within the Highly Proficient Knowledge range. Pre-service teachers possess adequate subject-matter knowledge that they can apply in instructional contexts; however, enhancing the depth and contextual application of this knowledge remains an important developmental area. The mean TPACK rating is 2.76, indicating a Highly Proficient level. This indicates that the ability to integrate technology with pedagogy and subject matter is well established among the respondents, though not yet at a distinguished level. Targeted activities that promote the seamless integration of these domains are recommended to further enhance their competence (Malik, 2019).

Overall, the TPACK level of pre-service teachers had a grand mean of 2.76, indicating Highly Proficient Knowledge. This suggests that pre-service teachers are performing at a highly proficient level across all domains of the TPACK framework and show strong potential to become effective 21st-century educators. However, to attain Distinguished Knowledge, enhancements that focus on deeper integration, contextual application, and strengthening self-efficacy in using the TPACK framework are encouraged. As emphasized by Malik et al. (2019), developing TPACK requires intentional and experiential learning opportunities in which teachers design and deliver instruction that simultaneously addresses what to teach (CK), how to teach (PK), and how technology can enhance the teaching process (TK).

TPACK Self-efficacy of Pre-service Teachers

This section presents the results of the TPACK self-efficacy levels of pre-service teachers, focusing on their readiness and confidence in integrating technology into classroom instruction, as reflected in their mean ratings across various TPACK self-efficacy domains. Understanding these self-efficacy levels is essential, as they influence teachers' readiness to implement technology-enhanced learning and guide future professional development initiatives (Schmidt et al., 2009). Table 2 summarizes their readiness within the TPACK framework.

Table 2. TPACK Self-efficacy of Pre-Service Teachers

Indicators	Mean	Interpretation
a. Confidence in integrating technology into pedagogy	2.76	Highly Proficient Knowledge
b. Ability to design lessons that incorporate TPACK principles	2.46	Proficient Knowledge
c. Effectiveness in using technology to support diverse learners	2.48	Proficient Knowledge
d. Competence in assessing student learning through technology	2.72	Highly Proficient Knowledge
Grand Mean	2.60	Highly Proficient Knowledge

Legend: 3.25 – 4.00 Distinguished Knowledge, 2.51 – 3.24 Highly Proficient Knowledge, 1.75 – 2.50 Proficient Knowledge, 1.00 – 1.74 Beginning Knowledge

The results indicate that TPACK self-efficacy reflects pre-service teachers' willingness to integrate technology into teaching, with mean scores ranging from Beginning to Distinguished Knowledge on a four-level scale. Overall, pre-service teachers demonstrated a Highly Proficient level of TPACK self-efficacy, particularly in their confidence in integrating technology into pedagogy ($M = 2.76$) and in assessing student learning through technology ($M = 2.72$). These findings suggest a strong foundational understanding of the TPACK framework and align with studies emphasizing that familiarity with technological tools enhances self-efficacy (Bandura, 1997). However, reaching a distinguished level requires deeper engagement with global best practices and more consistent application across diverse classroom contexts (Altun, 2019).

In contrast, the ability to design lessons that incorporate TPACK principles ($M = 2.46$) and the effectiveness of using technology to support diverse learners ($M = 2.48$) were both rated at the Proficient Knowledge level. These lower ratings indicate challenges in translating TPACK understanding into effective lesson design and in adapting technology to address diverse learner needs. Consistent with the existing

literature, pre-service teachers often struggle to apply TPACK holistically in instructional design, underscoring the need for guided workshops, collaborative planning, and inclusive technology training. As emphasized by Basham, Hall, and Stahl (2016), equipping teachers with pedagogical and technological strategies is essential for creating equitable, learner-centered environments. Overall, the grand mean of 2.60 confirms that pre-service teachers perceive themselves as highly proficient in TPACK self-efficacy, yet specific areas require targeted enhancement. Structured learning experiences, including hands-on assessment practices, inclusive technology integration, and experiential lesson design, are recommended to strengthen weaker dimensions. As noted by Voogt et al. (2013), engaging pre-service teachers in real-world teaching applications is crucial for deepening their technological assessment skills and overall TPACK competence, providing a strong basis for future professional development initiatives.

Relationship between TPACK Level and TPACK Self-efficacy

The Pearson correlation analysis revealed a statistically significant and strong positive relationship between TPACK Level and TPACK self-efficacy ($df = 87$, $p < .001$). This result indicates that teachers with higher levels of technological pedagogical content knowledge tend to possess greater confidence in their ability to integrate technology effectively into instructional practices. The strength of this relationship suggests that TPACK is closely associated not only with teachers' knowledge structures but also with their beliefs about their professional competence in technology-enhanced teaching. Consistent with related research, these results align with findings that well-trained teaching assistants enhance teachers' efficiency and self-efficacy, which may contribute to improved educational outcomes (Villarama et al., 2024). By strengthening instructional support and professional competence, educational institutions can empower teachers and foster a more resilient and effective educational environment.

Table 3. TPACK Level and TPACK Self-Efficacy of Pre-service Teachers

Variables	1	2
1. TPACK Level	-	-
2. TPACK Self-efficacy	.828	-

Note. $N = 89$. Values represent Pearson's r .

$df = 87$.

$**p < .001$

This finding strongly supports the TPACK framework proposed by Mishra and Koehler (2006), which conceptualizes effective technology integration as the intersection of technological, pedagogical, and content knowledge. As teachers develop more coherent and integrated knowledge across these domains, they are better equipped to make informed instructional decisions, leading to increased confidence in planning, implementing, and evaluating technology-supported learning activities (Koehler & Mishra, 2009; Voogt et al., 2013).

From a psychological perspective, the significant association between TPACK Level and self-efficacy is consistent with Bandura's (1997) social cognitive theory, which emphasizes that self-efficacy develops through mastery experiences and successful performance. Teachers with higher TPACK levels are more likely to experience successful technology integration in real classroom contexts, reinforcing their belief in their instructional capabilities. These repeated mastery experiences contribute to sustained confidence and willingness to innovate with instructional technologies (Bandura, 1986; Tschannen-Moran & Hoy, 2001).

Empirical studies further support this relationship, demonstrating that teachers' self-efficacy in technology use is more strongly influenced by pedagogically grounded knowledge than by technical skills alone. Research has shown that when teachers understand how technology aligns with instructional goals, learner needs, and assessment strategies, their confidence and effectiveness increase significantly (Chai et al., 2013; Scherer et al., 2018). This explains why higher TPACK levels consistently predict stronger self-efficacy beliefs across diverse educational contexts.

Moreover, the findings align with prior studies indicating that teachers with strong TPACK are more likely to adopt innovative teaching practices, persist in the face of instructional challenges, and demonstrate positive attitudes toward educational technology integration (Graham et al., 2009; Wang et al., 2018). This suggests that strengthening TPACK may serve as a foundational mechanism for enhancing teachers' confidence, instructional quality, and long-term engagement with technology-supported pedagogy.

Overall, the significant relationship between TPACK Level and TPACK self-efficacy underscores the importance of integrated, pedagogy-focused professional development. Teacher education programs should prioritize authentic learning experiences that allow teachers to design, implement, and reflect on technology-integrated instruction, as these experiences are critical in fostering both TPACK development and self-efficacy. Emphasizing the interconnected nature of knowledge and belief systems may lead to more sustainable and meaningful technology integration in educational settings.

Within the Philippine educational context, the importance of strengthening teachers' TPACK has been emphasized in recent studies examining technology integration in teacher education. Research in Philippine schools indicates that developing TPACK competencies improves teachers' readiness and confidence to implement technology-enhanced instruction and digital learning strategies in contemporary classrooms (Aziez, F., et al., 2025). Similarly, studies in teacher education institutions highlight that integrating technology within pedagogical training enhances pre-service teachers' preparedness for modern teaching environments and supports the development of 21st-century teaching skills (Tamoria, F. V., 2016). These findings suggest that strengthening TPACK among future educators is essential in addressing the evolving technological demands of the Philippine education system.

Institutional policy implications

From an institutional and policy perspective, the results imply that teacher education institutions should prioritize TPACK-oriented training and technology-integrated coursework in their curricula. Providing authentic learning experiences, such as designing digital learning materials, implementing technology-supported lessons, and engaging in reflective teaching practice, can help develop both knowledge and self-efficacy among pre-service teachers. Previous studies emphasize that structured TPACK-based training and technology-rich learning experiences significantly enhance teachers' competence and confidence in integrating digital tools into instruction (Mishra & Koehler, 2006). In the Philippine context, research has shown that strengthening teachers' TPACK competencies improves their capacity to implement technology-supported instruction and adapt to digital and distance learning environments (Tamoria, F. V., 2016). Studies involving Filipino pre-service teachers also highlight that developing TPACK contributes to the enhancement of 21st-century teaching skills and readiness for modern technology-mediated classrooms (Soncio et al., 2024). Strengthening these competencies may therefore support the broader goal of improving instructional quality and promoting sustainable technology integration in Philippine classrooms.

CONCLUSIONS AND RECOMMENDATION

Based on the study's results, several conclusions were drawn. Results revealed significant and strong positive relationships between all components of TPACK (technological, pedagogical, content knowledge, and overall TPACK) and all dimensions of self-efficacy ($df=87$, $p < .001$). These findings indicate that higher levels of TPACK are associated with greater confidence in teaching, lesson design, addressing diverse learners, and technology-based assessment. The study also identified significant challenges encountered by teachers, including the need for specific training in TPACK integration, poor internet connectivity and technological issues in the classroom, difficulties in designing educational projects from a sustainability perspective, and adapting teaching styles to different types of learners. Based on these findings, an SDG-aligned professional development plan was developed, consisting of nine key areas: significant findings, content areas, objectives, teaching methods, persons involved, time frame, estimated budget, success indicators, and integration of the Sustainable Development Goals (SDGs).

Moreover, the study advances the discourse on education for sustainable development by proposing an SDG-aligned professional development framework that integrates TPACK competencies with sustainability-oriented teaching practices. In particular, the framework supports the advancement of Sustainable Development Goal 4 (Quality Education) by promoting inclusive, innovative, and technology-enabled learning environments. Overall, the study highlights the need for teacher education institutions to strengthen TPACK-oriented training and sustainability-focused pedagogical practices to prepare future educators for the demands of 21st-century and sustainable education systems. Future research may further explore the long-term impact of TPACK-oriented professional development on teachers' instructional practices and student learning outcomes, and examine how sustainability-focused technology integration can be effectively implemented across diverse educational contexts.

Credit authorship contribution statement

Mark Lawrence Y. Dupitas was solely responsible for Conceptualization, Methodology, Formal analysis, Data curation, Writing – original draft, Writing – review & editing, and Funding acquisition.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Ethical Declaration

All participants provided informed consent before participation. They were informed of the study's purpose and procedures and of their right to withdraw at any time without penalty. Ethical approval for the study was obtained under Ethical Clearance Certificate UREC-1130.

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