International Journal of Interdisciplinary Viewpoints
ISSN: 3082-5318(Print) 3082-5326(Online)
Journal Homepage: edukar.net/ijiv

Technological, Pedagogical, and Content Knowledge as a Predictor of Mathematics Pre-Service Teachers' Teaching Competency: A Multiple Regression Analysis

Rolando Bayo Jr.[1*], Romulo G. Doronio[2]
[1]Davao de Oro State College, Philippines
[2] Assumption College of Nabunturan, Philippines
Corresponding Author's Email: ck.7bayo@gmail.com

How to cite:
Bayo Jr. R., & Doronio, R. G.* (2025). Technological, Pedagogical, and Content Knowledge as a Predictor of Mathematics Pre-Service Teachers' Teaching Competency: A Multiple Regression Analysis. *International Journal of Interdisciplinary Viewpoints, 1(3),165-196.

Research Article
Received: 29 May 2025
Revised: 14 Jun 2025
Accepted: 29 Jun 2025
Available: 15 Jul 2025

Keywords:
Mathematics Teaching
Teaching Competency
Pre-service Teachers

ABSTRACT
The paper looked at how Technological Pedagogical and Content Knowledge (TPACK) changes the way that Davao de Oro State College math teachers-to-be teach math. We talked to 70 people who wanted to be teachers and used a descriptive-correlational method to get their information. One looked at their TPACK in seven areas, and the other was a sample teaching number that we used to grade their teaching skills. The people who took part in the study trained very well and used TPACK a lot. What they knew about TPACK as a whole was strongly linked to how well they could teach. As could be seen, it was very important to know how to teach content, know how to use technology, and know how to teach content. It's important to teach people who want to be teachers everything they need to know about tools, technology, and how to teach. TPACK training should keep getting better, according to the study. This can be done by focusing on these important areas in hands-on classes, lessons that are tailored to each student, and real-life teaching experiences.

INTRODUCTION

Education serves as a fundamental pillar in the development of a nation, with the educational system's quality largely dependent on teachers' competencies in the classroom. These teachers significantly shape where the public goes and what it does in the future. (Kumar & Arora, 2023). In addition, teaching competency is a broad term affected by academic, social, and psychological factors. According to Mishra & Koehler (2006), teaching competency involves using the combination of Technological Knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK) in making the students' learning significant. This highlights that teachers now support students by blending these three knowledge areas to handle the many different and fast-changing needs in the 21st century. Moreover, teaching is an art and science because this profession faces many challenges. Teachers lead in providing qualitative education (Prada & Gonzales, 2014).

Despite the critical role of quality teaching, the primary, secondary, and university levels face a crucial challenge in rarely meeting the standards demanded by the new global economy (Johnson et al., 2023). These challenges affect several countries, including Asia, Western world, and substantial portions of Sub-Saharan Africa, especially in public schools (Ibanda Municipality Education Office, 2021; Kalule & Bouchamma, 2013; Kiiru, 2015), and one of the factors is the lack of competent teachers. For instance, Indonesian teacher quality is still low regarding competency, content knowledge, and pedagogical skills (Rosser & Fahmi, 2018). A difference in how well-trained teachers are can make learning difficult for students and result in lower student achievement (Kanya et al., 2021). Similarly, the Philippines has not been exempted from this educational crisis.

The latest survey of PISA 2022 showed that the Philippines was sixth from the bottom with an average score of 355 in mathematics competency (Montemayor, 2023). This poor performance in math highlights how urgently reforms are needed throughout the country's schools. This also points out what many experts have been saying for a while—the education system in the country is in distress. Accordingly, it was discovered that Filipinos perform at the starting level in mathematics (Cordova & Tan, 2018). The need for significant changes, especially in mathematics education, is highlighted by this dismal performance, ascribed to several causes, including the caliber of the teachers. A report of the World Bank on the Pacific region and East Asia states that the teachers in the Philippines have one of the least effective methods in Southeast Asia, and teacher training programs did not affect the mastery of their content (Chi, 2023). It shows that the main challenge in improving education, particularly mathematics, arises from inadequate teaching strategies and the lack of proper teacher training, which requires special actions to enhance teacher skills and content proficiency. In this context, students' perceptions of mathematics can be affected by how much the teacher guides them, which is connected to their teaching abilities and strongly affects students' achievement (Waseka et al., 2016).

In Davao De Oro State College New Bataan, BSED Mathematics students find it difficult to use technology, teaching strategies, and mathematical content simultaneously in lessons, a challenge shown by the TPACK framework. Even though the model links content, teaching, and technology, many students have challenges linking these fields. They can have deep subject knowledge without the ability to use the proper teaching methods or knowing how technology supports teaching and learning. These challenges suggest that while students may be exposed to the TPACK framework, they often lack sufficient practical opportunities to develop and apply these competencies in real classroom settings. If teachers do not connect theory and practice well, it could become difficult for them to plan educational and innovative lessons, which underlines the importance of more support and training in teacher preparation courses. This study examines how TPACK components predict the teaching competency of Mathematics Education students. Using multiple regression analysis, the study will identify which aspects of TPACK are most strongly associated with teaching performance, providing insights to enhance teacher preparation for technology-integrated instruction.

Literature Review

Technological Pedagogical and Content Knowledge (TPACK) concept was developed in 1986-1987, as explained by Mishra and Koehler (2006). This expertise describes the science involved in technology, education, and different fields, and its use in teaching. TPACK's technology integration into the PCK model is one of its best features (Santos & Castro, 2021). TPACK is further meant to show the various types of knowledge that teachers need to use technology effectively (Schmidt-Crawford & Thompson, 2020). For technology to be effective in classroom teaching, technology integration should be carried out consciously, and teachers should carefully plan their lessons (Gunuc & Babacan, 2017). This implies that there is a change in how teachers deliver their content. Research and practice in teacher education heavily use the TPACK framework (Zhang & Tang, 2021), mainly to measure teachers' skills and improve them through suitable professional development (Chai et al., 2013). Several studies have shared samples and plans for supporting TPACK in teacher education (Voogt et al., 2013; Wang et al., 2018), all of which emphasize strong planning of lessons that use technology knowledgeably. The TPACK model can surpass the typical simplification of treating digital tools as simple additions to traditional lessons. It focuses on how learning and teaching relate, the learning objectives, and technology's role (Chai et al., 2013). Still, there have been some negative views about the model, even though it is highly praised. Identifying the knowledge dimensions and explaining their links is contentious (Graham, 2011; Kimmons, 2015). Many have examined TPACK's effects on teachers' beliefs (Krauskopf & Forssell, 2018). Many researchers also have looked at TPACK about planning lessons (Bilici et al.,2016), about teachers' use of technology (Agyei & Voogt, 2011; Chuang et al., 2015; Heitink et al., 2016; Schmidt-Crawford et al., 2017), and finally, at TPACK in relationship to student learning outcomes (Kopcha et al., 2014; Akyuz, 2018; Krauskopf & Forssell, 2018). Despite these challenges, teacher education programs still find TPACK a meaningful framework, even with these problems. Attention to teacher training has shown that using technology with what and how to teach is essential (Koehler & Mishra, 2009). Experience shows that using TPACK during teacher training leads to stronger skills and greater confidence in using technology (Chai et al., 2023; Voogt et al., 2013). TPACK makes it easier for us to identify the knowledge teachers require to include technology in instruction and the ways they could gain or develop these skills (Voogt et al., 2013). TPACK helps improve how teachers teach mathematics with technology. Much research has demonstrated that TPACK can assess teacher knowledge, help design professional development programs, and improve instruction (Kartal & Cinar, 2022; Orlando & Attard, 2015). Ideas in math are easier to grasp when using technology, so teachers must use technology, teaching practices, and math together (Bonafini & Lee, 2021; Scott, 2021). TPACK has been explored in different topics and settings from individuals who are being prepared to teach science (Kadıoğlu-Akbulut et al., 2020), to secondary English educators (Greene & Jones, 2020), and building devices (Wang et al., 2018). Polly (2011b) and Niess et al. (2014) have shown that the TPACK framework can meaningfully contribute to studying professional development and technology use in math classrooms. TPACK is still essential for advancing mathematics by guiding teachers to use technology more effectively in classrooms (Li et al., 2024).

Technological Knowledge (TK). TK helps teachers understand the use of technology when they teach according to the TPACK model (Willermark, 2018). TK is generally accepted as broadly defined, including many different tools from traditional instructional technologies such as chalkboards to modern instructional technologies such as social robots (Petko, 2020). Still, there has been criticism toward the definition of what " technology " means in teaching for the lack of definition of TK in the TPACK model (Angeli & Valanides, 2009; Graham, 2011). This unclear definition has led to some concern about its connection to CK and PK. Despite its criticism, research has shown that it is relevant for teachers to have TK to increase their confidence and capacity in using technology in their lessons (Knezek & Christensen, 2015). For teachers to effectively facilitate digital activities, it is a vital factor that needs to be explored more in teacher education (Jang & Chen, 2010). TK is even more important in preservice teacher education for developing teaching competency. According to Petko et al. (2017), feeling supported by teacher education institutions during their preparation boosts both preservice teachers' technology knowledge and confidence in using it. Besides, successful teacher education courses include practical work demonstrating how digital tools are used and help trainees learn by doing (Tai & Crawford, 2014). The New Zealand curriculum illustrates how Digital Technologies (DT) help build computational thinking, a significant part of how we solve problems nowadays (Dong et al., 2019). It is necessary for teachers to design and produce digital solutions, enhancing students' problem-solving capabilities and enabling authentic learning experiences (MOE, 2018). These experiences are essential because they value TK and TPACK, allowing teachers to mix pedagogy, content, and technology (Valtonen et al., 2019). TK's relationship with other knowledge groups in the TPACK framework is also central to the theoretical discussion. According to some research, TK helps to develop TPACK by first impacting TPK and TCK (Schmid et al., 2020). However, a study suggests that improving both TK and PK straightaway leads to better TPACK in the case of in-service teachers, while the argument remains the same for teachers generally (Koh et al., 2013). Because of this approach, the reader can better understand the theories and their meaning. Several research studies indicate that knowledgeable TK teachers can develop lessons that blend technical, teaching, and subject knowledge, which helps them improve their performance in teaching (Koh et al., 2013; Schmid et al., 2020). TK brings essential value to teaching competency by boosting student engagement and allowing for individualized ways of learning. For instance, Sacristan (2021) noted that when students do open-ended technology-based tasks, they become better at math, build their identity, and take charge of their education. It reveals the broader effects TK has on how students do in school. Many studies suggest that well-organized PLD for using digital technologies supports the growth of teachers' digital skills, builds their belief in using new tools, and enhances their confidence (Pargman et al., 2020; Vivian et al., 2020). However, because technology is used differently by each teacher, PLD programs should tailor instruction to their needs and technology targets individually rather than applying a general strategy (Celepkolu et al., 2020). This aligns with the social aspects of education by helping students see how mathematics is relevant in the real world (Neumann et al., 2013; LaMar & Boaler, 2021). As a result, TK in TPACK assists teachers in using theoretical concepts in their teaching and improving how well their students do. Moreover, teachers' confidence and opinions about technology's role in teaching influence their drive to use computer tools. According to Bandura's social cognitive theory, self-efficacy helps explain that more confidence in technology from teachers comes from receiving positive support and having good teaching experiences (Christensen & Knezek, 2020). As a result, educators with stronger TK tend to use technology in Mathematics lessons and are thus more competent in teaching (Rich et al., 2021). While developing TK is essential, we should not ignore the fact that what teachers report knowing is not always clear in their work in class (Willermark, 2018). Young teachers who believe they are ready for their job may not always perform as planned once their teaching begins (Schmid et al., 2020). This difference calls for teacher education programs to have students apply their learning in real teaching settings. If this gap is addressed, preservice teachers can utilize technology in future teaching discussions and improve their teaching approach (Jin, 2019).

Pedagogical Knowledge (PK). PK helps preservice teachers in mathematics prepare so they can apply what they learn to their daily teaching (Mishra & Koehler, 2006). It is widely debated in teacher education that universities give students theory, while actual classroom teaching in schools is necessary for preservice teachers to master teaching skills (Flores, 2016; König et al., 2018). It points out how joining theory with education practice strengthens one's grasp of pedagogy. When preservice teachers are weak in PK, they may not adjust their strategies well to the needs of different students and classroom conditions (European Commission, 2013; König et al., 2020; Delamarter, 2015). New teachers typically lack the routines and knowledge structures experienced educators possess, making it challenging to navigate classroom management and instructional adaptation (Berliner, 2004; Stigler & Miller, 2018). Not being able to relate the things taught in classes to actual classroom work can cause preservice teachers to rely overly on standard, non-flexible teaching methods (Chizhik & Chizhik, 2018; Wolff et al., 2021). This gap emphasizes the need for enhanced PK training within teacher education programs, as effective teaching practices are crucial for fostering student engagement and learning. Research suggests that coursework and fieldwork must be connected to create meaningful links between theory and practice (Clift & Brady, 2005; Ball & Forzani, 2009). However, teacher education's success is currently assessed regarding how well graduates pass the transition into professional teaching (Konig et al., 2024). Notably, Opportunities to learn (OTL) are crucial for forming the experienced knowledge of in-service and preservice teachers (Blömeke et al., 2011; Tatto et al., 2012). This implies that emphasizing PK in teacher education can better equip preservice teachers to implement innovative mathematics practices, enhancing their teaching competency. During the pandemic, among pandemic emergency remote teaching (ERT), many teachers were poorly prepared to teach in various technological modalities such as synchronous, asynchronous, and Bichronous learning environments (Hodges et al., 2020; Bartlett, 2022). The shift from traditional to online formats necessitated reevaluating pedagogical approaches to accommodate these new teaching environments (Kohnke & Moorhouse, 2021). Consequently, since students use various ways to learn online, teachers' PK should increase to cover these methods so they can provide exciting, interactive, and practical learning sessions (Ge & Huang, 2022). Incorporating Bichronous online learning, which combines synchronous and asynchronous modalities, enhances teachers' pedagogical knowledge by enabling real-time interaction and immediate feedback alongside self-paced study (Martin et al., 2020). Working in both ways encourages teachers to explore the subject more deeply and cooperate (Ge & Huang, 2022). The data indicates that Bichronous online learning encourages motivation and success in school, which points to its role in enhancing teacher PK (Utomo & Ahsanah, 2022). Furthermore, the adaptability of Bichronous learning in supporting pedagogical frameworks such as PBL demonstrates its effectiveness in developing teachers' competencies necessary for modern teaching contexts (Coiado et al., 2020). As such, innovative online approaches are needed to help preservice teachers handle different forms of teaching (Mohammadi, 2023). Moreover, using technology effectively in education requires teachers to have specific training in teaching techniques (Hennessy et al., 2022). Research results revealed that the OTPD courses enhance educators' teaching abilities in ways that contribute to greater effectiveness with technology in their classrooms (Kessler & Hubbard, 2017; Mohammadi & Tafazoli, 2022). Through these courses, teachers engage in project-based learning (PBL) to gain teaching practices that enable them to change in a world of schooling (Hirschel & Humphreys, 2021). When teachers increase their PK through OTPD, they can better teach in ways that support technology (Mai et al., 2022).

Content Knowledge (CK). CK means understanding the content teachers have to teach (Mishra & Koehler, 2006). Teachers should learn about the concepts they will cover and why the knowledge type differs in each subject. Many studies have shown that strong CK plays a key role in teaching, especially when teaching mathematics, where understanding abstract concepts is very important (Ball et al., 2008). Through CK, mathematics educators can present ideas, identify and tackle students' misunderstandings, and improve guidance as needed. When students' pedagogy and content work together, teachers can encourage students to grasp the subject more deeply and be more actively involved (Mishra & Koehler, 2006). The relationship between CK, TK, and PK within TPACK is also emphasized. In the work of Chai et al. (2013), CK serves as the foundation for

teachers to choose the right technology for teaching. According to Niess (2005), some student teachers chose not to apply technology because of their usual teaching approach, how challenging it could be to teach students the technology, or a limited understanding of how technology may shape student learning. Moreover, A study proved that teachers need to use skills related to the restrictions and benefits of technology when using technology in their lessons (Abbitt, 2011). If teachers are not experienced with what they are teaching, the use of technology might be ineffective. In addition, Teachers' CK also plays a teacher's role in addressing diverse student needs, which is a key aspect of teaching competency. Teachers with strong CK are better equipped to differentiate instruction, offer multiple representations of mathematical ideas, and scaffold learning for students who struggle with certain concepts (Baumert et al., 2010). Studies have highlighted that the teachers' mastery of CK teachers impacts student performance and engagement in specific subjects (Blazar & Kraft, 2017; Hill et al., 2008). A teacher must understand the essential concepts of math well to help students gain knowledge and become interested in the field (Keller et al., 2017). In other words, TPACK indicates that teachers use knowledge from both technology and their field to create instruction that meets the requirements of each student (Schmidt & Thompson, 2020). This approach is particularly significant in mathematics education, where students often display varied levels of understanding regarding key foundational concepts. Professional development initiatives to enhance CK are essential to improving teachers' instructional practices, especially in STEM subjects. Rwanda has supported continuous teacher training because it helps teachers improve their CK and supports students' success in math and science (Nsabayezu et al., 2023a). The World Bank's initiative in Sub-Saharan Africa similarly underscores the critical need for teachers to deepen their content knowledge to address the poor performance in STEM subjects and foster economic growth (Ejiwale, 2016). Moreover, implementing Rwanda's competence-based curriculum highlights the necessity of continuously updating teachers' CK to meet the teachers' and learners' needs (Ministry of Finance and Economic Planning, 2013). The introduction of Continuous Professional Development (CPD) programs, such as the CPD Certificate in Innovative Teaching Mathematics and Science (ITMS), aims to boost teachers' expertise in content and innovative teaching methods (Nsabayezu et al., 2023).
Adopting this approach helps teachers understand the concepts well and use the right tools, improving their teaching skills overall (Nkundabakura et al., 2023). Besides, students using CK in TPACK are encouraged to reflect deeply on issues they deal with. Good CK in mathematics allows teachers to create learning activities that force students to think about their understanding by using it in innovative ways (Schmidt et al., 2009). Koehler et al. (2013) stated that educators who are confident with content tend to try different technologies and instruction methods. Students who relate their lessons to everyday uses are more interested in mathematics (NCTM, 2018). Teachers who have strong CK can use technology to illustrate the use of math in both our lives and world problems. The activity supports students in better understanding the subject and developing a sense of why they are learning (Boaler, 2016).

Pedagogical Content Knowledge (PCK). Techniques from PCK are needed to support effective teaching in science and mathematics. According to Magnusson and colleagues (1999, discussed by Abell et al., 2009), PCK combines subject knowledge with teaching strategies to present information that appeals to students' previous knowledge and what they are ready to learn. The framework states that teachers must know the subject well and be able to discuss it in a way adapted to the learners' needs and understandings (Alvarado et al. 2015). Since establishing conducive learning environments significantly impacts students' achievements in scientific inquiry and reasoning, these studies have emphasized the importance of PCK (Hofstein & Lunetta, 2004; Wei & Liu, 2018). Research in the past few years has demonstrated that some individual characteristics of teachers, such as their beliefs, self-confidence, and teaching motivation, significantly affect their PCK (Kunter et al., 2013; Yang et al., 2020). For instance, the studies have demonstrated that compared with the teachers who think that students are users of the taught information, the teachers who believe that students are involved in their learning generally develop much more sophisticated PCK (Blömeke et al., 2014). Therefore, promoting positive beliefs and motivations in the teacher training and thus improving PCK and students' learning (Fukaya et al., 2024). Research has also demonstrated that providing cultural and linguistic information benefited teachers by helping them to enhance student learning (Flores & Rosa, 2015). Safe from their positionality and the social implications of their teaching practices, educators are more likely to engage students in conversations about race, language, and math (Weldon, 2012). Regarding mathematics education, preservice teachers who hold PCK are more likely to design lessons that recognize and incorporate the language use of pre-students, which will help engage students and deepen their understanding (Baker-Bell, 2020a, 2020b). Sedlacek et al. (2023) concluded that using research and expertise leads to significant advancements in mathematics education teaching. Having pre-service teachers contemplate their teaching and views about language will result in mathematics teaching that values all students and increases the likelihood of students learning (Baker-Bell et al., 2020). Pedagogical content knowledge (PCK) and practical work are two hot topics in research nowadays, considering how to show the advantages of practical work for students' understanding of more sophisticated ideas. Using practical work in science teaching is based on four categories of practical work: confirmatory, exploratory, discovery, and problem-based (Chen & Eilks, 2019). This practical work enriches students' understanding of theoretical knowledge and helps students to develop other skills like critical thinking and inquiry learning (Tacoshi & Fernandez, 2014). In addition to that, the usefulness of practical work depends on the PCK of teachers because they are the ones who should be able to design, carry out, and assess real tasks that serve learning objectives (Abrahams & Millar, 2008; Chen et al., 2022). This relationship is significant for good teaching, mainly for the teachers because they are in training and working on the instructional approach. Moreover, research has demonstrated that testing and validating tools that measure PCK provide information about how teachers reflect on their experience and teaching relevant to any training they may have experienced (Irmak & Yilmaz Tuzun, 2019; Chen & Chen, 2021). For instance, this research validated a questionnaire that measures high school science teachers' perceptions of PCK and its impact on the design and implementation of practical work (Vargas et al., 2023). The tool's validity was due to the high internal consistency (Cronbach's alpha = .881), which was used to guide reflection on classroom teaching (Alneyadi, 2019). The implications of this line of research can be found in mathematics education, as knowing how TPACK relates to PCK will enhance the skills of beginning mathematics teachers and assist them with their teaching.

Technological Content Knowledge (TCK). One of the most important in TPACK is TCK, which means teachers should know how technology can represent the content of the subjects, and the learning becomes more comprehensible to the students (Mishra & Koehler, 2006; Chai et al., 2011). It is essential to teach mathematics, as many students face difficulties with the ideas of mathematics. Using TCK in their lessons, the teachers can present the mathematics in many ways to cover the learning preferences and increase the understanding (Jang & Tsai, 2012). According to the studies, teachers use technology more for administrative purposes, such as preparing lessons or searching for resources online. They are not using technology to increase the learners' learning (Kartal & Cinar, 2018). Teachers should understand TPACK better when teaching a math class lesson. When the teachers are competent in TPACK, they are more likely to create a learning environment that would help the students to learn more by engaging in the learning and increase the teaching competency (Schmidt et al., 2009). When the teachers are competent in TCK, they can find more effective ways to engage students and help them learn the mathematics topics that are not easy (Jang & Chen, 2010). Much research investigates the advantages and roadblocks teachers face when teaching with TCK students. For example, research has reported that preservice teachers have difficulty identifying the differences between TPK, TPACK, and TPACK elements (Dikkartin-Ovez & Akyuz, 2013). Research also builds on this difficulty by stating that preservice teachers in mathematics initially considered technology primarily as a visualization tool, i.e., facilitating diagram folding and creation with dynamic geometry software to simplify it (Kartal & Cinar, 2018). Teachers can use technology efficiently, but have difficulty integrating it into their math classes to enhance student learning. Moreover, the research highlighted that combining TCK with PCK was essential for fostering effective mathematics instruction incorporating technology (Kaya & Dag, 2013). If teachers were strong TCKs, they could alter their technological equipment to meet the needs of the area, which encouraged students to be more engaged and learn more. Furthermore, how much progress TCK sees depends on the degree of technology exposure teachers receive during their preparation in college and in school. Petko et al. (2017) explain that educational institutions help future teachers develop their TCK by allowing them to work with technology in a safe environment. Research suggests that preservice teachers who observe and engage in technology-enhanced learning environments tend to have more positive attitudes toward technology integration in their future teaching practices (Nelson & Hawk, 2020). When teachers use TCK in practice for teaching, teachers use technology for teaching better and more confident (Wang et al., 2018). However, making teachers use their TCK in real teaching is still hard. Different research points out a problem in teachers' TCK: Teachers have a high reported TCK score, but cannot use their TCK knowledge to teach in real teaching situations (Willermark, 2018; Jin, 2019). So, further research stresses that teacher education programs should give information and practical opportunities with technology to learn how to use technology well in any subject area (Jin, 2019).

Technological Pedagogical Knowledge (TPK). Technology integration can support the traditional strategies of teaching by combining educational and technological expertise (Mishra & Koehler, 2006). This structure follows principles of discovery learning, allowing students to use technology to learn about mathematics independently (Kim, 2018). According to the study, TPK increases the confidence level of teachers to use technology during the lesson (Herring et al., 2016). Furthermore, teachers with high TPK can potentially use different kinds of instructional technologies to support their teaching and learning to reach pedagogical goals that promote the overall implementation of technology in mathematics teaching (Kim, 2018; Hidayat et al., 2024). It can be concluded that the level of TPK may affect future trainers' views on the importance of technology. Research findings reveal that when teachers learn TPK, they can use ICT to engage students, give immediate feedback, and produce authentic learning environments to explore and understand (Leendertz et al., 2013). Leendertz et al. (2013) stated that using ICT in mathematics lessons makes everything more efficient, asks students to learn by doing, and gives immediate responses to students, enhancing their learning. However, teachers have different levels of ICT skills and other beliefs on traditional teaching methods, which hinders them from effectively using ICT (Ling Koh et al., 2014; Morsink et al., 2011). Therefore, professional development programs must involve reflection and teamwork and match with teachers' situations to help technology-enhanced pedagogy become an ongoing part of their teaching (Polly & Hannafin, 2011). Learning new skills and adopting new approaches is vital for teachers to maintain their TPK and fit into today's schools (Beswick, 2007). Adding technology to mathematics is easier and results in greater student engagement and better learning, thanks to TPK (Özdemir & Tabuk, 2004). Learning how to use technology should go hand in hand with finding effective ways to incorporate these tools into classroom teaching to explain better school topics (Akkoç et al., 2008). Following the TPACK framework, TPK recommends that teachers use technology, teaching methods, and learning content together for the best possible results (Mishra & Kohler, 2006). This approach has shifted education from traditional methods to innovative practices, where technology supports deeper mathematical understanding and teaching process management (Ersoy, 2003; Dursun & Peker, 2003). Thus, teachers with strong TPK are better prepared to address the modern educational demands of the 21st century (Lai & Bower, 2019). Cariaga and colleagues' research from 2022-2024 provides valuable context for the current study on the influence of Technological Pedagogical and Content Knowledge (TPACK) on the teaching capacity of Davao de Oro State College's preservice mathematics teachers. Cariaga's (2022) study on mathematics education during the pandemic is consistent with current research aims, emphasizing the need of adaptive and technology-integrated teaching strategies during times of disruption. Furthermore, Cariaga's (2023) complete picture of the Philippine education system and its future direction supports the present study's emphasis on curricular alignment and teacher training changes that promote digital pedagogy and innovation. Cariaga's 2024 work emphasizes 21st-century skills like as critical thinking, cooperation, and creativity, which aligns with the TPACK framework, which encourages the integration of such competencies via proper use of technology and subject knowledge. Furthermore, Cariaga and El Halaissi's (2024) research on design thinking and culturally responsive education broadens the discussion to include global and employability contexts, reinforcing the idea that teacher education should prioritize not only content delivery but also broader competencies that prepare students for real-world challenges. Cariaga, Pospos, and Dagunan's (2024) qualitative research on the use of ICT and creative teaching strategies in rural education backs up the present findings, especially the emphasis on Technological Knowledge (TK) as a significant predictor of teaching ability.

Teaching Competency. The influence of Teaching Competency on the success of learning methods is considered increasingly important, especially in creative teaching (Koster & Dengerink, 2008). Promoting an innovative and creative classroom relies on fully grasping competency, which helps teachers assist students in constructing knowledge (Rinkevich, 2011). Research has indicated that many mathematics teachers lack the necessary competencies to apply creative teaching methods effectively, which has resulted in a decline in students' creative problem-solving abilities (Effandi & Zanaton, 2007). While the Ministry of Education seeks to make teachers more skilled through various training and improvements, they are not using enough creative teaching strategies in math classes (Lim et al., 2002; Rinkevich, 2011). Teaching competency is critical in math education because the Iceberg Competency Model explains that effective teaching requires more than familiarity with the subject content (Koster & Dengerink, 2008). Sale (2005) believes teachers must creatively use their knowledge, skills, and attitudes to help students succeed. Teaching competency has become increasingly critical in modern education, especially with the evolving roles of teachers considering advancements in instructional technologies and the changing dynamics of student engagement (Borko, 2004). Effective mathematics teaching hinges on several factors, with teacher qualifications paramount; research indicates that the more qualified teachers are, the higher their students' success rates (Guo et al., 2012; Wake & Burkhardt, 2013). Furthermore, teachers are expected to create an environment conducive for learning that caters to diverse student backgrounds, psychological stability, and social interactions (Eacute & Esteve, 2000). The competencies required for teaching include a blend of knowledge, skills, and attitudes, which facilitate the ability of a teacher to engage students effectively and promote a positive learning experience (King & Newmann, 2001; Leyser & Wertheim, 2002). Pre-service training aims to equip people who want to teach with the competencies necessary to handle different ways of instructing and reacting to various classroom situations (Sabaz, 2004). Therefore, enhancing pre-service teachers' competencies is vital, as those with positive attitudes toward their profession tend to achieve higher levels of success and ultimately become more qualified educators (Bayraktar, 2011). Nurturing these skills matters for teachers, as it supports strong student learning, so training programs must reflect the latest education developments (Tschannen-Moran & Woolfolk Hoy, 2001). Improving students' mathematics ability helps them use math skills in real-life situations, positively affecting their school performance (Kariadinata et al., 2019; Pauji et al., 2023). When teachers relate mathematics to things students care about, students gain confidence and are motivated to apply their minds and understand concepts better (Sugilar et al., 2019; Sunaryo & Fatimah, 2019). Teachers bridge the gap between theoretical ideas and real-world applications by adapting instructional strategies to align with students' lived experiences (Johnston-Wilder et al., 2010; Kurniawan & Susanti, 2021). Given that Indonesia performs poorly on international tests like PISA and TIMSS, improving teacher skills is necessary to help students improve their math (OECD, 2016; Gusmawan & Herman, 2022). Therefore, developing the teaching competency of future mathematics educators is imperative for improving student engagement and outcomes in mathematics (Windyariani, 2019). Although the outbreak of COVID-19 made distance education necessary in most schools, this change significantly affected teachers, especially in mathematics, which relies heavily on technology integration (King et al., 2001; İşman, 2011). As remote learning was put in place, instructors changed their lessons to use various ICT tools, and research shows that this has improved student involvement and success levels (Aydos, 2015; Öz, 2015). The ability to use these technologies effectively is closely tied to teachers' TPACK, which includes their ability to integrate technology into their teaching (Dikkartın et al., 2013). Based on the study, teachers with high levels of TPACK can produce an interactive classroom by encouraging students to participate in and engage in critical thinking (Ursavaş et al., 2014; Marpa, 2020). In addition, Mathematics teachers who utilize technology frequently have higher learning abilities and thus higher teaching abilities (Perinen, 2020). Since there are changing ways of education, future mathematics teachers' TPACK should be better for teaching effectively in the modern era (Niess et al., 2009). For that reason, the importance of TPACK in explaining teaching competency in mathematics has emerged mainly in positions where the teachers will be required for the demands of distance education (Akyürek, 2020; Alea et al., 2020; Zheng et al., 2016).

Statement of the Problem

The purpose of the study is to examine the influence of TPACK on the teaching competency of preservice teachers in Davao De Oro State College (DDOSC).

Specifically, it sought to answer the following questions:

1. What is the level of preservice teachers TPACK in terms of:
    - 1.1. Technological Knowledge?
    - 1.2. Pedagogical Knowledge?
    - 1.3. Content Knowledge?
    - 1.4. Pedagogical Content Knowledge?
    - 1.5. Technological Content Knowledge?
    - 1.6. Technological Pedagogical Knowledge?
    - 1.7. Technological Pedagogical Content Knowledge?
2. What is the level of preservice teachers' teaching competency?
3. Is there a significant relationship between TPACK and Teaching Competency of Mathematics preservice teachers?
4. Do the domains of TPACK predict the teaching competency of Mathematics pre-service teachers?

Null Hypothesis

H_0: There is no significant relationship between TPACK and Teaching Competency of Mathematics preservice teachers.

H_0: There is no domain of TPACK that predicts Teaching Competency of Mathematics preservice teachers.

MATERIALS AND METHODS

Study Area

This study was conducted in Davao De Oro, formerly Compostela Valley Province, in the Davao region. The research took place in Davao De Oro State College (DDOSC) campuses during the 2024-2025 academic year. DDOSC is a public higher education institution in the southern Philippines. Under RA 11575, DDOSC was formerly known as Compostela Valley State College (CVSC). This institution operates four campuses: DDOSC-Compostela (Main), DDOSC-New Bataan, DDOSC-Montevista, and DDOSC-Maragusan. Each campus offers the Bachelor of Secondary Education major in Mathematics (BSED-Math) program. However, Montevista campus does not currently have enrolled fourth-year Math students; therefore, no data were collected from this campus for the study. Data collection focused on the Compostela (Main), New Bataan, and Maragusan campuses, where the targeted respondents are enrolled. The respondents of this study were fourth-year BSED-Math students registered in the second semester of the 2024-2025 academic year across all campuses of DDOSC. The study captures a wide range of perspectives by including students from different campuses. The research utilized universal sampling, ensuring the inclusion of all eligible students within this specific group, both regular and irregular enrollees. Respondents were selected based on their willingness to participate and current enrollment in the Mathematics Education program. They must consent to complete the adapted TPACK questionnaire and participate in the demo-teaching assessment. This approach ensures a broad representation of the target population. The table below illustrates the respondents' distribution on the different DDOSC campuses.

Table 1. Distribution of the Respondents

Schools	**N**
Davao de Oro State College – Compostela	30
Davao de Oro State College – New Bataan	17
Davao de Oro State College – Montevista	0
Davao de Oro State College – Maragusan	23
Total	**70**

Sampling Design

This study used a quantitative predictive correlational design to find the relationship between TPACK and teaching competency of preservice Mathematics teachers. Quantitative research measures and analyzes variables to get outcomes (Apuke, 2017). Aliaga and Gunderson (2002) define quantitative research methods as a way of understanding a problem or phenomenon by collecting data in numerical form and analyzing it with mathematical tools, specifically statistics. Using different instruments for each variable, this study used numerical data to find learners' TPACK and teaching competency. On the other hand, correlational predictive design seeks to determine if there is any link between variables and how well independent variables may predict dependent variables (Pulido et al., 2022). This study fitted a correlational predictive design because the study aimed at finding a relationship between TPACK and teaching competency and to identify the predictive power of TPACK. Moreover, multiple regression analysis is applied in this study as this statistical approach examines whether there's a significant statistical relationship between the outcome variable (Teaching Competency) and the combination of several predictor variables (TPACK domains) to draw an inference of a potential causal connection (Warner, 2013).

Research Instrument

The instruments used in this study were an adapted version of the existing TPACK questionnaire and a demo teaching tool for teaching competency. This study adapted the TPACK questionnaire developed by Schmidt et al. (2020) to determine the TPACK levels of the respondents. The demo teaching tool used to assess the teaching competency of the preservice Mathematics students was used by DDOSC to evaluate their students' in-house and practicum teaching demonstration, which was adapted from Pawilen et al. (2019). The first section is a questionnaire designed to determine the TPACK level of the respondents. There are 28 items in this section, four for each TPACK area. Having an equal number of items for each domain ensures that they are well represented and enables better evaluation of the respondents' abilities to use technology, teaching approaches, and content. The respondents assessed each item on a four-point Likert scale questionnaire: one (1) for "strongly disagree," and four (4) for "strongly agree." The second section is the use of a demo-teaching tool designed to determine the teaching competency of the respondents. It sought to examine how the preservice teachers demonstrate their classroom abilities. Below is a list of criteria for assessing a teacher's personality, lesson planning, content, teaching methods, classroom management, and questioning abilities. To measure each criterion, a four point Likert scale was utilized where one (1) stood for "Needs Improvement," two (2) for "Fair," three (3) for "Very Satisfactory," and four (4) for "Outstanding," With this scale, teachers can be evaluated using the same method which makes the results reliable and consistent. Moreover, to enhance the relevance and applicability of the TPACK scales in the study context, the questionnaires underwent necessary modifications to align with the specific needs of preservice Mathematics teachers at DDOSC. Such modifications consist of replacing terms with language that respondents are likely to understand and ensuring the questions relate to key areas in mathematics. These adjustments aim to create a more meaningful and context-appropriate tool for data collection. Because of these changes, one must validate the questionnaire with experts to ensure it remains valid. A panel of experts checked and approved TPACK accuracy in this setting. This step ensures that the instrument remains reliable and valid for the study's objectives.

Validation of Instrument

The instruments were validated to ensure they assessed TPACK domains and teaching competency in preservice Mathematics teachers. The drafted TPACK questionnaire was presented to the expert validators, consisting of subject matter specialists and the researcher's adviser, to check that it was relevant, well-explained, clear, and connected to the main study goals. This was done to make sure that the instrument is reliable and valid. After getting expert feedback, required changes were added to ensure the instrument would better assess the various elements of TPACK. A pilot test was organized after expert validation. Twenty preservice teachers, similar to the leading group but not involved in the main study, were given the TPACK questionnaire. This process helped identify ambiguities and ensure the clarity of the items. Using reliability analysis with Cronbach's alpha, TK is 0.835, PK is 0.809, CK is 0.846, PCK is 0.802, TCK is 0.804, TPK is 0.791, and TPCK is 0.806; these results showed a strong internal consistency in all seven domains. All values were above 0.70 and most over 0.80, so the instrument proved reliable and fit for the main study. These figures show that the questionnaire items were understood and always measured the topics they aimed to assess. Because of its strong internal consistency, the instrument can be relied upon to assess TPACK levels among preservice teachers for the main study. Checking that the instrument is reliable and valid is necessary to confirm that what is collected accurately measures respondents' TPACK and teaching competency. It is also important for an instrument to have validity, measure what it is intended for, and be reliable, meaning that it gives the same results throughout various cases. This helps ensure the results truly reflect what participants know and can do. Experts' feedback and pre-testing of an instrument help the researcher ensure the tool is accurate and consistent, which permits trustworthy data collection.

Likert Scale Parameters for Assessing TPACK Domains

Range of Mean	Description	Interpretation
3.50 – 4.00	Strongly Agree	This means that the domain of Technological, Pedagogical, and Content Knowledge is extremely evident in the pre-service teacher.
2.50 – 3.49	Agree	This means that the domain of Technological, Pedagogical, and Content Knowledge is evident in the pre-service teacher.
1.50 – 2.49	Disagree	This means that the domain of Technological, Pedagogical, and Content Knowledge is sometimes evident in the pre-service teacher.
1.00 – 1.49	Strongly Disagree	This means that the domain of Technological, Pedagogical, and Content Knowledge is not evident in the pre-service teacher.

Likert Scale Parameters for Assessing Teaching Competency

Range of Mean	Description	Interpretation
3.50 – 4.00	Outstanding	This means that the Pre-service teacher demonstrates excellent teaching skills, performance is exemplary and exceeds expectation in all areas.
2.50 – 3.49	Very Satisfactory	This means that the Pre-service teacher demonstrates strong teaching skills, meets expectations with minor areas for improvement.
1.50 – 2.49	Fair	This means that the Pre-service teacher demonstrates limited teaching skills, performance is below expectations and requires improvement.
1.00 – 1.49	Needs Improvement	This means that the Pre-service teacher demonstrates poor teaching skills, performance is far below expectations, and needs primary intervention.

Data Collection Procedure

The researcher took great care in following every step of the process to ensure that the data collected for this study were accurate, reliable, and ethically gathered. Before anything else, permission was sought from the Dean of Assumption College of Nabunturan and the head of the Graduate School. To make sure the research met ethical standards, the study was submitted to the school's Ethics Review Committee, which reviewed the procedures for involving participants. Any concerns raised were thoughtfully addressed, and full approval was granted before moving forward. The researcher then wrote a formal letter to DDOSC, clearly explaining the purpose, goals, method, and timeline of the study, along with all the necessary documents. Approval was also requested from the school administrators and instructors in the chosen schools. The class advisers were briefed and reminded to respect the privacy of students and reassure them that participation was completely voluntary. Students were told they were free to join or leave the study at any time without any pressure. On the scheduled day, the researcher, along with the class adviser, administered the questionnaire, giving students one hour to complete it. After collecting the data, the researcher carefully organized and analyzed it using appropriate statistical tools, with all identities kept anonymous. Finally, a report of the findings was submitted to the school's research office, with sincere thanks extended to the schools and participants who made the study possible.

Statistical Treatment

The following statistical tools were used in this study: Mean was used to determine the following: (1) the level of TPACK domains and (2) the level of teaching competency. Pearson-r was used to test if there is a significant relationship between the TPACK domains and teaching competency. Multiple Regression was used to analyze the TPACK domains' influence on the teaching competency of Mathematics pre-service teachers.

Ethical Consideration

Participants, all fourth-year BSED-Math students from DDOSC, were selected fairly without bias, and each received an Informed Consent Form explaining the study's purpose, procedures, and their rights—including the freedom to withdraw at any time without consequence. Participation was purely voluntary, and no pressure or coercion was applied. The researcher ensured that respondents felt safe and comfortable throughout the process by clearly explaining each step and respecting their right to skip questions or exit the study if they felt uneasy. Although the research posed no significant risks, the potential benefit of contributing to better teacher education was shared with participants. Privacy and confidentiality were strictly observed, in line with the Data Privacy Act of 2012—personal information was kept anonymous, securely stored, and later disposed of responsibly. Transparency was maintained by providing participants with copies of their responses and sharing a summary of the findings. While this was the researcher's first graduate-level study, their prior experience as a research adviser, panelist, and statistician helped ensure that data were analyzed fairly and reported without bias, following institutional ethical standards throughout.

RESULTS AND DISCUSSION

This section presents the findings addressing the first statement of the problem, which examines the TPACK level of preservice mathematics teachers based on their self-assessment across seven domains.

Table 2.Preservice Mathematics Teachers' Level of TPACK in terms of Technological Knowledge

Items		Mean	SD	Descriptive Rating
1.	I keep up with new technologies relevant to teaching Mathematics.	3.60	0.493	Strongly Agree
2.	I frequently experiment with technological tools that can be used in teaching Mathematics.	3.39	0.546	Agree
3.	I know about various technologies that can be used to enhance Mathematics instruction.	3.37	0.543	Agree
4.	I have the technical skills needed to effectively use technology for teaching Mathematics.	3.37	0.487	Agree
TK Overall Mean		**3.43**	**0.397**	**Agree**

Table 2 shows the level of preservice teachers' TK based on their self-assessment across four items. The mean scores range from 3.37 to 3.60, with a standard deviation between 0.487 and 0.546. The relatively high mean score was recorded in item 1, "I keep up with new technologies relevant to teaching Mathematics," with a descriptive rating of "Strongly Agree." Items 2, 3, and 4 yielded mean scores of 3.39, 3.37, and 3.37, respectively, each with a descriptive rating of "Agree". The overall mean for the TK domain is 3.43 with a standard deviation of 0.397, also described as "Agree."

Table 3. Preservice Mathematics Teachers' Level of TPACK in terms of Pedagogical Knowledge

Items		Mean	SD	Descriptive Rating
1.	I can adapt my teaching of Mathematics based on what students currently understand or do not understand.	3.59	0.496	Strongly Agree
2.	I can adjust my teaching style to suit different learners in Mathematics.	3.60	0.493	Strongly Agree
3.	I can use a variety of teaching approaches to help students learn Mathematics.	3.53	0.503	Strongly Agree
4.	I can assess student learning in Mathematics using multiple methods.	3.23	0.663	Agree
PK Overall Mean		**3.49**	**0.387**	**Agree**

Table 3 shows the preservice teachers' PK level based on their self-assessment across four items. The mean scores range from 3.23 to 3.60, with a standard deviation between 0.493 and 0.663. The highest mean score was recorded in item 2, "I can adjust my teaching style to suit different learners in Mathematics," with a mean of 3.60, followed closely by item 1, "I can adapt my teaching of Mathematics based on what students currently understand or do not understand," at 3.59. Item 3, "I can use a variety of teaching approaches to help students learn Mathematics" at 3.53. All three items were descriptively rated as "Strongly Agree." Item 4, "I can assess student learning in Mathematics using multiple methods," received a lower mean of 3.23 with a descriptive rating of "Agree." The overall mean for the PK domain is 3.49, with a standard deviation of 3.387 and a descriptive rating of "Agree."

Table 4. Preservice Mathematics Teachers' Level of TPACK in terms of Content Knowledge

Items		Mean	SD	Descriptive Rating
1.	I have sufficient knowledge of the concepts and skills required in teaching Mathematics.	3.33	0.473	Agree
2.	I can apply subject-specific ways of thinking when teaching Mathematics.	3.37	0.487	Agree
3.	I understand the basic theories and principles of Mathematics as they apply to teaching.	3.37	0.487	Agree
4.	I am familiar with the historical development and foundational theories in Mathematics.	3.13	0.635	Agree
CK Overall Mean		**3.30**	**0.358**	**Agree**

Table 4 shows pre-service teachers' CK level based on their self-assessment across four items. The mean scores range from 3.13 to 3.37, with standard deviations between 0.473 and 0.635. Item 2, "I can apply subject-specific ways of thinking when teaching Mathematics," and item 3, "I understand the basic theories and principles of Mathematics as they apply to teaching," both recorded a mean score of 3.37, followed closely by item 1 "I have sufficient knowledge of the concept and skills required in teaching Mathematics" with mean of 3.33. The lowest mean score was noted in item 4, "I am familiar with the historical development and foundational theories in Mathematics," at 3.13. All items received a descriptive rating of "Agree." The overall mean for the CK domain is 3.30, with a standard deviation of 0.358 and a descriptive rating of "Agree."

Table 5. Preservice Mathematics Teachers' Level of TPACK in terms of Pedagogical Content Knowledge

Items	Mean	SD	Descriptive Rating

1. I know how to choose effective teaching approaches to guide students' understanding of Mathematics concepts.	3.47	0.557	Agree
2. I know how to create tasks that encourage students to think critically about Mathematics.	3.51	0.531	Strongly Agree
3. I know how to develop exercises that help students consolidate their understanding of Mathematics.	3.36	0.483	Agree
4. I know how to evaluate students' performance in Mathematics effectively.	3.50	0.532	Strongly Agree
PCK Overall Mean	**3.46**	**0.353**	**Agree**

Table 5 shows the level of preservice teachers' PCK based on their self-assessment across four items. The mean scores range from 3.36 to 3.51, with a standard deviation between 0.483 and 0.557. The highest mean score was recorded in item 2, "I know how to create tasks that encourage students to think critically about Mathematics," at 3.51, followed by item 4, "I know how to evaluate students' performance in Mathematics effectively," with a mean of 3.50. Both items received a descriptive rating of "Strongly Agree." Item 1, "I know how to choose effective teaching approaches to guide students' understanding of Mathematics concepts," had a mean score of 3.47. In contrast, item 3, "I know how to develop exercises that help students consolidate their understanding of Mathematics," reported the lowest mean of 3.36. These two items were rated as "Agree". The overall mean for the PCK domain is 3.46, with a standard deviation of 0.353 and a descriptive rating of "Agree."

Table 6. Preservice Mathematics Teachers' Level of TPACK in terms of Technological Content Knowledge

Items	Mean	SD	Descriptive Rating
1. I understand how technological developments have influence the teaching and learning of Mathematics.	3.61	0.490	Strongly Agree
2. I can explain which technologies are commonly used in research and applications of Mathematics.	3.26	0.502	Agree
3. I am aware of emerging technologies that can be used to teach Mathematics.	3.47	0.531	Agree
4. I know how to use technology to explore and explain concepts in Mathematics.	3.39	0.490	Agree
TCK Overall Mean	**3.43**	**0.338**	**Agree**

Table 6 shows preservice teachers' TCK level based on their self-assessment across four items. The mean scores range from 3.26 to 3.61, with a standard deviation between 0.490 and 0.531. The highest mean was observed in item 1, "I understand how technological developments have influenced the teaching and learning of Mathematics," with a mean of 3.61 and a descriptive rating of "Strongly Agree." Items 3, "I am aware of emerging technologies that can be used to teach Mathematics," and 4, "I know how to use technology to explore and explain concepts in Mathematics," recorded mean scores of 3.47 and 3.39, respectively. In contrast, item 2, "I can explain which technologies are commonly used in research applications in Mathematics," had the lowest mean of 3.26. These three items were all descriptively rated as "Agree." The overall mean for the TCK domain is 3.43, with a standard deviation of 3.338, corresponding to a descriptive rating of "Agree."

Table 7. Preservice Mathematics Teachers' Level of TPACK in terms of Technological Pedagogical Knowledge

Items	Mean	SD	Descriptive Rating
1. I can select technologies that support effective teaching approaches for Mathematics lessons.	3.53	0.503	Strongly Agree
2. I can choose technologies that enhance students' learning in Mathematics.	3.44	0.500	Agree

3.	I can adapt the use of technology to suit different teaching activities in Mathematics.	3.47	0.503	Agree
4.	I critically reflect on how to use technology to improve Mathematics instruction.	3.44	0.500	Agree
TPK Overall Mean		**3.47**	**0.384**	**Agree**

Table 7 shows the level of preservice teachers' TPK based on their self-assessment across four items. The mean scores range from 3.44 to 3.53, with standard deviations between 0.500 and 0.503. The highest mean score was recorded in item 1, "I can select technologies that support effective teaching approaches for Mathematics lessons," at 3.53, with a descriptive rating of "Strongly Agree." Items 2, "I can choose technologies that enhance students' learning in mathematics," and 4, "I critically reflect on how to use technology to improve Mathematics instruction," both received mean scores of 3.44. In contrast, item 3, "I can adapt the use of technology to suit different teaching activities in Mathematics," had a mean of 3.47. These three items were rated as "Agree". The overall mean for the TPK domain is 3.47, with a standard deviation of 0.384 and a descriptive rating of "Agree."

Table 8. Preservice Mathematics Teachers' Level of TPACK in terms of Technological Pedagogical Content Knowledge

Items		Mean	SD	Descriptive Rating
1.	I can design strategies that combine content, technology, and teaching approaches for Mathematics lessons.	3.39	0.546	Agree
2.	I can choose technologies that enhance the content and delivery of Mathematics lessons.	3.49	0.503	Agree
3.	I can select technologies that improve both the teaching and learning process in Mathematics.	3.54	0.502	Strongly Agree
4.	I can effectively teach Mathematics lessons that integrate content, technology, and pedagogical approaches.	3.36	0.512	Agree
TPCK Overall Mean		**3.44**	**0.402**	**Agree**

Table 8 shows the level of preservice teachers' TPCK based on their self-assessment across four items. The mean scores range from 3.36 to 3.54, with a standard deviation between 0.502 and 0.546. The highest mean was recorded in item 3, "I can select technologies that improve both the teaching and learning process in Mathematics," at 3.54, with a descriptive rating of "Strongly Agree." Items 2, "I can choose technologies that enhance the content and delivery of Mathematics lessons," and 1, "I can design strategies that combine content, technology, and teaching approaches for Mathematics lessons," had mean scores of 3.49 and 3.39, respectively. In contrast, item 4, "I can effectively teach Mathematics lessons that integrate content, technology, and pedagogical approaches," recorded the lowest mean of 3.36. These three items were rated as "Agree". The overall mean for the TPCK domain is 3.44, with a standard deviation of 0.402 and a descriptive rating of Agree.

Summary on the extent of TPACK

Table 9. Summary on the extent of Preservice Teachers' TPACK across its seven Domains

Items		**Mean**	**SD**	**Descriptive Rating**
1.	Technological Knowledge (TK)	3.43	0.397	Agree
2.	Pedagogical Knowledge (PK)	3.49	0.387	Agree
3.	Content Knowledge (CK)	3.30	0.358	Agree
4.	Pedagogical Content Knowledge (PCK)	3.46	0.353	Agree
5.	Technological Content Knowledge (TCK)	3.43	0.338	Agree
6.	Technological Pedagogical Knowledge (TPK)	3.47	0.384	Agree
7.	Technological Pedagogical Content Knowledge (TPCK)	3.44	0.402	Agree
TPACK Overall Mean		**3.43**	**0.262**	**Agree**

The table summarizes the preservice teachers' self-assessment level of TPACK across its seven domains. The mean scores of all domains fall within the "Agree" descriptive rating, indicating a generally high level of perceived competence. Among the domains, PK recorded the highest mean of 3.49, followed by TPK at 3.47 and PCK at 3.46. The lowest mean was observed in CK at 3.30. The remaining domains – TK and TCK – had mean scores of 3.43, while TPCK reported a mean of 3.44. Overall, the TPACK composite mean was 3.43 with a standard deviation of 0.262, indicating that the pre-service Mathematics teachers generally agreed that they possess the knowledge and skills described in the TPACK framework.

Level of Teaching Competency

This section presents the results addressing the second statement of the problem, which examines the level of Teaching Competency of preservice mathematics teachers. Shown in Table 10 are the mean score, standard deviation, and descriptive rating based on their demo teaching performance.

Table 10. Preservice Mathematics Teachers' Level of Teaching Competency

Items	Mean	SD	Descriptive Rating
Teaching Competency	**3.41**	**0.212**	**Very Satisfactory**

Table 10 shows the level of teaching competency of preservice Mathematics teachers, with a mean score of 3.41 and a standard deviation of 0.212, corresponding to a "Very Satisfactory" descriptive rating. This means that the pre-service teacher demonstrates strong teaching skills and meets expectations with minor areas for improvement.

Test of Null Hypothesis

This section presents the results of the statistical tests conducted to examine the relationship between TPACK and the teaching competency of preservice Mathematics teachers, as well as to determine whether the domains of TPACK significantly predict their teaching competency.

Table 11. Relationship between TPACK and Teaching Competency of Preservice Mathematics Teachers

Correlation Matrix

Variables	Correlation Coefficient	p-value	Remarks
TPACK - Teaching Competency	**0.824**	**<0.001**	**Significant**

As shown in the correlation matrix, the result indicates a correlation coefficient of 0.824 with a p-value of <0.001. This suggests a strong positive relationship between TPACK and teaching competency, statistically significant at 0.05. Given the outcome, the null hypothesis stating "there is no significant relationship between the TPACK and Teaching Competency of Mathematics pre-service teachers" is rejected. This implies that higher levels of TPACK are associated with higher levels of teaching competency among the pre-service Mathematics teachers at Davao de Oro State College.

Table 12. TPACK as predictors of Teaching Competency of Preservice Mathematics Teachers Model Fit Table

Model Fit Measures

				Overall Model Test	
Model	**R**	**R^2**	**Adjusted R^2**	**F**	**p**
1	0.848	0.719	0.687	22.67	<0.001

Note. Models estimated using a sample size of N=70

Table 12 revealed a strong model fit, as indicated by the correlation coefficient (R) of 0.848. The coefficient of determination (R2) was 0.719, suggesting that 71.9% of the variance in teaching competency scores can be counted for by the collective contribution of the seven TPACK domains. The adjusted R2, which accounts for the number of predictors in the model, was 0.687. The F-statistic for the overall regression model was 22.67 with a significant level of p < 0.001, indicating that the model as a whole was statistically significant and not due to chance. The table presenting the model coefficient below displays the results of the multiple regression analysis. It outlines the contribution of each predictor within TPACK domains and their respective relationships with the dependent variable, teaching competency. This table offers detailed insights into the magnitude and significance of each domain's influence on the overall regression model.

Table 13. TPACK as predictors of Teaching Competency of Preservice Mathematics Teachers Coefficient Table

Model Coefficient

Model		Unstandardized Coefficient		Standardized coefficient	t	p
		B	Std. Error	Beta		
1	(Constant)	1.089	0.198		5.514	<0.001
	Technological Knowledge (TK)	0.190	0.056	0.356	3.373	0.001
	Pedagogical Knowledge (PK)	0.049	0.047	0.089	1.050	0.298
	Content Knowledge (CK)	0.103	0.045	0.173	2.255	0.028
	Pedagogical Content Knowledge (PCK)	0.199	0.050	0.332	3.982	<0.001
	Technological Content Knowledge (TCK)	0.026	0.058	0.041	0.450	0.654
	Technological Pedagogical Knowledge (TPK)	0.044	0.065	0.080	0.683	0.497
	Technological Pedagogical Content Knowledge (TPCK)	0.066	0.052	0.125	1.261	0.212

Dependent Variable: Teaching Competency

Regarding individual predictors, the standardized beta coefficients show that three domains had statistically significant contributions to the model. TK had a beta coefficient of 0.356 with a t-value of 3.373 and a p-value of 0.001, indicating a statistically significant relationship. CK also contributed significantly to the prediction of teaching competency, with a beta coefficient of 0.173, a t-value of 2.255, and a p-value of 0.028. PCK showed the highest significance among the domains, with beta coefficients of 0.332, a t-value of 3.982, and a p-value less than 0.001. On the other hand, PK, TCK, TPK, and TPCK did not yield statistically significant results in the regression model. PK had a beta of 0.089 (t=1.050, p=0.298), TPK had a beta of 0.080 (t=0.683, p=0.497), and TPCK had a beta of 0.125 (t=1.261, p=0.212). These results indicate that while the overall model is significant, only specific domains with the TPACK framework significantly contribute to the prediction of teaching competency.

Level of TPACK in terms of Technological Knowledge (TK)

The table on Technological Knowledge (TK) reveals that the preservice Mathematics teachers believed they could utilize technology in their teaching. The mean score indicates that the TK is evident in the pre-service Mathematics teacher. Notably, the highest-rated item suggests that most pre-service teachers are proactive in staying updated with relevant technological advancements. The high average ratings obtained for TK items show that the preservice teachers are ready to use different online classroom resources. In the modern era of education, using technology is very important for successful and exciting teaching in the classroom. The result also suggests that preservice teachers are ready to explore and use different technological applications, adapt and accept them to improve teaching and learning in Mathematics.The result supports the findings of Ozudogru and Ozudogru (2019). It states that mathematics teachers with high levels of TK are better positioned to involve students and increase their motivation through technological tools. Similarly, Aldemir et al. (2022) suggest that teachers and educators must use technology in their instruction, strengthening the argument for preservice teachers to develop their TPACK skills. Thus, preservice teachers should construct their TPACK. In other words, preservice teachers are ready to use different technological tools to make the lesson effective.

Level of TPACK in terms of Pedagogical Knowledge (PK). The table presenting the level of Pedagogical Knowledge (PK) shows that preservice Mathematics teachers rated themselves positively in this domain. The mean value shows that OK is evident in preservice Mathematics teachers. This means that the respondents can do the tasks in teaching that should be done in successful teaching. The highest-rated item suggests that the respondents can modify instruction depending on the diversity of learners and what they already know. This point is essential in Mathematics education because learners come with different knowledge levels before instruction and learning needs. The study of Aldemir et al. (2022) states that pedagogical knowledge is one of the basic components that teachers can use different instruction according to diverse learners and their understanding. Similarly, Ozudogru and Ozudogru (2019) also stated that mathematics teachers with basic pedagogical knowledge can provide better engagement and experience to learners through different instruction. Furthermore, Akapame et al. (2019) suggest that pre-service secondary mathematics teachers should increase their TPACK and that PK is essential in bringing theory and practice together. With all these studies, it is seen that feeling good when teaching different learners is important.

Level of TPACK in terms of Content Knowledge (CK). The results for CK show that preservice Mathematics teachers perceive themselves to have a high knowledge of the content essential for teaching Mathematics. The mean score means that the CK is evident in the preservice Mathematics teachers. This shows that they believe they have mastered the main ideas in mathematics. Mean scores at the top level indicate that teachers are confident in using math in the classroom. However, the item that has the lowest mean signals an average knowledge of the broader history and concepts connected to Mathematics. These results imply that these future educators are well-versed in math applied in teaching, but should consider learning more about its deeper and historical meanings. This is necessary because an extensive knowledge base allows teachers to teach the steps and equations and provide meaningful explanations that benefit student understanding. According to Durdu and Dag's study (2017), a solid CK background allows teachers to incorporate technology well into their instruction, helping learners gain a better understanding and more interest. Similarly, Aldemir et al. (2022) argue that CK is key in the TPACK framework as it allows teachers deliver math lessons to support all kinds of learners. Kim (2018) discusses how Mathematics teachers in training with constructivist views tend to have higher mathematical knowledge and show more effective teaching. These studies suggest that confidence in Math alone is not enough; more exploration into the central ideas and history of the subject can help preservice teachers become more effective instructors.

Level of TPACK in terms of Pedagogical Content Knowledge (PCK). PCK results show that preservice Mathematics teachers agree they can teach mathematics. The mean score means that the PCK is evident in the preservice Mathematics teachers. This indicates that preservice mathematics teachers think positively about content knowledge and can use appropriate pedagogical content knowledge for mathematics teaching. These results imply that preservice teachers can make math meaningful and enjoyable for all students using appropriate teaching methods and assessments. Connecting pedagogical methods with relevant topics increases students' chances of thinking more deeply about what they are learning. Aldemir et al. (2022) found that PCK is essential in the TPACK framework because it enables teachers to incorporate teaching techniques into their subject understanding to benefit students. Similarly, Durdu and Dag (2017) discovered that the participation of preservice teachers in TPACK-based courses improved their instructional practices in designing critical thinking tasks and assessment. Moreover, Kim (2018) investigated the correlation between preservice Mathematics teachers' feelings about teaching and their PCK and concluded that those who focus on students' understanding of content emphasize students. As a result, it can be said that these pedagogical strategies to content support the preservice Mathematics teachers' ability, which enables students to understand the lessons and think.

Level of TPACK in terms of Technological Content Knowledge (TCK). The results of TCK mean that the preservice Mathematics teachers know how to use technology in mathematical content. The mean score means that TCK is evident in the preservice mathematics teachers. The highest-rated item indicates a strong awareness of the influence of technology on Mathematics education. Other items, such as awareness of emerging technologies and the ability to use technology in explaining concepts, also received favorable ratings, showing how technology improves our understanding of math. These findings imply that preservice teachers know that mathematics and technology are a team and that technology reinforces and develops the teaching process. It is essential to understand this fact to design lessons that use technology best to teach complex mathematical topics and attract students' attention. This finding aligns with Assadi and Hibi (2020), who shared that preservice teachers who plan and present lessons using technology (GeoGebra in this study) show visible improvements in their TPACK levels, especially in TCK. Moreover, Aldemir et al. (2022) also highlighted the significance of developing TPACK competencies that will enable teachers to incorporate technological innovations into their Mathematics lessons. Furthermore, according to Abunda (2020), Mathematics educators with high levels of TPACK use technological tools frequently in their instructional settings. Therefore, it can be argued that preservice Mathematics teachers understand technology's role in learning mathematics.

Level of TPACK in terms of Technological Pedagogical Knowledge (TPK). The results for TPK showed that most preservice Mathematics teachers agree that they can use technology associated with pedagogical practices when teaching. The mean score means that the TPK is evident in the preservice Mathematics teachers. All items received good ratings. This means that the preservice mathematics teachers are aware and feel confident that technology is used in a pedagogical way. These results imply that the preservice teachers know that they should not use technology to be technologically savvy, but somewhat along with teaching methods where tools are supported by research. Technology is essential in Mathematics as it provides animated displays, simulations, and other fun activities that are not always available in Math classes. Aldemir et al. (2022) pointed out that TPK is a relevant part of the TPACK, letting teachers incorporate technologies and methods to enhance students' learning. Similarly, Bwalya and Rutegwa (2023) stated in their study that high levels of self-efficacy in TPK will enhance future educators' confidence in integrating technology while teaching mathematics. Furthermore, Su (2023) also reported the results of his bibliometric review of TPK research articles, focusing on the global trends of preservice teachers' TPCK development. All the studies above support our claim that preservice Mathematics teachers realize the importance of appropriately choosing and applying technological tools for effective teaching.

Level of TPACK in terms of Technological Pedagogical Content Knowledge (TPCK). The results for TPCK showed that most of the preservice Mathematics teachers agreed that they have the integrated knowledge to integrate content, pedagogy, and technology into teaching. The overall mean score means that the TPCK is evident in the preservice Mathematics teacher. The highest rating was the score for integrating instructional delivery using technology and its corresponding learning activities. Other items also demonstrated agreement, showing that mathematics teachers could design and deliver lessons that integrated the three domains. These results imply that preservice Mathematics teachers are acquiring knowledge about content, pedagogy, and technology, and use this embedded knowledge to meet the needs of today's Mathematics classroom, since technology is a learning tool and a means to better understanding. In their literature studies, Ishartono et al. (2023) stated that digital tools such as GeoGebra, Matlab, and even augmented reality can improve students' math skills. While that, Guerrero-Ortiz (2023) in her literature study stated that she studied how TPCK can be used in mathematical modeling learning. Pre-service teachers can create instruction by incorporating technology to increase student engagement and understanding in mathematical modeling education. In her literature study, Halili (2023) stated that TPCK can also show that pre-service mathematics teachers can teach with technology. From all the above, we can see that future teachers will already use all these areas together by participating in this training.

Summary on the extent of TPACK across its seven Domains. The summary of the level of TPACK among the preservice mathematics teachers revealed an overall mean score corresponding to a descriptive rating of "Agree." This means that TPACK is evident among preservice mathematics teachers. This overall rating indicates that the respondents generally perceive themselves as competent in combining the major knowledge domains in their teaching practice. Each domain – TK, PK, CK, PCK, TCK, TPK, and TPCK- received a mean score within the "Agree" range, highlighting a balanced and consistent level of self-assessed proficiency across all facets of TPACK. The relatively high mean scores in domains such as PK, PCK, and TPK show that the preservice teachers feel particularly confident in their pedagogy and in embedding technology with pedagogy. Meanwhile, the slightly lower mean scores in CK and TCK indicate areas where further strengthening may be beneficial, especially regarding more profound content mastery and technological application. These findings imply that the teacher education program builds the necessary skills in TPACK to make preservice teachers capable of teaching Mathematics using technology. However, the findings also suggest the ongoing need for interventions to deepen content knowledge and enhance technological fluency, aligned explicitly with Mathematics content. According to Durdu and Dag (2017), creating lessons with structured TPACK allows preservice teachers to better combine technology into their lessons, so such courses should be required in education programs. Similarly, Aldemir, Karakuş, and Niess (2023) emphasize that a well-developed TPACK framework enables preservice teachers to balance subject expertise, pedagogical strategies, and technological tools effectively, ensuring meaningful learning experiences. Additionally, Selda (2024) indicates that even though teachers are making good progress across the different TPACK categories, feedback from their mentors suggests that some adjustments could help them improve their technological abilities.

Level of Teaching Competency of Pre-service Mathematics Teachers. The extent of preservice Mathematics teachers' Teaching Competency is rated based on their demo teaching performance. The results on the level of Teaching Competency among preservice teachers revealed a mean indicating that the preservice mathematics teacher demonstrates strong teaching skills and meets expectations with minor areas for improvement. This level of competency reflects a solid grasp of pedagogical practices such as teachers' personality, lesson planning, content, teaching method, classroom management, and questioning skills. Although the rating does not reach the "Outstanding" level, it shows that preservice teachers are well-prepared and capable of delivering effective instruction while still having room to develop in certain aspects of their teaching practice. Espiritu (2024) examined preservice teachers' competency and awareness, revealing that they were proficient in key teaching domains, including lesson planning, classroom management, and assessment strategies. Similarly, Macasaddu et al. (2024) evaluated the proficiency of preservice teachers in Mathematics in the Modern World, finding that respondents were nearly proficient in applying mathematical concepts, indicating strong foundational knowledge but room for improvement in instructional strategies. Furthermore, Danar et al. (2024) analyzed code-switching in mathematics teaching and proved that students' understanding improved when teachers used effective language strategies.

Relationship between TPACK and Teaching Competency of Pre-service Mathematics Teachers. The Pearson correlation analysis revealed a correlation coefficient indicating a statistically significant positive relationship between TPACK and Teaching Competency among preservice Mathematics teachers. This means that as the level of TPACK increases, the teaching competency also tends to improve. The strength of this relationship suggests that integrating technology, pedagogy, and content knowledge plays a vital role in shaping the instructional capabilities of preservice teachers. Teachers with greater levels of TPACK are more inclined to plan, deliver, and assess mathematics instruction effectively in meaningful and engaging ways for learners. It affirms that competence in all three areas is essential for high-quality teaching performance. The result we found connects with the research of Durdu and Dag (2017), which confirmed that using TPACK in course development helps pre-service teachers apply technology in their lessons, resulting in improved teaching skills. Similarly, Aldemir et al. (2023) stress that a well-developed TPACK framework allows future Mathematics educators to effectively combine content knowledge, pedagogical approaches, and technological tools to create meaningful learning experiences. Furthermore, Selda (2024) explains that pre-service teachers commonly experience solid improvement in all aspects of TPACK. However, their assessments of their abilities may not match the evaluations from their experienced teachers. Thus, educators should strengthen curricula related to technology in teacher education. Collectively, these studies support the view that as TPACK proficiency increases, so does teaching competency, highlighting the critical role of integrated knowledge in preparing effective 21st-century educators.

TPACK as predictors of Teaching Competency of Pre-service Mathematics Teachers. The multiple regression analysis showed that the domains of TPACK collectively have significant predictive power on the teaching competency of preservice Mathematics teachers. The model indicates that approximately 71.9% of the variance in teaching competency can be explained by the combined influence of the TPACK domains. The result provides strong evidence in we fail to reject the second null hypothesis, positing that no TPACK domain predicts teaching competency. Looking into the individual contributions of each domain, three components emerged as significant predictors – TK, CK, and PCK. These findings imply that these three domains contribute meaningfully to the teaching competency of preservice teachers. In contrast, the other domains – PK, TCK, TPK, and TPCK – did not significantly predict teaching competency in this model. The results suggest that technological proficiency, strong content knowledge, and combining pedagogy with content are critical to effective teaching performance.TK shows a greater need for educators who can apply technology effectively in the classroom. CK demonstrates that a strong understanding of math is necessary for success. The strong ability of PCK to foresee how students will learn suggests that we should turn math content into lessons that suit various teaching methods. These results are consistent with the framework of the study and E-learning Theory, which focuses on the effective utilization of technology in learning. The importance of TK, CK, and PCK is evident in the theory of learning and teaching with digital technologies: meaningfully integrating technology (TK), teaching content (CK), and applying pedagogy in content (PCK). This provides support for the claim that competency in teaching with digital technologies is enhanced when technology, content, and pedagogy are combined and contemplated. Matabane (2024) examined effects on preservice Mathematics teachers' use of technology in the classroom, stating that TK, CK and PCK are major factors that affect their teaching process. Durdu and Dag (2017) also noted that preservice teachers can use technological tools in pedagogical ways more effectively with courses based on structured TPACK (Durdu & Dag, 2017). Moreover, Selda (2024) stated that pre-service teachers' TPACK competencies increased with the activities that draw attention to the necessity of CK in their professional life (Selda, 2024). In other words, this research is meaningful regarding factors that determine a teacher. Therefore, it is suggested that teacher education courses should draw attention to these issues in terms of PCK and CK.

Conclusion and Recommendations

This study examined how Technological Pedagogical and Content Knowledge (TPACK) influences the teaching performance of preservice mathematics professors at Davao de Oro State College. The findings revealed that these potential educators had a high level of TPACK in all categories, with Pedagogical Knowledge (PK) and Pedagogical Content Knowledge (PCK) somewhat higher than the others. Their teaching performance was rated "Very Satisfactory," indicating that they mostly met expectations but had room to improve. A strong positive relationship was observed between total TPACK and teaching competence, with Technological Knowledge (TK), Content Knowledge (CK), and PCK appearing as important predictors. These results underscore the need of incorporating subject expertise, good teaching strategies, and appropriate technology into teacher education. To enhance TPACK, the researchers recommend greater training via seminars, sample teaching, and technology-based lesson preparation, as well as encouraging curriculum designers to include TPACK ideas into all areas of education. Institutions should also invest in technology, provide focused professional development, and provide real-world teaching experiences via partnerships. More research on broad topics and larger populations is needed to assess the long-term impact of TPACK on real-world classroom performance.

Acknowledgements

The authors would like to thank the school principal for granting permission to conduct the training outside the campus and for supporting the study's implementation. They also extend appreciation to the individual who provided valuable guidance, effort, and assistance in helping the study achieve its objectives.

Conflict of Interest

The authors declare no conflict of interest in the preparation and publication of this research.

Funding

The authors funded this research.

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