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A PSYCHOPEDAGOGICAL MODEL OF TPACK DEVELOPMENT IN DEEP LEARNING-ORIENTED ECONOMICS TEACHER EDUCATION

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Abstract

The rapid advancement of digital technology and the growing emphasis on deep learning-oriented education have increased the demand for teachers who can effectively integrate technology into meaningful instructional practices. Among the frameworks developed to explain technology integration competence, Technological Pedagogical Content Knowledge (TPACK) has emerged as one of the most influential. However, existing studies have primarily focused on measuring TPACK levels and evaluating technology integration interventions, while limited attention has been devoted to understanding the developmental mechanisms underlying TPACK formation, particularly among pre-service economics teachers. This conceptual paper aims to develop a psychopedagogical model of TPACK development in deep learning-oriented economics teacher education. Using a conceptual synthesis approach, the study integrates literature on TPACK, teacher professional development, educational technology, deep learning-oriented education, and psychopedagogical factors influencing teacher competence. The proposed model identifies psychological factors, including self-efficacy, motivation, and technology-related beliefs, as foundational conditions influencing teachers' readiness to engage in technology-enhanced learning. These factors interact with pedagogical factors, namely pedagogical readiness, reflective teaching orientation, and deep learning orientation, which function as mechanisms supporting TPACK development. The model further positions TPACK as a key competence contributing to deep learning-oriented teaching competence. The study contributes to the literature by reconceptualizing TPACK development as a psychopedagogical process and provides a theoretical foundation for future empirical research and teacher education program design.

Keywords: TPACK, psychopedagogical model, deep learning-oriented education, economics teacher education, pre-service teachers

INTRODUCTION

The rapid advancement of digital technology has fundamentally transformed educational practices worldwide. Educational institutions are increasingly expected to prepare learners with competencies that enable them to navigate complex social, economic, and technological environments. Consequently, teachers are required not only to possess strong content knowledge and pedagogical skills but also to effectively integrate technology into instructional processes. In contemporary educational settings, technology integration is no longer considered an additional competence; rather, it has become a core component of professional teaching practice. The ability to design meaningful learning experiences through the integration of technology, pedagogy, and subject matter knowledge is, therefore, essential for future teachers (Baran & Uygun, 2016).

The urgency of developing technology-integrated teaching competencies has become even more pronounced with the emergence of educational approaches emphasizing meaningful and

sustainable learning. Across various educational systems, there has been a growing shift from surface-level learning toward deeper forms of learning that encourage critical thinking, conceptual understanding, reflection, and knowledge transfer. This paradigm is commonly referred to as deep learning-oriented education. Deep learning emphasizes learners' ability to construct meaningful understanding, connect knowledge across contexts, and apply concepts to solve authentic problems. Rather than focusing solely on memorization and procedural knowledge, deep learning promotes higher-order cognitive engagement and lifelong learning competencies.

In Indonesia, the importance of deep learning-oriented education has gained increasing attention through recent educational reforms. The implementation of educational policies emphasizing meaningful learning experiences requires teachers to create learning environments that encourage reflection, inquiry, collaboration, and problem-solving. Such expectations place substantial demands on teachers, particularly regarding their capacity to integrate technology into pedagogically meaningful instructional practices. Consequently, teacher education institutions face increasing pressure to prepare future teachers capable of designing and implementing deep learning-oriented instruction in digitally enriched environments.

Within this context, Technological Pedagogical Content Knowledge (TPACK) has emerged as one of the most influential theoretical frameworks for understanding teacher competence in technology integration. Originally developed from Shulman's concept of Pedagogical Content Knowledge (PCK), the TPACK framework conceptualizes effective teaching with technology as an interaction among three fundamental domains of knowledge: content knowledge, pedagogical knowledge, and technological knowledge (Baran & Uygun, 2016). Rather than treating technology as an isolated skill, TPACK emphasizes the dynamic interplay between technology, pedagogy, and content that enables teachers to facilitate meaningful learning experiences.

Over the past decade, TPACK has become a dominant framework in educational technology research. Studies have consistently demonstrated that teachers with stronger TPACK competencies are more capable of integrating digital technologies into instructional practices, designing student-centered learning environments, and facilitating meaningful learning experiences (Tseng et al., 2022). Similarly, Tondeur et al. (2020) found that the development of TPACK among pre-service teachers significantly contributes to their readiness to implement technology-enhanced learning. These findings suggest that TPACK serves as a critical foundation for effective teaching in contemporary educational environments.

The importance of TPACK is particularly evident in teacher education programs. Pre-service teachers represent the future workforce responsible for implementing educational innovations and responding to evolving educational demands. Developing TPACK during teacher preparation programs is therefore essential to ensure that future teachers can effectively utilize technology to support student learning. Previous studies have reported that pre-service teachers generally demonstrate varying levels of TPACK competence, indicating that TPACK development is neither automatic nor uniform across individuals (Krisnaresanti et al., 2023). Such findings suggest that additional factors may influence the formation of TPACK during teacher preparation.

Although TPACK has been extensively studied, existing research has primarily focused on measuring TPACK levels, evaluating teacher training programs, or examining the effects of technology-related interventions. Much of the literature conceptualizes TPACK as an educational outcome resulting from exposure to technology-enhanced learning experiences. Consequently, limited attention has been devoted to understanding the underlying mechanisms that facilitate the development of TPACK itself. This limitation indicates a need for further investigation into the antecedents and developmental processes that shape TPACK among future teachers.

Recent studies have suggested that teacher competence in technology integration is influenced not only by technological knowledge but also by various psychological and pedagogical factors. Psychological factors such as self-efficacy, beliefs about technology, motivation, and confidence have been identified as important determinants of teachers' willingness and ability to adopt

educational technologies. Joo et al. (2018) reported that pre-service teachers' intention to use technology is significantly influenced by their self-efficacy beliefs and perceived technological competence. Similarly, Cheng et al. (2024) demonstrated that teachers' pedagogical beliefs and technology value beliefs play important roles in determining technology integration practices within educational settings.

The influence of psychological factors can be explained through social cognitive perspectives, which emphasize the role of personal beliefs in shaping behavior and professional competence. Teachers with strong self-efficacy are more likely to experiment with innovative instructional strategies, engage in technology integration, and persist when encountering challenges during the teaching process. Conversely, low levels of self-efficacy may inhibit technology adoption and reduce teachers' confidence in designing meaningful learning experiences. These findings suggest that psychological readiness represents a crucial foundation for the development of TPACK.

In addition to psychological dimensions, pedagogical factors also play a significant role in shaping teachers' technology integration competencies. Effective technology integration requires teachers to understand not only how technology functions but also how it can be used to support pedagogical objectives and student learning processes. Pedagogical readiness, reflective teaching orientation, instructional design competence, and learner-centered teaching beliefs are therefore important elements that influence TPACK development. Teachers who possess strong pedagogical competencies are more likely to integrate technology in ways that promote meaningful learning rather than merely using technology for presentation purposes.

The interaction between psychological and pedagogical factors suggests that TPACK development should be viewed as a psychopedagogical process. From this perspective, TPACK is not simply a technical competency acquired through technology training. Instead, it emerges through complex interactions among individual beliefs, motivations, pedagogical understandings, and technology-related experiences. This perspective aligns with contemporary views of teacher professional development, which emphasize the integration of cognitive, affective, and pedagogical dimensions in the formation of professional competence.

Despite increasing recognition of the importance of psychopedagogical factors, several research gaps remain evident within the existing literature. First, most TPACK studies continue to focus on in-service teachers rather than pre-service teachers. While experienced teachers provide valuable insights into technology integration practices, the pre-service phase represents a critical period during which professional competencies are initially formed. Understanding the factors that influence TPACK development during teacher preparation may therefore provide important implications for teacher education programs.

Second, studies examining TPACK among economics teacher candidates remain relatively limited. Much of the existing literature focuses on science, mathematics, language, and general education contexts. Economics education possesses unique characteristics that require teachers to facilitate abstract conceptual understanding, critical analysis of socio-economic phenomena, and application of theoretical knowledge to real-world situations. These characteristics make technology integration particularly important for supporting meaningful learning experiences in economics classrooms. Consequently, further investigation into TPACK development among future economics teachers is warranted.

Third, limited research has examined TPACK development within the context of deep learning-oriented education. Existing TPACK studies generally focus on technology integration without explicitly considering how technology can support deeper forms of learning. Meanwhile, deep learning-oriented education requires teachers to design learning experiences that promote inquiry, reflection, critical thinking, and knowledge transfer. Such instructional demands suggest that TPACK development should be aligned with broader pedagogical goals associated with deep

learning. Integrating these perspectives may provide a more comprehensive understanding of teacher competence in contemporary educational environments.

Furthermore, previous studies have tended to examine psychological or pedagogical variables independently rather than considering their combined influence on TPACK development. This fragmented approach may limit understanding of the complex interactions underlying teacher competence formation. Given that teaching competence emerges through the integration of multiple dimensions, there is a need for a more holistic framework that captures the interconnected roles of psychological and pedagogical factors in shaping TPACK.

Addressing these gaps requires the development of a conceptual framework capable of explaining how psychopedagogical factors contribute to TPACK development among future teachers. Such a framework may provide theoretical insights into the mechanisms underlying teacher competence formation while also offering practical guidance for teacher education programs. By identifying key psychological and pedagogical determinants, teacher educators may be better equipped to design interventions that strengthen TPACK and prepare future teachers for deep learning-oriented instructional practices.

Therefore, this study proposes a psychopedagogical model of TPACK development within the context of deep learning-oriented economics teacher education. The proposed model conceptualizes TPACK as a dynamic competence shaped by the interaction of psychological and pedagogical factors. Psychological dimensions may include self-efficacy, motivation, and technology-related beliefs, whereas pedagogical dimensions encompass pedagogical readiness, reflective teaching orientation, and deep learning orientation. Together, these factors are expected to contribute to the development of TPACK competencies necessary for implementing meaningful and technology-enhanced learning experiences.

The significance of this study lies in its potential contributions to both theory and practice. Theoretically, the study extends the TPACK literature by shifting attention from outcome-oriented perspectives toward the developmental mechanisms underlying TPACK formation. The proposed model contributes to emerging discussions regarding the antecedents of teacher technology competence and integrates insights from educational technology, teacher education, and learning sciences. Practically, the model may provide a foundation for designing teacher preparation programs that systematically foster the psychological and pedagogical capacities required for effective technology integration.

Based on the aforementioned arguments, the purpose of this conceptual paper is to develop a psychopedagogical model of TPACK development in deep learning-oriented economics teacher education. Specifically, the study seeks to synthesize existing theoretical and empirical literature, identify key psychopedagogical determinants of TPACK, and propose a conceptual framework that may guide future empirical investigations and educational interventions aimed at strengthening the professional competencies of future economics teachers.

LITERATURE REVIEW AND HYPOTHESIS FORMULATION

Technological Pedagogical Content Knowledge (TPACK)

Technological Pedagogical Content Knowledge (TPACK) has become one of the most widely accepted frameworks for explaining teachers' competence in integrating technology into teaching and learning processes. The framework extends Shulman's concept of Pedagogical Content Knowledge by incorporating technological knowledge as a critical component of effective teaching in digital learning environments (Baran & Uygun, 2016). TPACK emphasizes that successful technology integration requires more than technological proficiency; it requires the ability to align technological tools with pedagogical approaches and subject content.

The TPACK framework consists of three primary knowledge domains—Technological Knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK)—and four intersecting domains, namely Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK),

Technological Pedagogical Knowledge (TPK), and Technological Pedagogical Content Knowledge (TPACK). These domains collectively explain how teachers make instructional decisions when integrating technology into classroom practice. Previous studies have consistently demonstrated the importance of TPACK in enhancing teaching quality and promoting meaningful learning experiences. Tseng et al. (2022) argued that TPACK serves as a critical foundation for technology-enhanced instruction across educational disciplines. Similarly, Tondeur et al. (2020) found that pre-service teachers who possess higher levels of TPACK demonstrate greater readiness to implement technology-supported instructional strategies.

Research on TPACK has expanded significantly over the past decade. A scientometric analysis conducted by Krisnaresanti et al. (2024a) revealed a substantial increase in TPACK-related publications between 2014 and 2024, indicating growing scholarly interest in teacher technology competence. The study also found that recent TPACK research has increasingly focused on teacher professional development, digital learning environments, and technology-supported pedagogical innovation. Within teacher education, TPACK is increasingly recognized as a fundamental competency that should be developed during the pre-service stage. Krisnaresanti et al. (2023) reported that TPACK levels among pre-service teachers remain heterogeneous, suggesting that technology integration competence develops through a complex process involving multiple influencing factors. Furthermore, a review by Krisnaresanti et al. (2024b) emphasized that sustainable teacher professional development in the digital era requires continuous strengthening of TPACK dimensions rather than isolated technology training programs.

The importance of TPACK is also evident in economics education. Economics teachers are expected to facilitate conceptual understanding, critical thinking, decision-making, and the application of economic principles to real-world contexts. These instructional goals increasingly require the integration of digital technologies capable of supporting interactive, contextual, and student-centered learning experiences. Consequently, understanding how TPACK develops among future economics teachers has become an important research agenda. Despite extensive attention to TPACK measurement and intervention studies, relatively limited research has focused on identifying the underlying determinants of TPACK development. Existing studies predominantly conceptualize TPACK as an educational outcome rather than a competence shaped by psychological and pedagogical antecedents. This limitation suggests the need for a broader perspective that explains the developmental processes contributing to TPACK formation.

Deep Learning-Oriented Education

The rapid transformation of education in the digital era has encouraged educational systems worldwide to move beyond traditional instructional models toward learning approaches that promote deeper cognitive engagement. Deep learning-oriented education emphasizes meaningful understanding, critical reflection, knowledge construction, and the transfer of learning across contexts. Unlike surface learning approaches that prioritize memorization and procedural reproduction, deep learning encourages students to actively construct knowledge and apply conceptual understanding to authentic problems.

Recent educational reforms have increasingly highlighted the importance of deep learning competencies. According to Ghazy et al. (2025), digital transformation in education requires learning environments that support creativity, critical thinking, collaboration, and problem-solving. These competencies cannot be achieved through conventional teacher-centered instruction alone; instead, they require pedagogical approaches that engage students in meaningful learning experiences.

The growing adoption of deep learning-oriented education has significant implications for teacher competence. Teachers are expected to become facilitators of learning rather than mere transmitters of knowledge. This role requires them to design instructional activities that encourage inquiry, reflection, discussion, and authentic problem-solving. Consequently, effective technology

integration becomes increasingly important because digital technologies can provide opportunities for collaboration, simulation, visualization, and personalized learning experiences.

Recent developments in artificial intelligence and adaptive learning technologies further reinforce the relationship between technology and deep learning. Ansor et al. (2023) argued that artificial intelligence-based adaptive learning systems have the potential to address student learning disparities by providing personalized learning pathways. However, the effectiveness of such technologies ultimately depends on teachers' ability to integrate them pedagogically. Therefore, TPACK becomes an essential competency for facilitating deep learning-oriented instruction.

Teacher readiness also plays an important role in implementing educational innovations. Rofi'ah et al. (2024) found that teacher readiness significantly influences the successful implementation of educational reforms and curriculum innovations. This finding suggests that achieving deep learning-oriented education requires not only technological infrastructure but also teachers who possess the competencies necessary to design meaningful learning experiences.

The relationship between TPACK and deep learning is particularly relevant because both frameworks emphasize meaningful learning. While TPACK focuses on integrating technology, pedagogy, and content, deep learning emphasizes meaningful cognitive engagement and knowledge construction. Therefore, teachers with strong TPACK competencies are more likely to utilize technology in ways that support deep learning outcomes rather than merely delivering instructional content.

Psychopedagogical Factors in Teacher Development

Teacher competence is shaped by a combination of psychological and pedagogical factors. Within educational technology research, increasing attention has been devoted to understanding how teachers' beliefs, attitudes, motivations, and pedagogical orientations influence technology integration practices. One of the most widely studied psychological constructs is self-efficacy. Self-efficacy refers to individuals' beliefs regarding their capability to perform specific tasks successfully. According to Joo et al. (2018), self-efficacy significantly influences pre-service teachers' intention to use technology in educational settings. Individuals who possess stronger confidence in their technological capabilities are generally more willing to adopt and integrate digital tools into instructional practice.

Similarly, Cheng et al. (2024) found that self-efficacy, pedagogical beliefs, and technology value beliefs jointly influence teachers' technology integration behavior. These findings suggest that technology competence cannot be understood solely from a technical perspective; psychological readiness plays an equally important role. Motivation and technology-related beliefs also contribute to teacher competence development. Teachers who perceive technology as useful and valuable for learning are more likely to experiment with innovative instructional strategies and persist when encountering implementation challenges. Such beliefs influence not only technology adoption but also the quality of technology integration within classroom practice.

From a pedagogical perspective, teachers must possess the knowledge and skills necessary to design effective learning experiences. Pedagogical readiness includes instructional planning, assessment competence, learner-centered teaching approaches, classroom management, and reflective teaching practices. These competencies enable teachers to align technology use with learning objectives and student needs. Recent studies suggest that technology integration is most effective when psychological and pedagogical dimensions operate simultaneously. Teachers may possess strong technological skills but fail to utilize them effectively if they lack pedagogical competence or confidence. Conversely, teachers with strong pedagogical knowledge may struggle to implement innovative instructional practices if they lack confidence in technology use. Therefore, TPACK development should be understood as a psychopedagogical process involving the interaction of multiple dimensions of teacher competence.

This perspective is consistent with previous studies conducted by Krisnaresanti and colleagues. Research on TPACK profiles among pre-service teachers (Krisnaresanti et al., 2023) and sustainable teacher professional development (Krisnaresanti et al., 2024b) suggests that technology integration competence develops through continuous interactions among professional knowledge, beliefs, and pedagogical experiences. These findings provide a strong rationale for conceptualizing TPACK development as a psychopedagogical phenomenon.

Previous Studies and Research Synthesis

A synthesis of previous studies reveals several important patterns. First, TPACK research has predominantly focused on measuring technology integration competence and evaluating educational interventions (Tseng et al., 2022; Tondeur et al., 2020). While these studies provide valuable insights into teachers' competencies, they offer limited explanations regarding how TPACK develops. Second, growing evidence highlights the importance of psychological variables such as self-efficacy, beliefs, and motivation (Joo et al., 2018; Cheng et al., 2024). However, these variables are often examined independently rather than integrated into a comprehensive developmental framework.

Third, studies involving pre-service teachers indicate that TPACK competence varies considerably across individuals (Krisnaresanti et al., 2023). Such variation suggests the influence of multiple psychological and pedagogical factors that remain insufficiently understood. Fourth, research concerning deep learning-oriented education increasingly emphasizes the need for meaningful technology integration (Ghazy et al., 2025; Ansor et al., 2023). Nevertheless, limited studies have explicitly connected deep learning principles with TPACK development among future teachers. Finally, existing literature provides little evidence regarding the development of TPACK among pre-service economics teachers. Most studies focus on general teacher education, science education, or language education contexts. Consequently, the unique instructional demands of economics education remain underexplored.

Based on these gaps, this study proposes a psychopedagogical model of TPACK development in deep learning-oriented economics teacher education. The model integrates psychological dimensions (self-efficacy, motivation, and technology-related beliefs) and pedagogical dimensions (pedagogical readiness, reflective teaching orientation, and deep learning orientation) to explain the formation of TPACK among future economics teachers.

RESEARCH METHODS

Research Design

This study employed a conceptual paper approach aimed at developing a psychopedagogical model of Technological Pedagogical Content Knowledge (TPACK) development in deep learning-oriented economics teacher education. Conceptual papers are particularly appropriate when existing theories and empirical findings need to be synthesized to generate new theoretical frameworks and research propositions. Rather than testing causal relationships empirically, this study seeks to integrate relevant literature to explain how psychological and pedagogical factors contribute to the development of TPACK among future economics teachers.

The development of the proposed model was motivated by the growing recognition that TPACK is not merely a technological competence but a multidimensional professional capability shaped by various psychological and pedagogical influences (Baran & Uygun, 2016; Tseng et al., 2022). Although previous studies have identified factors associated with technology integration, limited attention has been devoted to developing an integrated framework that explains the mechanisms underlying TPACK formation, particularly within deep learning-oriented teacher education contexts.

Literature Identification and Selection

The conceptual model was developed through a systematic review and synthesis of literature related to TPACK, teacher professional development, educational technology integration, deep learning-oriented education, and psychopedagogical factors influencing teacher competence. The literature selection process focused on peer-reviewed journal articles, conference proceedings, review studies, and educational policy documents that met three criteria. First, the studies addressed TPACK, teacher technology integration, or educational technology competence. Second, the studies examined psychological or pedagogical variables associated with teacher development. Third, the studies provided theoretical or empirical insights relevant to pre-service teacher education and deep learning-oriented instruction.

Key references included foundational and contemporary studies on TPACK (Baran & Uygun, 2016; Tondeur et al., 2020; Tseng et al., 2022), teacher self-efficacy and technology acceptance (Joo et al., 2018), pedagogical beliefs and technology integration (Cheng et al., 2024), and teacher readiness in educational transformation (Rofi'ah et al., 2024). In addition, previous studies conducted by the authors concerning TPACK profiles among pre-service teachers, teacher professional development, and TPACK research trends were incorporated to strengthen the contextual relevance of the proposed model (Krisnaresanti et al., 2023; Krisnaresanti et al., 2024a; Krisnaresanti et al., 2024b).

Furthermore, literature addressing digital transformation and emerging learning paradigms was reviewed to establish the relevance of deep learning-oriented education. Studies by Ghazy et al. (2025) and Ansor et al. (2023) provided insights into the evolving demands of digital learning environments and the increasing importance of technology-supported meaningful learning.

Conceptual Synthesis Procedure

The conceptual synthesis process consisted of four interrelated stages.

Stage 1: Literature Mapping

The first stage involved mapping existing research to identify dominant themes and trends within the TPACK literature. Previous scientometric evidence indicates that TPACK research has expanded considerably over the last decade, particularly in relation to teacher professional development, digital pedagogy, and technology-enhanced learning environments (Krisnaresanti et al., 2024a). This stage enabled the identification of theoretical gaps concerning the antecedents of TPACK development.

Stage 2: Identification of Psychopedagogical Constructs

The second stage focused on identifying psychological and pedagogical variables frequently associated with teacher technology integration. The literature consistently highlighted self-efficacy, motivation, technology-related beliefs, and confidence as important psychological dimensions influencing technology use (Joo et al., 2018; Cheng et al., 2024). Simultaneously, pedagogical readiness, reflective teaching orientation, learner-centered instruction, and deep learning orientation emerged as critical pedagogical dimensions supporting effective technology integration.

Stage 3: Theoretical Integration

The third stage involved synthesizing the identified constructs into a coherent explanatory framework. During this process, theoretical relationships among psychological factors, pedagogical factors, and TPACK were examined and integrated. Existing evidence suggests that teachers with stronger self-efficacy and more positive beliefs about technology are more likely to engage in technology integration practices (Joo et al., 2018; Cheng et al., 2024). Likewise, teachers possessing strong pedagogical competence are better positioned to use technology in ways that facilitate meaningful learning experiences (Tondeur et al., 2020).

The integration process was also informed by the principles of deep learning-oriented education, which emphasize critical thinking, reflection, conceptual understanding, and knowledge

transfer (Ghazy et al., 2025). Consequently, deep learning orientation was incorporated as an important pedagogical dimension within the proposed framework.

Stage 4: Model Development

The final stage involved constructing a conceptual model that explains TPACK development as a psychopedagogical process. The proposed model conceptualizes TPACK as an outcome of interactions between psychological factors (e.g., self-efficacy, motivation, and technology beliefs) and pedagogical factors (e.g., pedagogical readiness, reflective teaching orientation, and deep learning orientation).

The resulting framework provides a theoretical foundation for future empirical studies aimed at validating the proposed relationships and identifying the most influential determinants of TPACK among pre-service economics teachers. Moreover, the model offers practical guidance for teacher education institutions seeking to design learning experiences that support the development of technology-enhanced teaching competencies in deep learning-oriented educational environments.

RESULTS AND DISCUSSION

Mapping the Evolution of TPACK Research

The literature review reveals that research on Technological Pedagogical Content Knowledge (TPACK) has experienced significant growth over the last decade. Initially, studies focused primarily on conceptualizing the TPACK framework and measuring teachers' levels of technological integration competence. As the field matured, research increasingly examined instructional interventions, teacher training programs, and technology-enhanced learning practices aimed at improving TPACK competencies among both in-service and pre-service teachers (Tseng et al., 2022).

A scientometric analysis conducted by Krisnaresanti et al. (2024a) demonstrated that TPACK research between 2014 and 2024 evolved from descriptive investigations toward more complex studies examining teacher professional development, digital pedagogy, and educational transformation. This trend suggests that scholars increasingly recognize TPACK as a multidimensional construct influenced by various contextual, pedagogical, and psychological factors rather than merely a technological competence.

Despite this growing body of knowledge, the literature remains largely dominated by studies that position TPACK as an outcome variable. Many researchers have focused on measuring teachers' TPACK levels, evaluating the effectiveness of technology integration programs, or examining relationships between TPACK and instructional performance (Tondeur et al., 2020). Comparatively fewer studies have attempted to explain how TPACK develops or what factors contribute to its formation among future teachers.

The review also reveals that pre-service teacher education has become an increasingly important context for TPACK research. Since teacher preparation programs represent the initial stage of professional competence formation, understanding the factors influencing TPACK development during this period is essential. Krisnaresanti et al. (2023) found substantial variations in TPACK levels among pre-service teachers, indicating that technology integration competence is not automatically acquired through exposure to digital technologies. Rather, TPACK appears to emerge through complex interactions among personal characteristics, educational experiences, and pedagogical competencies.

Furthermore, recent educational reforms emphasizing digital transformation and deep learning-oriented education have created new demands for teacher competence. These developments suggest that TPACK should no longer be viewed solely as a framework for technology integration but also as a foundation for designing meaningful learning experiences that promote critical thinking, reflection, and knowledge transfer (Ghazy et al., 2025). Based on this mapping

process, it becomes evident that existing TPACK literature has not adequately addressed the psychopedagogical mechanisms underlying TPACK development. Consequently, a new conceptual framework is required to explain how psychological and pedagogical dimensions contribute to the formation of TPACK among future economics teachers.

Identification of Psychopedagogical Determinants of TPACK Development

The second stage of analysis focused on identifying the psychological and pedagogical factors consistently associated with technology integration competence in previous studies. The literature suggests that TPACK development is influenced by multiple dimensions that extend beyond technological knowledge itself.

Psychological Factors

Among the psychological variables identified in the literature, self-efficacy emerged as one of the most influential determinants of technology integration competence. Joo et al. (2018) demonstrated that pre-service teachers with higher levels of self-efficacy exhibit stronger intentions to use technology in educational settings. Self-efficacy influences individuals' willingness to engage with new technologies, overcome implementation challenges, and persist when encountering difficulties during instructional practice.

Technology-related beliefs also play a critical role in shaping teachers' technology integration behaviors. Teachers who perceive technology as useful and valuable for enhancing student learning are more likely to experiment with innovative instructional approaches. Cheng et al. (2024) found that technology value beliefs significantly influence teachers' integration of educational technologies, particularly when combined with strong pedagogical beliefs and self-efficacy.

Motivation represents another important psychological dimension. Motivated teachers tend to seek opportunities for professional growth, explore emerging technologies, and continuously improve their instructional practices. In digitally transforming educational environments, intrinsic motivation may facilitate the development of competencies required for technology-enhanced teaching. Collectively, these findings suggest that psychological readiness forms the foundation upon which TPACK development occurs. Teachers who possess confidence, motivation, and positive beliefs regarding technology are more likely to engage in learning experiences that strengthen their technology integration competence.

Pedagogical Factors

In addition to psychological dimensions, the literature consistently highlights the importance of pedagogical factors in shaping TPACK development. Effective technology integration requires teachers to understand how learning occurs and how instructional strategies can be adapted to support student learning objectives. Pedagogical readiness emerged as a particularly important determinant. Teachers with strong pedagogical knowledge are better equipped to align technology use with curriculum goals, assessment strategies, and learner needs. Such competence enables them to move beyond technology use for presentation purposes and toward meaningful instructional integration.

Reflective teaching orientation also appears to contribute significantly to professional competence development. Reflection enables teachers to evaluate instructional effectiveness, identify learning challenges, and improve teaching strategies. Within technology-enhanced learning environments, reflective practices support continuous adaptation and innovation. Another pedagogical factor identified through the literature is deep learning orientation. Contemporary educational reforms increasingly emphasize meaningful learning, critical thinking, collaboration, and knowledge transfer (Ghazy et al., 2025). Teachers who embrace deep learning principles are more likely to utilize technology as a tool for facilitating inquiry, problem-solving, and conceptual understanding rather than simple information delivery.

Evidence from studies on teacher readiness further supports the importance of pedagogical dimensions. Rofi'ah et al. (2024) found that teachers' readiness significantly affects the successful implementation of educational innovations. This finding suggests that pedagogical preparedness serves as a critical prerequisite for adopting and utilizing educational technologies effectively. Taken together, these findings indicate that pedagogical factors function as mechanisms through which technology integration competence is translated into meaningful learning experiences. Consequently, pedagogical dimensions should be considered central components of any framework explaining TPACK development.

Development of the Proposed Psychopedagogical Model

The synthesis of literature resulted in the development of a psychopedagogical model of TPACK development in deep learning-oriented economics teacher education. The proposed model conceptualizes TPACK as a dynamic competence that emerges through interactions between psychological and pedagogical dimensions. The psychological dimension consists of three primary constructs: self-efficacy, motivation, and technology-related beliefs. These constructs influence teachers' willingness to engage with technology, explore innovative instructional practices, and persist in developing professional competence. Psychological factors are therefore conceptualized as enabling conditions that stimulate learning and professional growth.

The pedagogical dimension comprises pedagogical readiness, reflective teaching orientation, and deep learning orientation. These constructs represent teachers' capacity to design meaningful learning experiences, critically evaluate instructional effectiveness, and facilitate higher-order cognitive engagement among learners. The model proposes that psychological factors influence TPACK both directly and indirectly through pedagogical factors. Teachers with strong self-efficacy and positive technology beliefs are more likely to develop pedagogical competencies that support meaningful technology integration. Simultaneously, pedagogical readiness strengthens the ability to apply technological knowledge within authentic instructional contexts.

The incorporation of deep learning orientation represents a distinctive feature of the proposed model. Previous TPACK frameworks have largely emphasized technology integration without explicitly addressing the learning outcomes that technology integration seeks to achieve. In contrast, the present model positions deep learning orientation as a critical pedagogical mechanism linking TPACK to meaningful educational practice. Within economics teacher education, this relationship is particularly important because economics learning requires students to analyze complex issues, evaluate evidence, and apply conceptual knowledge to real-world situations. Teachers must therefore possess competencies that enable them to facilitate higher-order thinking through technology-supported learning environments.

The proposed model also aligns with contemporary perspectives on teacher professional development. Previous studies have argued that sustainable professional growth requires continuous interaction among cognitive, affective, and pedagogical dimensions (Krisnaresanti et al., 2024b). By integrating psychological and pedagogical constructs within a single framework, the model offers a more comprehensive explanation of TPACK development than existing approaches. Overall, the results of this conceptual synthesis suggest that TPACK development should be understood as a psychopedagogical process rather than a purely technological one. The proposed framework provides a theoretical basis for future empirical studies seeking to examine the relative influence of psychological and pedagogical determinants on TPACK among pre-service economics teachers. Furthermore, the model offers practical guidance for teacher education institutions aiming to prepare future teachers capable of implementing deep learning-oriented instruction in digitally enriched educational environments.

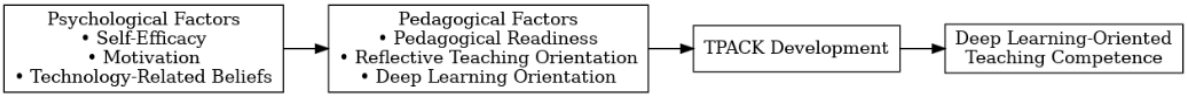


Figure 1. Conceptual Model

DISCUSSION

The present study aimed to develop a psychopedagogical model of TPACK development in deep learning-oriented economics teacher education. Through the synthesis of previous literature, the proposed model positions TPACK development as a dynamic process influenced by the interaction between psychological and pedagogical factors. The findings extend existing discussions on technology integration by arguing that TPACK is not solely a technological competence but rather a multidimensional professional capability shaped by teachers' beliefs, motivations, pedagogical readiness, and orientations toward meaningful learning. The proposed framework therefore contributes to a more comprehensive understanding of how future teachers develop the competencies required for effective teaching in digitally enriched educational environments.

TPACK Development as a Psychopedagogical Process

One of the primary contributions of this study is the reconceptualization of TPACK development as a psychopedagogical process. Existing TPACK research has predominantly focused on measuring teachers' technological, pedagogical, and content knowledge or examining the outcomes of technology integration interventions (Tseng et al., 2022; Tondeur et al., 2020). Although these studies have significantly advanced the field, they generally treat TPACK as an outcome variable rather than investigating the developmental mechanisms that lead to its formation.

The proposed model suggests that TPACK emerges through interactions between internal psychological dispositions and pedagogical capabilities. This perspective aligns with contemporary views of teacher professional development, which emphasize that professional competence is not merely acquired through knowledge transmission but develops through complex interactions among cognitive, affective, and contextual factors. Teachers do not automatically develop TPACK simply because they are exposed to technology. Instead, they must possess the confidence, motivation, and pedagogical understanding necessary to transform technological resources into meaningful learning opportunities.

This interpretation is supported by findings from Joo et al. (2018), who demonstrated that self-efficacy significantly influences pre-service teachers' intention to use technology. Similarly, Cheng et al. (2024) found that teachers' technology value beliefs and pedagogical beliefs jointly influence technology integration practices. These studies suggest that psychological readiness functions as an enabling condition for professional growth, supporting the argument that TPACK development should be viewed as a process involving both psychological and pedagogical dimensions. The psychopedagogical perspective also provides a more holistic explanation of teacher competence development. Rather than separating technological competence from pedagogical competence, the model recognizes that effective technology integration requires the simultaneous development of both dimensions. Consequently, efforts to strengthen TPACK among future teachers should move beyond technical training and incorporate interventions aimed at enhancing self-efficacy, motivation, reflective practice, and pedagogical readiness.

The Role of Psychological Factors in TPACK Development

The proposed model identifies self-efficacy, motivation, and technology-related beliefs as key psychological determinants of TPACK development. These factors serve as internal drivers that influence teachers' willingness to engage in professional learning and technology integration activities. Among these factors, self-efficacy appears particularly important. Social cognitive theory suggests that individuals who believe in their capabilities are more likely to undertake challenging tasks, persist in the face of difficulties, and demonstrate higher levels of performance. Within educational settings, teachers with strong self-efficacy are more likely to experiment with

innovative instructional practices and adopt new technologies. This perspective is consistent with previous research indicating that self-efficacy positively influences technology adoption and instructional innovation (Joo et al., 2018).

Motivation also plays a critical role in shaping professional competence. Teachers who are intrinsically motivated to improve their teaching practices tend to seek learning opportunities, explore emerging technologies, and engage in continuous professional development. In the context of digital transformation, motivation becomes increasingly important because technological innovations require ongoing adaptation and learning. Without sufficient motivation, teachers may resist change or limit technology use to routine instructional tasks.

Technology-related beliefs constitute another important psychological dimension. Teachers' perceptions regarding the usefulness, relevance, and educational value of technology influence their decisions concerning technology integration. Cheng et al. (2024) demonstrated that teachers who perceive technology as beneficial for learning are more likely to incorporate it into classroom instruction. Therefore, positive technology beliefs not only encourage technology adoption but also influence the quality and depth of technology integration. The inclusion of these psychological factors contributes to a growing body of literature emphasizing the affective dimensions of teacher competence. Previous studies have frequently focused on knowledge and skills while paying comparatively less attention to beliefs and motivations. The present model highlights that psychological readiness is not merely a supplementary factor but a foundational condition influencing the development of TPACK.

Pedagogical Readiness as a Developmental Mechanism

While psychological factors provide the internal conditions for professional growth, pedagogical factors function as developmental mechanisms through which TPACK is translated into meaningful instructional practice. The proposed model identifies pedagogical readiness, reflective teaching orientation, and deep learning orientation as essential pedagogical dimensions. Pedagogical readiness encompasses teachers' capacity to design instruction, facilitate learning, assess student performance, and manage classroom interactions effectively. Previous research has consistently emphasized the importance of pedagogical competence in successful technology integration (Tondeur et al., 2020). Technology can only contribute to learning when it is embedded within pedagogically sound instructional strategies. Consequently, pedagogical readiness represents a critical bridge connecting technological knowledge and classroom practice.

Reflective teaching orientation further strengthens this relationship by encouraging continuous professional learning. Reflection enables teachers to evaluate instructional effectiveness, identify challenges, and adapt their teaching strategies to changing learning needs. Within technology-enhanced learning environments, reflective practice becomes particularly important because technological innovations continuously reshape educational opportunities and challenges. The significance of reflective teaching can also be understood within the broader context of professional development. Sustainable professional growth requires teachers to engage in ongoing cycles of planning, implementation, evaluation, and improvement. Through reflection, teachers become active participants in their own professional learning, thereby increasing the likelihood of meaningful TPACK development.

The integration of pedagogical readiness and reflective teaching orientation within the proposed model therefore emphasizes that TPACK development is not a static achievement but a continuous developmental process. This perspective aligns with previous discussions regarding sustainable teacher professional development and the need for lifelong learning among educators (Krisnaresanti et al., 2024b).

Deep Learning Orientation and Contemporary Teacher Education

A distinctive feature of the proposed model is the incorporation of deep learning orientation as a core pedagogical construct. While existing TPACK frameworks primarily focus on technology integration, they often provide limited guidance regarding the educational purposes that technology integration should serve. The present model addresses this limitation by explicitly linking TPACK development to deep learning-oriented education. Deep learning emphasizes meaningful understanding, critical thinking, knowledge transfer, collaboration, and problem-solving. These competencies have become increasingly important as educational systems respond to rapid technological, economic, and social change. Consequently, teachers are expected not only to integrate technology but also to utilize technology in ways that support deeper forms of learning. The integration of deep learning orientation into the model reflects recent educational transformation trends. Ghazy et al. (2025) argued that contemporary education requires learning environments capable of fostering creativity, innovation, and critical inquiry. Similarly, adaptive learning technologies and artificial intelligence-based educational systems increasingly support personalized and meaningful learning experiences (Ansor et al., 2023). However, the educational value of these innovations ultimately depends on teachers' ability to utilize them effectively.

For economics education, deep learning orientation is particularly relevant. Economics involves complex concepts, abstract reasoning, evidence-based analysis, and decision-making processes that require higher-order cognitive engagement. Therefore, future economics teachers must be capable of designing learning experiences that encourage students to analyze economic phenomena critically and apply theoretical concepts to authentic situations. The inclusion of deep learning orientation expands the scope of TPACK by emphasizing not only how technology should be integrated but also why technology should be integrated. In this sense, technology becomes a means of facilitating meaningful learning rather than an end in itself. This perspective strengthens the relevance of the proposed model for contemporary teacher education programs seeking to prepare teachers for the demands of twenty-first-century learning environments.

Theoretical Contributions of the Proposed Model

The proposed model contributes to the literature in several important ways. First, it extends existing TPACK research by shifting attention from measurement and intervention studies toward the developmental mechanisms underlying TPACK formation. By conceptualizing TPACK as a psychopedagogical process, the model offers a more comprehensive explanation of how technology integration competence develops among future teachers. Second, the model integrates psychological and pedagogical perspectives that have often been examined separately in previous research. Existing studies have investigated self-efficacy, technology beliefs, pedagogical competence, and teacher readiness independently. The present framework synthesizes these variables into a unified model, thereby providing a more holistic understanding of teacher competence development.

Third, the model introduces deep learning orientation as an essential pedagogical construct influencing TPACK development. This contribution responds to growing calls for educational research that connects technology integration with meaningful learning outcomes rather than focusing exclusively on technology adoption. Finally, the model contributes specifically to the field of economics teacher education. While TPACK research has expanded considerably, relatively few studies have focused on future economics teachers. The proposed framework therefore provides a theoretical foundation for future investigations examining technology integration competence within economics education contexts.

Practical Implications for Economics Teacher Education

The proposed model also offers important practical implications for teacher education institutions. First, teacher preparation programs should move beyond technology skills training and adopt more comprehensive approaches that address psychological and pedagogical dimensions

simultaneously. Developing self-efficacy, motivation, and positive technology beliefs should become integral components of teacher education curricula. Second, teacher education programs should provide opportunities for reflective practice and authentic technology integration experiences. Such experiences can help future teachers connect technological knowledge with pedagogical decision-making and classroom realities.

Third, the findings suggest that deep learning principles should be integrated into teacher preparation programs. Future teachers need opportunities to design learning experiences that promote inquiry, collaboration, critical thinking, and knowledge transfer. By combining deep learning pedagogy with TPACK development, teacher education institutions can better prepare graduates for the demands of contemporary education. Ultimately, the proposed model highlights that preparing future economics teachers for digital transformation requires more than technological competence alone. It requires the development of psychopedagogical capacities that enable teachers to utilize technology strategically, reflectively, and meaningfully in support of deep learning-oriented educational goals.

CONCLUSION

This study developed a psychopedagogical model of TPACK development in deep learning-oriented economics teacher education through a conceptual synthesis of existing literature on educational technology, teacher professional development, and deep learning-oriented instruction. The proposed model addresses an important gap in the TPACK literature by shifting attention from technology integration outcomes toward the developmental mechanisms that contribute to the formation of TPACK among future teachers.

The findings suggest that TPACK development should be understood as a dynamic psychopedagogical process rather than merely a technological competency. The model identifies psychological factors, including self-efficacy, motivation, and technology-related beliefs, as foundational conditions that influence teachers' readiness to engage with technology-enhanced learning environments. Simultaneously, pedagogical factors, namely pedagogical readiness, reflective teaching orientation, and deep learning orientation, function as developmental mechanisms that translate psychological readiness into meaningful instructional competence. Through the interaction of these dimensions, pre-service economics teachers develop the capacity to integrate technological, pedagogical, and content knowledge effectively.

A distinctive contribution of the proposed model lies in the integration of deep learning orientation into the TPACK development process. While previous studies have primarily emphasized technology integration, the present framework highlights the importance of aligning technology use with meaningful learning outcomes such as critical thinking, knowledge construction, problem-solving, and knowledge transfer. Consequently, the model extends existing TPACK perspectives by linking technology integration competence to the broader goals of deep learning-oriented education.

The study also offers practical implications for economics teacher education programs. Teacher preparation institutions should design learning experiences that not only strengthen technological competencies but also cultivate psychological readiness, reflective practice, and pedagogical capabilities that support meaningful technology integration. Such an approach may better prepare future teachers to respond to the challenges of digital transformation and contemporary educational reform.

As a conceptual study, this research has several limitations. The proposed relationships among psychological factors, pedagogical factors, and TPACK development have not yet been empirically tested. Therefore, future studies are encouraged to validate the proposed model using quantitative approaches, such as Structural Equation Modeling (SEM) or Partial Least Squares Structural Equation Modeling (PLS-SEM), involving pre-service economics teachers. Empirical

validation will provide further evidence regarding the relative influence of each construct and contribute to the refinement of the psychopedagogical model proposed in this study.

In conclusion, the proposed framework provides a theoretical foundation for understanding TPACK development in deep learning-oriented economics teacher education and offers a promising direction for future research and teacher professional development initiatives in the digital era. Ultimately, preparing future economics teachers for the demands of the digital era requires more than technological proficiency; it requires the development of psychopedagogical capacities that enable technology to become a catalyst for meaningful and deep learning.

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