A Psychopedagogical Framework for TPACK Development among Pre-Service Economics Teachers for Deep Learning-Oriented Instruction

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Abstract

TPACK development among pre-service economics teachers has largely been examined in terms of competence levels and technology integration. At the same time, limited attention has been given to the psychopedagogical conditions underlying its development. This study aims to develop and validate a psychopedagogical model explaining TPACK development among pre-service economics teachers for deep learning-oriented instruction. A conceptual research design was employed through literature identification, conceptual synthesis, construct identification, theoretical integration, expert judgment, and model refinement. The synthesis identified six key psychopedagogical constructs: self-efficacy, motivation, and technology-related beliefs as psychological factors, and pedagogical readiness, reflective teaching orientation, and deep learning orientation as pedagogical factors. These constructs were integrated into a developmental framework positioning psychological conditions as foundational factors and pedagogical factors as mechanisms supporting TPACK development. Expert judgment was conducted to assess the conceptual relevance, coherence, and appropriateness of the proposed relationships, resulting in refinement of the model. The resulting framework conceptualizes TPACK as a developing professional capability rather than merely a technological competence and positions deep learning as the pedagogical purpose guiding technology integration. The validated conceptual model provides a theoretical foundation for subsequent empirical testing and offers implications for strengthening pre-service economics teacher education.

Keywords: Deep Learning; Pre-Service Economics Teachers; Psychopedagogical Factors; Teacher Competence; TPACK;

I. INTRODUCTION

The rapid transformation of digital technology has fundamentally changed the knowledge, skills, and competencies expected of teachers. Technology is increasingly embedded in instructional planning, learning resources, classroom interaction, assessment, and the development of learning experiences that are more contextual and learner-centered. Consequently, effective technology integration requires more than teachers' ability to operate digital tools. Teachers need to understand how technology can be strategically aligned with pedagogical approaches and subject-specific content to facilitate meaningful learning. Technological Pedagogical Content Knowledge (TPACK) has emerged as an influential framework for conceptualizing this integrated form of teacher competence. TPACK extends the concept of pedagogical content knowledge by emphasizing the dynamic interaction among technological, pedagogical, and content knowledge in technology-enhanced teaching (Baran & Uygun, 2016; Tondeur et al., 2020). Thus, the quality of technology integration depends not simply on technological proficiency but on teachers' ability to make appropriate pedagogical decisions regarding when, why, and how technology should be used within particular content domains.

The development of TPACK is particularly important during the pre-service stage because teacher education represents a critical period for the formation of professional teaching competencies. Pre-service teachers are expected to develop not only disciplinary and pedagogical knowledge but also the capacity to integrate technology into authentic instructional situations. Evidence indicates that TPACK can be deliberately developed through teacher education experiences. Tondeur et al. (2020), for example, demonstrated that strategies such as teacher educators serving as role models, reflection on the role of technology, learning technology through design, peer collaboration, authentic technology experiences, and continuous feedback can support the development of pre-service teachers' TPACK. Similarly, a meta-analysis by Ning et al. (2022) found a positive overall effect of teacher education interventions on teachers' TPACK, indicating that TPACK should be understood as a competence that can be cultivated rather than as a fixed personal characteristic. These findings reinforce the importance of examining the developmental processes through which future teachers acquire and integrate technological, pedagogical, and content knowledge.

However, the development of TPACK cannot be fully explained by educational experiences or technological exposure alone. Increasing evidence suggests that teachers' psychological characteristics and beliefs influence how they engage with technology and translate technological knowledge into instructional practice. One important psychological factor is teacher self-efficacy, referring to individuals' beliefs regarding their capability to successfully perform particular tasks. In the context of educational technology, self-efficacy can influence teachers' willingness to experiment with unfamiliar technologies, persist when encountering difficulties, and apply technology to improve student learning. Joo et al. (2018), using structural equation modeling with 296 pre-service teachers, demonstrated significant relationships among TPACK, teacher self-efficacy, perceived ease of use, perceived usefulness, and technology-use intentions. Their findings indicate that technology integration is closely connected to teachers' perceptions of their own capabilities and their perceptions of technology.

Technology-related beliefs constitute another important psychological dimension. Teachers may possess adequate technical knowledge but remain reluctant to integrate technology when they perceive limited pedagogical value or usefulness. Conversely, positive beliefs regarding the utility and educational value of technology can encourage experimentation and more active integration into teaching. Nelson and Voithofer (2022), based on structural equation modeling involving pre-service teachers from multiple institutions, found that interest in educational technology and beliefs regarding its utility predicted TPACK application. Their study also demonstrated that self-efficacy for improving student learning through technology predicted both technology value beliefs and TPACK application. These findings suggest that psychological readiness is not peripheral to technology integration but represents an important condition underlying the translation of technological knowledge into teaching practice.

The role of psychological factors becomes even more important when TPACK is conceptualized as a developmental rather than static competence. The literature has frequently examined TPACK by measuring teachers' knowledge levels or evaluating the effectiveness of interventions designed to improve technology integration. Although such studies have made important contributions, comparatively less attention has been directed toward explaining the psychological mechanisms through which TPACK develops. Recent evidence indicates that beliefs, self-efficacy, motivation, and educational experiences interact in shaping teachers' technology-related practices. Therefore, understanding TPACK development requires attention not only to what teachers know about technology but also to what they believe, how confident they feel, and how motivated they are to use technology for instructional purposes (Joo et al., 2018; Nelson & Voithofer, 2022).

In addition to psychological conditions, TPACK development is closely related to pedagogical competence and readiness. Technology does not automatically improve learning merely because it is incorporated into instruction. Teachers must be able to identify learning objectives, understand learners' characteristics, select appropriate instructional strategies, and determine how technology can contribute to particular learning outcomes. Baran and Uygun (2016) emphasized that TPACK-in-action involves connecting theoretical knowledge with practical instructional decision-making. Their design-based learning approach demonstrated the importance of theory–practice connections, readiness for practice, technological proficiency, and sustainable development of TPACK within teacher education. Likewise, Tondeur et al. (2020) showed that authentic experiences, reflection, collaboration, and feedback constitute important strategies for preparing pre-service teachers to integrate technology meaningfully.

Reflective teaching orientation is therefore relevant to TPACK development because technology integration requires continuous evaluation and adaptation. Teachers need to consider whether the technology selected actually supports learning objectives, whether students are meaningfully engaged, and whether alternative pedagogical strategies may produce better learning outcomes. Reflection can facilitate the transformation of teaching experiences into professional knowledge by encouraging teachers to identify problems, evaluate instructional decisions, and revise subsequent practices. In this sense, reflective orientation complements technological and pedagogical knowledge by supporting the continuous development of teachers' instructional decision-making.

The relevance of these psychopedagogical dimensions becomes increasingly apparent in the context of deep learning-oriented instruction. Contemporary educational reforms have increasingly emphasized learning that goes beyond memorization toward conceptual understanding, critical thinking, reflection, problem solving, collaboration, and the transfer of knowledge across contexts. Such an orientation requires teachers to use technology purposefully to create meaningful learning experiences rather than merely to digitize conventional teaching practices. Recent evidence from Indonesia indicates that teacher readiness to adopt deep learning pedagogy is associated with technological knowledge and broader twenty-first-century competencies. Fitrah et al. (2025), based on a survey of 802 teachers in Indonesia, found that both technological knowledge and twenty-first-century competencies contributed to teachers' readiness to adopt deep learning pedagogy, with twenty-first-century competencies demonstrating a stronger contribution in their model.

The connection between TPACK and deep learning is consequently important because technology integration should ultimately serve pedagogical purposes. A teacher may possess substantial technological knowledge but still fail to create deep learning opportunities if technology is used primarily for presentation, information delivery, or routine classroom administration. Conversely, TPACK provides a basis for selecting and adapting technological resources according to content, pedagogical strategies, and intended learning outcomes. This perspective suggests that deep learning orientation can function as an important pedagogical condition in the development and application of TPACK, particularly when future teachers are expected to design learning experiences emphasizing inquiry, reflection, critical thinking, problem solving, and knowledge transfer.

The context of pre-service economics teachers deserves particular attention. Economics education requires teachers to connect abstract economic concepts with real-world phenomena, decision-making, problem solving, data interpretation, and contemporary socioeconomic issues. Digital technologies can potentially provide access to economic data, simulations, interactive visualizations, collaborative learning environments, and authentic problem contexts. However, effective use of these resources requires the integration of technological, pedagogical, and economics-specific content knowledge. Previous research by Krisnaresanti et al. (2023) specifically examined TPACK profiles among pre-service teachers

in an Economics Education Study Program at Universitas Jenderal Soedirman. The study involved 111 respondents and found that all seven TPACK components were categorized as good, although Technological Knowledge and Technological Content Knowledge were relatively more prominent while Content Knowledge was the lowest component. These findings indicate that pre-service economics teachers possess a meaningful foundation of technology-related competence but also suggest the importance of examining the factors that explain differences in their TPACK development.

This issue is consistent with broader trends in TPACK research. A scientometric analysis conducted by Krisnaresanti et al. (2024) identified substantial growth in TPACK research during 2014–2024 and demonstrated increasing scholarly attention to technology integration, teacher professional development, digital learning environments, and educational transformation. Nevertheless, the expansion of TPACK research does not necessarily mean that the developmental mechanisms underlying TPACK are sufficiently understood. Jurnal Pendidikan Progresif The conceptual synthesis developed in the authors' previous ICSEMA study similarly proposed that TPACK development should be viewed as a psychopedagogical process involving psychological factors—such as self-efficacy, motivation, and technology-related beliefs—and pedagogical factors—including pedagogical readiness, reflective teaching orientation, and deep learning orientation. The conceptual model positioned these factors as conditions supporting the development of TPACK among future economics teachers and explicitly identified empirical validation as an important direction for subsequent research.

Despite these developments, several research gaps remain. First, much of the TPACK literature has focused on measuring TPACK levels or examining interventions rather than directly explaining the psychological and pedagogical determinants underlying TPACK development. Second, psychological variables such as self-efficacy, motivation, and technology-related beliefs have frequently been investigated separately, making it difficult to understand their combined contribution to teacher technology competence. Third, pedagogical conditions such as readiness, reflection, and orientation toward meaningful learning have not always been integrated with psychological determinants into a unified explanatory model. Fourth, empirical research specifically examining TPACK development among pre-service economics teachers remains limited compared with studies involving broader teacher populations or other disciplinary contexts. Finally, the relationship between TPACK development and deep learning-oriented instruction remains insufficiently examined, particularly within the context of Indonesian teacher education. The authors' previous conceptual work addressed these gaps by proposing an integrated psychopedagogical framework; however, the proposed relationships require empirical examination.

Accordingly, this study aims to develop and conceptually validate a psychopedagogical model of TPACK development among pre-service economics teachers for deep learning-oriented instruction. Specifically, the study identifies and integrates psychological factors, comprising self-efficacy, motivation, and technology-related beliefs, and pedagogical factors, comprising pedagogical readiness, reflective teaching orientation, and deep learning orientation, into a theoretically grounded framework for explaining TPACK development. The study contributes theoretically by extending the understanding of TPACK from a predominantly competence-oriented perspective toward a psychopedagogical developmental perspective. Practically, the model provides a foundation for designing teacher education experiences that strengthen psychological readiness, pedagogical capability, reflective practice, and purposeful technology integration for deep learning-oriented instruction.

II. METHOD

This study employed a conceptual research design to develop and validate a psychopedagogical model of Technological Pedagogical Content Knowledge (TPACK) development among pre-service economics teachers for deep learning-oriented instruction. The study was conducted as an initial model-development stage within a broader research program that is intended to be followed by empirical testing. The research design was based on a conceptual synthesis approach, in which relevant theoretical and empirical literature was systematically examined and integrated to identify constructs, clarify their conceptual relationships, and develop a coherent explanatory framework. The approach was considered appropriate because the primary objective of the present stage was not to statistically test causal or predictive relationships, but to establish a theoretically grounded model that could subsequently be subjected to empirical validation.

The conceptual development process integrated literature related to TPACK, pre-service teacher education, teacher professional development, educational technology, psychological determinants of teacher competence, pedagogical development, and deep learning-oriented education. The resulting synthesis was used to formulate the proposed relationships among psychological factors, pedagogical factors, and TPACK development. The study subsequently employed expert judgment to assess the conceptual relevance and coherence of the proposed model. Thus, the methodological sequence consisted of literature identification and synthesis, construct identification, theoretical integration, initial model development, expert validation, and model refinement. This procedure is consistent with the conceptual framework previously developed in the authors' work, which identified self-efficacy, motivation, technology-related beliefs, pedagogical readiness, reflective teaching orientation, and deep learning orientation as relevant components of the proposed psychopedagogical framework.

The first stage involved identifying relevant literature concerning the development of TPACK and the factors that may contribute to technology-integrated teaching competence. The literature synthesis covered five interconnected areas: (1) TPACK and technology integration, (2) pre-service teacher education, (3) psychological determinants of teacher competence, (4) pedagogical development and reflective practice, and (5) deep learning-oriented instruction. The literature was examined not merely to summarize previous findings but to identify recurring constructs and theoretical relationships that could explain how TPACK develops within teacher education. Particular attention was given to studies examining teacher self-efficacy, technology-related beliefs, motivation, pedagogical readiness, reflective practice, and approaches to meaningful or deep learning.

The synthesis resulted in the identification of six core constructs. Three constructs were categorized as psychological factors: self-efficacy, motivation, and technology-related beliefs. Three additional constructs were categorized as pedagogical factors: pedagogical readiness, reflective teaching orientation, and deep learning orientation. These constructs were subsequently integrated into a developmental framework in which psychological conditions provide an important foundation for pedagogical development and TPACK development.

The conceptual synthesis did not assume that the identified relationships had already been empirically established. Rather, the relationships were formulated as theoretically informed propositions requiring subsequent empirical testing. This distinction is important because the present study represents the model-development and validation stage, rather than the empirical hypothesis-testing stage. Following the literature synthesis, each construct was conceptually defined and positioned within the proposed model. Self-efficacy was conceptualized as confidence in one's capability to perform teaching-related tasks and effectively use technology in instructional contexts. Motivation represented the motivational conditions that encourage prospective teachers to engage with learning, teaching, and technology-supported instructional activities. Technology-related beliefs referred to beliefs regarding the usefulness, value, and role of technology in teaching and learning.

The pedagogical dimension consisted of pedagogical readiness, reflective teaching orientation, and deep learning orientation. Pedagogical readiness represents preparedness to design and implement appropriate instructional practices. Reflective teaching orientation represents the tendency to critically examine and improve instructional decisions and experiences. Deep learning orientation represents an orientation toward meaningful learning characterized by critical thinking, knowledge construction, problem solving, contextual understanding, and knowledge transfer. The six constructs were then integrated into a developmental model of TPACK. The model positions psychological factors as foundational conditions and pedagogical factors as mechanisms through which these conditions may contribute to the development of TPACK. TPACK is subsequently positioned as an integrated professional capability that enables prospective economics teachers to connect technological, pedagogical, and content knowledge in designing deep learning-oriented instruction. The resulting model therefore represents a theoretical proposition rather than a statistically verified structural model. The proposed relationships are intended to guide subsequent empirical research involving pre-service economics teachers.

After the initial conceptual model was developed, expert judgment was conducted to evaluate the conceptual relevance, coherence, and appropriateness of the proposed framework. Expert validation was used because conceptual model development requires an assessment not only of whether individual constructs are theoretically meaningful, but also whether their positioning and relationships within the framework are logically defensible. The experts reviewed the conceptual definitions of the constructs, the categorization of psychological and pedagogical factors, the proposed developmental relationships, and the position of TPACK within the framework. Particular attention was given to the distinction between TPACK as an integrated teacher competence and deep learning as the pedagogical orientation or instructional purpose supported by technology.

Expert feedback was used to identify aspects requiring clarification or refinement. The validation process therefore functioned as a mechanism for improving the conceptual coherence of the model before its future empirical implementation. This approach is consistent with the authors' previous conceptual work, in which expert judgment supported the relevance and coherence of the framework and resulted in refinements concerning psychological readiness, pedagogical development, reflection, and the distinction between TPACK and deep learning. The final stage involved refining the conceptual model based on the results of the expert validation. Refinement focused on the clarity of construct definitions, the logical sequence of the proposed relationships, and the positioning of the constructs within the broader teacher-development process.

The final model retains six psychopedagogical constructs—self-efficacy, motivation, technology-related beliefs, pedagogical readiness, reflective teaching orientation, and deep learning orientation—and positions them as conditions associated with TPACK development in pre-service economics teacher education. TPACK is subsequently linked conceptually to the capacity to design and implement technology-enhanced, deep learning-oriented instruction. At this stage, no questionnaire was administered to pre-service economics teachers and no empirical statistical testing was conducted. Consequently, the study does not report respondent characteristics, descriptive statistics, measurement-model results, structural coefficients, significance tests, or explanatory values. These analyses are reserved for the subsequent empirical phase of the research.

The conceptual model produced through this process provides the theoretical and methodological foundation for future quantitative validation using survey data and structural modeling techniques such as Structural Equation Modeling (SEM) or Partial Least Squares Structural Equation Modeling (PLS-SEM). This future empirical stage will be necessary to determine whether the proposed relationships are supported by data and to assess the relative contribution of each psychopedagogical construct to TPACK development.

III. RESULTS AND DISCUSSIONS

A. Result

The conceptual synthesis resulted in a psychopedagogical model that explains TPACK development among pre-service economics teachers through the interaction of psychological and pedagogical conditions. The synthesis indicates that TPACK development should not be understood solely as the acquisition of technological knowledge or the ability to operate digital tools. Rather, it represents a developmental process in which prospective teachers' psychological readiness and pedagogical orientations shape how technology is understood, selected, integrated, and connected with economics content and instructional purposes.

Similarly, the meta-analysis conducted by Ning et al. (2022) demonstrated that teacher education interventions have a positive overall effect on TPACK development. This provides further support for conceptualizing TPACK as a competence that can be developed through appropriately designed teacher education experiences rather than as a static individual characteristic. The synthesis in the present study extends this perspective by organizing the determinants of TPACK development into two interconnected dimensions. The first is the psychological dimension, consisting of self-efficacy, motivation, and technology-related beliefs. The second is the pedagogical dimension, consisting of pedagogical readiness, reflective teaching orientation, and deep learning orientation. These dimensions are positioned as complementary rather than independent sets of factors.

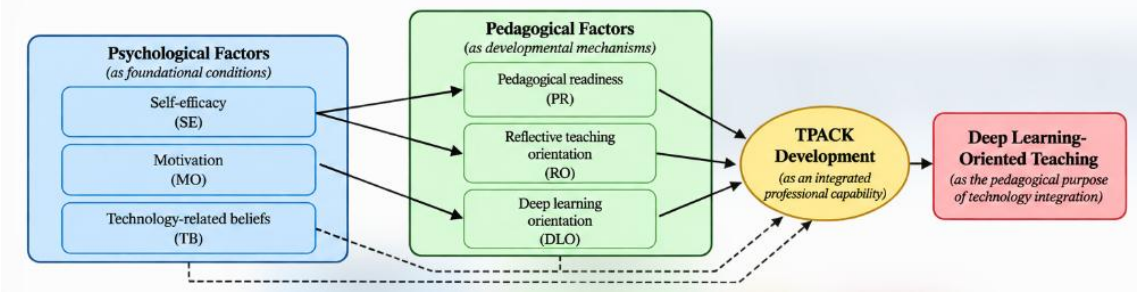

Figure 1. Conceptual Framework

The model therefore proposes that the development of TPACK is supported by psychological conditions that enable prospective teachers to engage confidently and meaningfully with technology, while pedagogical orientations determine how that technological capacity is translated into instructional practice. This conceptualization is particularly relevant to economics teacher education. Previous research by Krisnaresanti et al. (2023) found that pre-service teachers in the Economics Education Study Program at Universitas Jenderal Soedirman demonstrated generally good levels across the seven TPACK components, although technological knowledge and technological content knowledge were relatively more prominent while content knowledge was the lowest component. These findings provide an important contextual basis for the present model because they indicate that TPACK among pre-service economics teachers cannot be adequately understood by considering technological proficiency alone.

The broader scientometric analysis conducted by Krisnaresanti et al. (2024) further indicates that TPACK research has developed substantially over the past decade, while several areas remain open for further investigation, including the contextual and developmental factors underlying TPACK. The present conceptual model responds to this direction by

shifting attention from measuring the level of TPACK toward understanding the psychopedagogical conditions that may contribute to its development.

The first major result of the conceptual synthesis is the identification of three psychological constructs as foundational conditions for TPACK development: self-efficacy, motivation, and technology-related beliefs. Self-efficacy emerged as an important psychological foundation because prospective teachers' confidence in their ability to perform teaching tasks influences their willingness to engage with challenging instructional activities, including technology integration. In the context of TPACK development, self-efficacy is particularly relevant because technology integration requires teachers to make decisions involving not only technological tools but also content representation and pedagogical strategies.

The relationship between self-efficacy and technology-related teaching competence is supported by Joo et al. (2018), who found that TPACK was significantly associated with teacher self-efficacy among pre-service teachers. Their findings also demonstrated that self-efficacy was related to technology-use intentions, suggesting that psychological confidence plays an important role in the process through which prospective teachers engage with educational technology. Nelson and Voithofer (2022) provide further support for the relevance of self-efficacy. Their study found that pre-service teachers' self-efficacy for improving student learning through technology predicted their technology value beliefs and TPACK application. Based on these findings, the present model positions self-efficacy as a foundational psychological condition rather than as a direct substitute for TPACK. A prospective teacher may possess access to technological resources and knowledge about digital tools, but without sufficient confidence in applying those resources to instructional problems, technology integration may remain superficial.

Motivation represents the second psychological dimension. The conceptual synthesis indicates that TPACK development requires sustained engagement with complex learning and teaching tasks. Developing the capacity to integrate technology, pedagogy, and economics content involves experimentation, problem solving, reflection, revision, and continued learning. Such processes are unlikely to be sustained when prospective teachers perceive technology integration merely as an external requirement. Motivation therefore provides a condition that may encourage prospective teachers to explore technological possibilities, experiment with instructional designs, and persist when technology-supported teaching does not initially produce the expected results.

This interpretation is consistent with evidence from Nelson and Voithofer (2022), who found that intrinsic interest in technology and perceptions of its utility were associated with TPACK application among pre-service teachers. ScienceDirect The finding supports the conceptual distinction between simply possessing technological knowledge and being motivated to apply that knowledge meaningfully in instructional contexts. Accordingly, the present model conceptualizes motivation as a psychological condition that supports active engagement in the developmental processes through which TPACK can emerge. However, because the current study has not yet involved empirical respondents, the model does not claim that motivation has a statistically significant effect on TPACK. Its position represents a theoretically and conceptually validated relationship requiring subsequent empirical testing.

The third psychological construct is technology-related beliefs. These beliefs concern how prospective teachers perceive the usefulness, value, relevance, and role of technology in

teaching and learning. The conceptual synthesis suggests that technology integration is influenced not only by whether teachers know how to use technology but also by whether they perceive technology as pedagogically meaningful. This distinction is important because technology can be used at a purely operational level without contributing substantially to learning. Technology-related beliefs may therefore influence whether prospective teachers seek to connect technological resources with instructional purposes and subject-matter content. Joo et al. (2018) demonstrated that TPACK was related to perceived usefulness and perceived ease of use of technology among pre-service teachers, while Nelson and Voithofer (2022) found that technology interest, utility beliefs, and self-efficacy were associated with TPACK application. The present model consequently positions technology-related beliefs as part of the psychological foundation for TPACK development. Positive beliefs may create a disposition toward meaningful technology integration, while weak or predominantly instrumental beliefs may constrain the translation of technological knowledge into pedagogically purposeful practice.

The second major result of the conceptual synthesis is the identification of three pedagogical constructs: pedagogical readiness, reflective teaching orientation, and deep learning orientation. Pedagogical readiness refers to the prospective teacher's preparedness to design and implement learning experiences based on appropriate instructional principles. The model positions pedagogical readiness as an essential component because technology integration cannot be separated from decisions concerning learning objectives, instructional strategies, student characteristics, assessment, and content representation. Baran and Uygun (2016) demonstrated the importance of connecting TPACK with instructional design through their integrated TPACK-design-based learning approach. Their findings indicated that design-based activities could support theory-practice connections, readiness for practice, technological proficiency, and sustainable TPACK learning. Tondeur et al. (2020) similarly emphasized authentic technology experiences, design activities, reflection, collaboration, and feedback as important elements of teacher preparation for TPACK.

These findings support the positioning of pedagogical readiness as a mechanism through which technological knowledge can become integrated with actual teaching decisions. Thus, the model does not treat TPACK as an accumulation of separate technological, pedagogical, and content knowledge components. Instead, it emphasizes the capacity to coordinate these forms of knowledge in response to instructional needs.

Reflective teaching orientation represents the prospective teacher's willingness and capacity to examine, evaluate, and improve instructional decisions. Reflection is particularly important in TPACK development because effective technology integration rarely follows a single predetermined procedure. Teachers need to evaluate whether a technological choice actually supports content understanding, learner engagement, critical thinking, and instructional objectives. Reflection was explicitly identified as one of the strategies within the Synthesis of Qualitative Evidence (SQD) framework examined by Tondeur et al. (2020). Their study identified reflection on the role of technology in education as one of the strategies associated with TPACK development among pre-service teachers.

Within the present model, reflection therefore functions as a developmental mechanism. Psychological readiness may encourage prospective teachers to engage with technology, while reflective orientation allows them to critically examine the quality and consequences of their

technology-supported instructional decisions. This positioning also distinguishes the proposed model from approaches that equate TPACK development with exposure to technology alone. Exposure provides opportunities, but reflection provides a mechanism for learning from those experiences and progressively improving instructional decisions.

The third pedagogical construct is deep learning orientation. This construct represents an orientation toward instructional practices that emphasize meaningful understanding, critical thinking, problem solving, inquiry, knowledge construction, application, and transfer rather than merely transmitting information. The inclusion of deep learning orientation represents one of the distinctive features of the proposed model. Existing TPACK research has often focused on technology integration, teacher knowledge, or technology-supported instructional practices. The present framework instead asks a more fundamental pedagogical question: what is technology integration intended to accomplish?

Within this model, the answer is deep and meaningful learning. Technology is therefore not positioned as the ultimate outcome of teacher competence. Instead, TPACK represents a professional capability through which technology can be strategically connected with pedagogy and economics content to support deeper learning processes. Recent evidence from Indonesia strengthens the relevance of this orientation. Fitrah et al. (2025), based on a study involving 802 teachers, found that technological knowledge and 21st-century competencies contributed to teachers' readiness to adopt deep learning pedagogy, with 21st-century competencies showing a stronger contribution in their model. Accordingly, the present model integrates deep learning orientation into the TPACK development process rather than treating deep learning as an outcome that occurs automatically after technology has been integrated.

The expert validation stage supported the conceptual relevance and coherence of the proposed framework. The validation focused on whether the constructs were appropriately positioned, whether the psychological and pedagogical dimensions were conceptually distinguishable, and whether the proposed developmental sequence was theoretically defensible. The validation resulted in refinement of several aspects of the model, particularly concerning the role of psychological readiness, the function of pedagogical development, the importance of reflection, and the distinction between TPACK and deep learning. This is consistent with the broader conceptual work undertaken in the development of the framework, in which expert judgment was used to refine the proposed architecture. An important refinement concerns the conceptual distinction between TPACK and deep learning. TPACK is treated as the integrated professional knowledge required to make appropriate technology-pedagogy-content decisions, whereas deep learning is treated as the pedagogical purpose that guides those decisions. Consequently, the model does not position deep learning as simply another component of TPACK. Rather, deep learning orientation provides the pedagogical direction within which TPACK is enacted.

B. Discussion

The central contribution of this study is the reconceptualization of TPACK development as a psychopedagogical process. This perspective expands conventional interpretations of TPACK that tend to emphasize the possession or measurement of technological, pedagogical, and content knowledge. The conceptual synthesis suggests that prospective teachers do not develop TPACK simply by acquiring knowledge about technological tools. Instead, TPACK development involves the interaction between what teachers believe and feel and how they approach teaching and learning. Self-efficacy,

motivation, and technology-related beliefs create psychological conditions for engagement, while pedagogical readiness, reflection, and deep learning orientation shape how such engagement is translated into instructional practice.

This interpretation is consistent with the empirical literature. Tondeur et al. (2020) demonstrated that TPACK development among pre-service teachers is associated with a combination of authentic experiences, reflection, collaboration, design, role modeling, and feedback rather than with technology exposure alone. Ning et al. (2022) found an overall positive effect of teacher education interventions on TPACK, reinforcing the view that TPACK is developable through educational experiences. The proposed model therefore shifts the analytical question from "How much TPACK do pre-service teachers possess?" toward "What psychological and pedagogical conditions support the development of TPACK?" This shift is particularly relevant to teacher education because identifying developmental conditions can provide a stronger basis for designing teacher preparation programs.

The model indicates that psychological factors should be considered foundational rather than peripheral to TPACK development. Self-efficacy, motivation, and technology-related beliefs influence whether prospective teachers are willing to engage with technology, experiment with instructional designs, and persist through the complexity of technology integration. The role of self-efficacy is particularly important. Joo et al. (2018) demonstrated significant relationships between TPACK and teacher self-efficacy, while Nelson and Voithofer (2022) found that self-efficacy for improving learning through technology predicted both value beliefs and TPACK application. These findings suggest that confidence in using technology pedagogically is closely connected with the willingness and capacity to translate knowledge into instructional action.

The model nevertheless avoids treating self-efficacy as sufficient by itself. High confidence without appropriate pedagogical knowledge may result in technically confident but pedagogically weak technology use. Similarly, positive technology beliefs without reflective and pedagogical capacities may encourage frequent technology use without ensuring meaningful learning. The psychopedagogical perspective therefore implies that psychological conditions should be developed together with pedagogical capabilities. Teacher education programs should not merely attempt to increase prospective teachers' confidence in technology; they should provide authentic opportunities through which confidence, motivation, beliefs, and pedagogical knowledge develop simultaneously.

The model further suggests that pedagogical factors function as mechanisms that translate psychological readiness into integrated teaching competence. Pedagogical readiness determines whether prospective teachers can connect technological possibilities with instructional objectives. Reflective teaching orientation enables them to evaluate and improve these decisions. Deep learning orientation provides the pedagogical direction for determining whether technology contributes to meaningful learning. This interpretation is consistent with Baran and Uygun (2016), who emphasized the importance of design-based learning for translating TPACK into practice and developing readiness for teaching. AJET It is also consistent with Tondeur et al. (2020), who identified design, authentic experiences, reflection, collaboration, and feedback as relevant components of TPACK-oriented teacher preparation.

Thus, pedagogical development should not be positioned after technological competence has already been acquired. Instead, technology, pedagogy, and content should develop through integrated instructional experiences.

For economics teacher education, this means that prospective teachers should experience learning activities requiring them to make authentic decisions such as selecting digital representations of economic concepts, designing technology-supported problem-

solving activities, interpreting economic data through digital tools, and evaluating whether technology contributes to students' conceptual understanding.

A distinctive contribution of the model is the explicit inclusion of deep learning orientation. The conceptual framework argues that TPACK should not be developed as an end in itself. Rather, technology integration should be directed toward meaningful educational purposes. This distinction is particularly important because technological innovation does not automatically generate deeper learning. A digital platform, simulation, video, artificial intelligence tool, or interactive application may improve the presentation of information without necessarily encouraging critical thinking, inquiry, problem solving, or knowledge transfer.

Fitrah et al. (2025) provide recent empirical support for this argument by demonstrating that teacher readiness to adopt deep learning pedagogy is associated with technological knowledge as well as broader 21st-century competencies. Their findings indicate that technology is important but insufficient on its own for deep learning-oriented pedagogical change. The proposed model consequently treats deep learning orientation as a pedagogical compass for TPACK development. It helps determine not simply whether technology is used, but whether the technology is used for an appropriate instructional purpose.

For economics education, this orientation is especially relevant because economics learning involves interpretation of real-world phenomena, analysis of economic problems, evaluation of alternative decisions, and application of theoretical concepts to contextual situations. Technology can support these processes, but only when its use is deliberately aligned with such learning objectives.

The model has several implications for the design of economics teacher education programs. First, TPACK development should be embedded across teacher preparation rather than delivered exclusively through technology-related courses. The findings from the conceptual synthesis indicate that authentic and integrated learning experiences are more consistent with the developmental nature of TPACK. Second, teacher education should provide opportunities for authentic technology-enhanced instructional design. Prospective economics teachers should be challenged to design lessons in which technology is used to address genuine pedagogical and content-related problems. Such activities are consistent with the design-based approach proposed by Baran and Uygun (2016).

Third, structured reflection should be incorporated into technology-supported microteaching, lesson design, and teaching practice. Prospective teachers should be encouraged to evaluate not merely whether a technological tool worked technically, but whether it improved students' understanding and supported the intended learning outcomes.

Fourth, teacher education should explicitly cultivate psychological readiness. Feedback, successful authentic experiences, peer collaboration, role modeling, and opportunities for experimentation may contribute to the development of confidence and positive beliefs regarding technology integration. These strategies are consistent with the teacher preparation strategies identified by Tondeur et al. (2020). Finally, deep learning should become the pedagogical purpose underlying technology integration. This is particularly important in the context of contemporary educational reform in Indonesia, where teacher readiness for deep learning requires technological, pedagogical, and broader professional competencies.

Although expert validation supports the conceptual relevance and coherence of the proposed model, the present study does not provide empirical evidence of the statistical relationships among the constructs. This limitation is inherent in the current stage of the research. The proposed relationships should therefore be interpreted as theoretically informed and conceptually validated propositions, rather than empirically confirmed causal relationships. The next stage should involve instrument development and empirical testing among pre-service economics teachers. Quantitative data can subsequently be analyzed using

SEM or PLS-SEM to examine the measurement properties of the constructs and test the proposed structural relationships.

Such empirical validation is particularly important because the relative contribution of each factor remains unknown. For example, the model proposes that self-efficacy, motivation, and technology-related beliefs provide psychological foundations, but it cannot yet establish whether one of these factors is more influential than the others. Likewise, the proposed role of pedagogical readiness, reflective teaching orientation, and deep learning orientation as mechanisms requires empirical verification.

IV. CONCLUSION

This study developed and conceptually validated a psychopedagogical model of Technological Pedagogical Content Knowledge (TPACK) development among pre-service economics teachers for deep learning-oriented instruction. Through conceptual synthesis and expert judgment, the model identifies six interconnected constructs comprising three psychological factors (self-efficacy, motivation, and technology) related beliefs and three pedagogical factors pedagogical readiness, reflective teaching orientation, and deep learning orientation. The model conceptualizes TPACK development not merely as the acquisition of technological competence, but as a psychopedagogical developmental process in which psychological conditions provide a foundation for pedagogical development and the integration of technological, pedagogical, and content knowledge. A distinctive feature of the model is the positioning of deep learning orientation as the pedagogical purpose that guides meaningful technology integration rather than as an additional component of TPACK. The expert validation supported the conceptual relevance and coherence of the proposed framework and informed refinement of the relationships among psychological readiness, pedagogical development, reflection, TPACK, and deep learning-oriented teaching. The model provides a theoretical foundation for strengthening pre-service economics teacher education through authentic technology experiences, reflective practice, pedagogically meaningful technology integration, and deep-learning-oriented lesson design. However, because the present study has not yet involved empirical data collection, the proposed relationships should not be interpreted as statistically confirmed effects. Future research should empirically validate the model among pre-service economics teachers through instrument testing and structural analysis, such as SEM or PLS-SEM, to examine the proposed relationships and further refine the model.

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REFERENCES

Baran, E., & Uygun, E. (2016). Putting technological, pedagogical, and content knowledge (TPACK) in action: An integrated TPACK-design-based learning (DBL) approach. Australasian Journal of Educational Technology, 32(2). https://doi.org/10.14742/ajet.2551

Fitrah, M., Sofroniou, A., Yarmanetti, N., Ismail, I. H., Anggraini, H., Nissa, I. C., Widyaningrum, B., Khotijah, I., Kurniawan, P. D., & Setiawan, D. (2025). Are teachers ready to adopt deep learning pedagogy? The role of technology and 21st-century competencies amid educational policy reform. Education Sciences, 15(10), 1344. https://doi.org/10.3390/educsci15101344

Joo, Y. J., Park, S., & Lim, E. (2018). Factors influencing preservice teachers' intention to use technology: TPACK, teacher self-efficacy, and Technology Acceptance Model. Educational Technology & Society, 21(3), 48–59

Krisnaresanti, A., Ahman, E., & Disman, D. (2023). Profile of Technological Pedagogical Content Knowledge (TPACK) on pre-service teachers in higher education. Journal of Office Administration: Education and Practice, 3(3), 204–213. https://doi.org/10.26740/joaep.v3n3.p204-213

Krisnaresanti, A., Ahman, E., Istikomah, N., Suwatno, S., & Budiman, A. (2024). Research trends in Technological Pedagogical Content Knowledge (TPACK) research (2014–2024): A scientometric analysis. Jurnal Pendidikan Progresif, 14(1). https://doi.org/10.23960/jpp.v14.i1.202426

Nelson, M. J., & Voithofer, R. (2022). Coursework, field experiences, and the technology beliefs and practices of preservice teachers. Computers & Education, 186, 104547. https://doi.org/10.1016/j.compedu.2022.104547

Ning, Y., Zhou, Y., Wijaya, T. T., & Chen, J. (2022). Teacher education interventions on teacher TPACK: A meta-analysis study. Sustainability, 14(18), 11791. https://doi.org/10.3390/su141811791

Tondeur, J., Scherer, R., Siddiq, F., & Baran, E. (2020). Enhancing pre-service teachers' technological pedagogical content knowledge (TPACK): A mixed-method study. Educational Technology Research and Development, 68, 319–343. https://doi.org/10.1007/s11423-019-09692-1