Pathways to Enhancing University Teachers' TPACK Competence Through Instructional Support Services

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ABSTRACT

Enhancing university teachers' competence in using information technology has become an increasingly pressing concern as higher education undergoes digital transformation. This study investigates how instructional support services can contribute to this goal, an issue that remains underexamined in the existing literature. The research adopts the Technological Pedagogical Content Knowledge (TPACK) framework and employs a qualitative case study methodology. The analysis identifies four main pathways through which instructional support services facilitate teachers' technological capacity development. First, technology empowerment assists instructors in moving from basic operational familiarity to skillful application of digital tools. Second, curriculum-driven support helps teachers naturally integrate technology into instruction during online course development and lecture recording. Third, competition-led encouragement motivates faculty to apply a combination of pedagogical and technical knowledge under performance pressure. Fourth, research collaboration deepens teachers' understanding of technology through engagement in scholarly projects. These pathways are mutually reinforcing and collectively enhance teachers' overall TPACK competence. The study also reveals persistent challenges, including insufficiently tailored support, a lack of long-term development mechanisms, superficial research collaboration, and weak incentive structures. In response, the paper proposes the establishment of discipline-specific support systems, sustainable professional development mechanisms, the transformation of technical staff into genuine research partners, and improved incentive frameworks. By shifting the perspective from individual teacher learning to the enabling role of institutional support services, this research offers practical insights for higher education institutions seeking to strengthen their instructional support systems. Future research could examine the generalizability of these pathways across different institutional contexts in multiple follow-up studies.

Keywords: teachers' information technology competence; instructional support services; TPACK framework; case study; higher education

INTRODUCTION

Research Background and Problem Statement

Since the release of the Education Informatization 2.0 Action Plan, information technology adoption in Chinese universities has gradually shifted from equipment installation to practical integration [1]. In this transition, teachers have become a pivotal factor—their ability to apply information technology directly influences how far digital teaching reform can progress. Yet, while smart classrooms and online platforms continue to multiply, many instructors still struggle with reluctance or inability to use these tools effectively [7].

Addressing this issue requires more than self-directed learning; external support is essential. Services such as technical training, course recording, competition coaching, and research collaboration are increasingly recognized as drivers of faculty professional development. However, existing studies have mostly concentrated on competency assessment frameworks [4] or training innovation models [9], with little attention paid to how instructional support services concretely help teachers. How exactly do these services contribute? What mechanisms lie behind them? These questions guide the present study.

Research Purpose and Methods

This research adopts the TPACK framework as its theoretical foundation and uses a case study approach [10], selecting the Teaching Informatization Support Center at a specific university as the research object. The center is responsible for managing multimedia and smart classrooms, participating in online course construction, teaching competition organization, and research project coordination—covering the main types of instructional support services. The primary data come from the center's work records, including annual summaries, maintenance logs, course support files, and competition documents.

Novelty of This Study

Unlike prior work that focuses on teacher competency assessment or isolated training interventions, this study examines instructional support as an organizational practice and identifies a systemic framework of four interconnected pathways. This perspective shifts the unit of analysis from individual teacher learning to the enabling role of support services, offering a novel angle on faculty development in the digital age.

THEORETICAL BASIS AND LITERATURE REVIEW

The TPACK Framework

A key theoretical lens for understanding teachers' information technology competence is the Technological Pedagogical Content Knowledge (TPACK) framework introduced by Mishra and Koehler in 2006 [2]. The core idea is that effective technology use requires integrating technology, pedagogy, and content knowledge within concrete teaching contexts [3].

Schmidt and colleagues developed a TPACK measurement instrument, breaking the construct into seven dimensions and providing a methodological foundation for empirical research [4]. Rosenberg and Koehler's systematic review further emphasizes that teachers' TPACK development is significantly influenced by contextual factors such as the instructional support environment and organizational culture [6]. Figure 1 illustrates the structure of the TPACK framework.

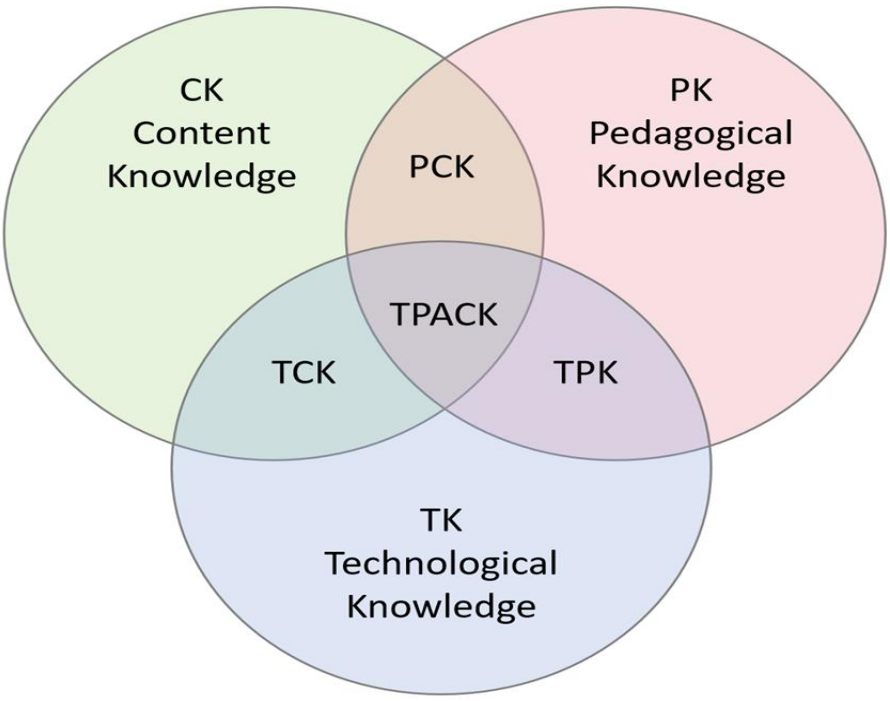

Figure 1. The TPACK framework (adapted from Mishra & Koehler, 2006)

Beyond these factors, the knowledge and skills of support providers also matter. Tondeur et al. [13] argue that teacher educators act as "gatekeepers" in preparing future teachers for technology integration. By analogy,

instructional support staff in higher education serve a similar gatekeeping role for in-service faculty. Principles from educational psychology—such as the role of feedback in visible learning [14] and cognitive load management [15]—also offer insights for designing support interventions. This study adopts the TPACK framework to understand how instructional support services contribute to enhancing teachers' capabilities.

Current Research on Teachers' Information Technology Competence

Research on university faculty's information technology competence has grown substantially. Lan et al. conducted a systematic literature review on Chinese in-service educators and found that although hardware conditions have improved markedly and overall competence has risen, significant gaps persist across regions, disciplines, and age groups. Moreover, teachers remain relatively weak in using technology to innovate teaching [1]. Zhao et al. similarly note that research on digital competence in higher education is shifting from technical operational skills to technology integration into teaching [7].

Existing studies largely focus on three areas: competency indicator systems, influencing factors, and enhancement strategies. International research has paid earlier attention to the role of instructional support services. Clauss-Ehlers and Pasquerella showed that campus instructional support centers can promote faculty teaching capacity through course design consultation and technology guidance [8]. Hoessler et al. further find that need-tailored support programs are more effective than generic training [9]. Researchers have also examined the heterogeneity of faculty needs. Scherer et al. [12] used latent profile analysis to identify distinct teacher profiles regarding online teaching readiness, suggesting that one-size-fits-all support is unlikely to succeed. Similarly, Earnshaw and Bodine Al-Sharif [11] found that contingent online faculty value contextualized, situation-specific guidance. These insights underscore the importance of precision in instructional support services.

Research Gap

A review of the literature reveals several gaps: although the TPACK framework is mature, few studies have applied it from the perspective of support services; research on teachers' technology competence is abundant, but the role of instructional support service units has received limited attention; and most research on support services stays at the macro level of functional descriptions, with insufficient exploration of micro-mechanisms. To address these gaps, this study adopts a practice-oriented perspective, employs the TPACK framework, and uses a case study method to systematically examine the pathways through which instructional support services enhance teachers' technology competence.

Case Description

Basic Information about the Case University

The university examined has been actively advancing digital transformation. In terms of teaching infrastructure, the institution possesses multiple classroom buildings equipped with a considerable number of multimedia and smart classrooms, forming a smart teaching environment that covers its various campuses.

Organizational Structure and Functions of the Teaching Informatization Support Center

The center under study is a specialized unit responsible for teaching informatization construction and instructional support services, operating under a dual-function model that combines technical support and teaching service. Its primary functions include the operation and maintenance of teaching infrastructure, support for teaching resource development, assistance with teaching competitions and research projects, and training and consultation on teaching informatization.

Specific Content of Instructional Support Services

Based on annual work records, the center's support activities can be grouped into four categories.

Technology assurance services form the foundational function. Through regular inspections and targeted maintenance, the center ensures stable operation of teaching equipment across the campus, allowing faculty to

focus on teaching rather than technical troubleshooting. The center also conducts periodic asset verification and disposal of obsolete items, optimizing asset structure and reducing operational costs.

Curriculum development services constitute an important avenue for promoting faculty professional development. The center is equipped with recording devices and a post-production team, assisting instructors in completing various course filming and editing tasks. Taking one university-level online course project as an example, the course adopted a blended teaching model, and the center provided end-to-end technical support, incorporating local cultural materials into the teaching cases to achieve an integration of technical instruction and value-based education.

Competition support services represent another significant channel. For student competitions, the center provides technical assistance for on-campus academic contests. For faculty competitions, the center organizes and supports educational technology achievement evaluation events, aiding instructors in completing their submissions.

Research collaboration services offer integrated, data-driven, technology-empowered support throughout the research lifecycle. Center staff have participated in multiple research projects, undertaking tasks such as data collection, analysis, and survey data processing, and have also led various incubation projects. Center staff have co-authored several academic papers.

Data Analysis Procedures

The analysis followed a thematic approach. The author first compiled all available documents (annual summaries, maintenance logs, course support records, competition files) and read them repeatedly to gain familiarity. Open coding was used to label relevant segments related to how the center helped teachers. These codes were then grouped into broader categories, which led to the identification of four recurring themes—technology empowerment, curriculum-driven support, competition-led encouragement, and research collaboration. To ensure trustworthiness, the coding was reviewed twice over a two-week interval, and the derived pathways were cross-checked against the original documents to confirm fit.

Observed Improvements in Teachers' Information Technology Competence

From these practices, positive changes in teachers' information technology competence can be observed. Technical operation skills have noticeably improved, and class disruptions due to technical failures have significantly decreased. The ability to integrate technology into teaching has also strengthened, as evidenced by the exploration of embedding technology into instructional design through online course development. The "competition-driven teaching" effect is evident: faculty participation and performance in educational technology achievement evaluations have increased. Furthermore, research collaboration has enhanced teachers' research capabilities, while the center's involvement in research projects has given it a deeper understanding of faculty's real needs.

Pathway Analysis

Through systematic examination, this study identifies four core pathways through which instructional support services contribute to improving teachers' information technology competence. These pathways act on different dimensions of teachers' TPACK knowledge structures and reinforce each other in practice.

Technology Empowerment Pathway: From "Able to Use" to "Skillful Use"

This pathway primarily relies on daily teaching support and technical assistance to help instructors overcome the initial threshold of technology use and gradually move from basic operation to proficient application. By establishing regular inspection schedules, emergency response mechanisms, and targeted maintenance, the center ensures stable equipment functioning. The sharp reduction in equipment failure rates allows teachers to concentrate on instructional content and organization rather than dealing with technical problems. Research has shown that frequent technical failures are a major source of teacher resistance to technology-enhanced teaching [7].

At a more advanced level, training sessions on smart classroom use, online platform operation, and teaching software enable teachers to become familiar with a broader range of tools. Technology thus evolves from a simple projection tool into a medium that supports classroom interaction and immediate feedback. From the TPACK perspective, this pathway primarily addresses teachers' technological knowledge (TK) dimension [3][5]. Compared with the technology acceptance model (TAM), which emphasizes perceived ease of use and usefulness, our findings highlight that reliable infrastructure and proactive maintenance are equally critical—an aspect often downplayed in technology adoption studies.

Curriculum-Driven Pathway: Integrating Technology through Course Development

This pathway supports teachers in engaging with online course construction, blended course development, and lecture recording, guiding them to deeply integrate technology into teaching during the actual process of building courses. The development of a particular university-level online course illustrates this mechanism. The course content itself involved technology applications, and the inherent fusion of technology and content made integration a natural part of course construction. The center's support included equipment provision, on-site guidance, post-production editing, and platform maintenance.

This support process involved collaborative work between center staff and the course instructor. Staff not only provided technical services but also participated in discussions about course design, helping the instructor reflect on pedagogical questions such as how to better present content using technology and how to design technology-supported interactive segments. This collaborative arrangement enhanced the instructor's technical operation skills and, more importantly, deepened technological pedagogical knowledge (TPK) and technological content knowledge (TCK) through reflection [2][4]. Unlike conventional training where technology is taught separately, this pathway embeds technology learning within authentic curriculum design, aligning with the situated learning perspective.

Competition-Led Pathway: Driving Capability Enhancement through Contest Participation

This pathway supports faculty involvement in various teaching competitions, using the pressure of competition to drive capability improvement. In the educational technology achievement evaluation event, the center provided comprehensive technical support, helping teachers prepare and submit their entries.

The motivating effect of competitions can be seen in three aspects. First, competitions require teachers to systematically organize and present their teaching achievements, a process that promotes reflection and refinement of instructional design. Second, the benchmarking effect exposes teachers to excellent practices from other institutions, broadening their perspectives. Third, winning awards provides positive reinforcement, encouraging teachers to continue exploring ways to merge technology with teaching. From the TPACK perspective, this pathway demands that teachers integrate technological, pedagogical, and content knowledge simultaneously [6]. This finding resonates with prior work on "competition-driven teaching" but adds a new dimension: the role of dedicated technical support in enabling teachers to focus on pedagogical design rather than production logistics.

Research Collaboration Pathway: Deepening Technology Understanding in Research Contexts

This pathway involves center staff participating in faculty-led research projects as team members, thereby helping teachers develop a more nuanced understanding of technology in a research setting. Center staff have been involved in provincial educational research projects (handling data collection and analysis) and municipal social science research projects (assisting with survey data organization). These experiences have transformed center staff from pure technology providers into research partners.

The impact of research collaboration is multifaceted. During data analysis and model building, teachers need various technological tools, and the technical expertise of center staff complements teachers' research capabilities. Research collaboration also exposes teachers to cutting-edge applications of technology in educational research, broadening their understanding of what technology can achieve. Finally, writing and publishing research papers encourages teachers to distill practical technology experiences into shareable scholarly outcomes. From the TPACK perspective, this pathway fosters a deeper comprehension of technology

in expanded application contexts [1][7]. Unlike typical TPACK studies that focus on classroom teaching, our findings show that research engagement can further strengthen teachers' technological knowledge by exposing them to new tools and analytical methods.

Interconnections among the Four Pathways

The four pathways are intertwined and mutually reinforcing. As illustrated in Figure 2, the technology empowerment pathway provides the technical foundation for the others; the curriculum-driven pathway achieves integration in course construction; the competition-led pathway uses pressure situations to drive competence leaps; and the research collaboration pathway expands the boundaries of technology application in research contexts.

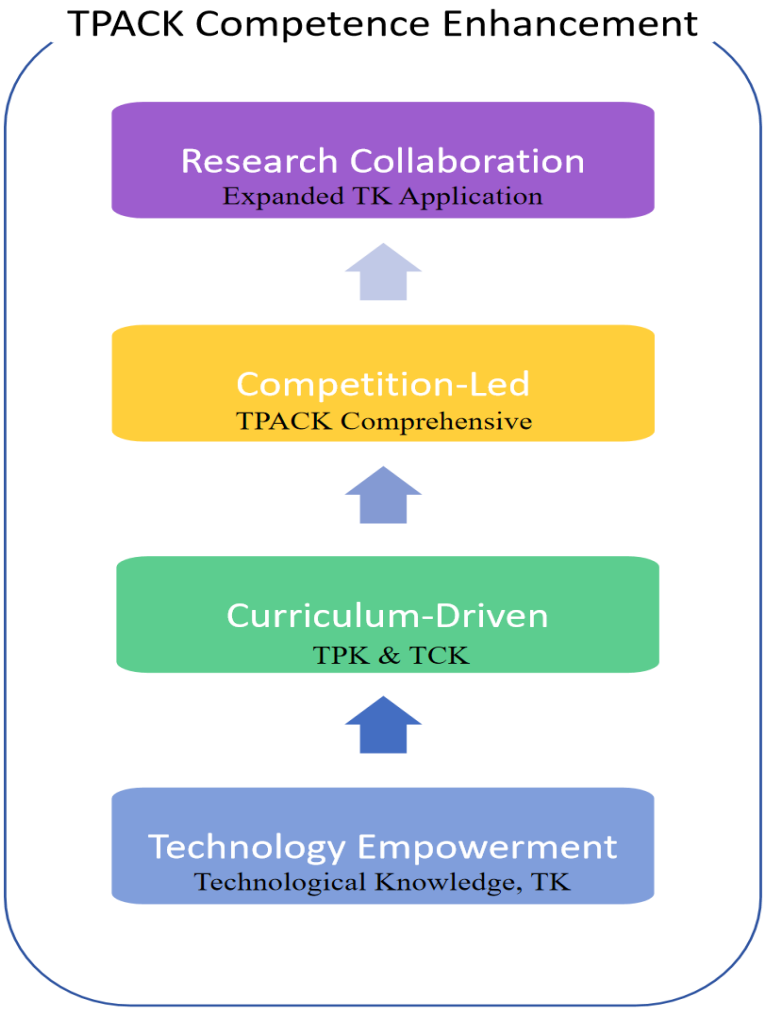

Figure 2. Pathways from instructional support services to teachers' TPACK competence.

Table 1 maps the relationships between the pathways and TPACK dimensions.

Pathway	Primary TPACK dimension targeted	Mechanism
Technology empowerment	Technological knowledge (TK)	Eliminates technical barriers, broadens technology awareness
Curriculum-driven	Technological pedagogical knowledge (TPK), Technological content knowledge (TCK)	Integrates technology with teaching during course development
Competition-led	TPACK comprehensive competence	Drives competence enhancement through pressure situations
Research collaboration	Expanded application of technological knowledge	Deepens technology understanding in research contexts

Table 1. Correspondence between instructional support pathways and TPACK dimensions

Existing Problems and Recommendations for Improvement

Major Problems in Current Instructional Support Services

Insufficient precision in service delivery. Current support services are broad and standardized. However, teachers from different disciplines with different technological backgrounds have significantly different requirements. From the TPACK perspective, the integration of technological, pedagogical, and content knowledge is highly contextual, and generic support cannot effectively promote TPACK development.

Lack of long-term mechanisms. Most technology training is one-off or short-term intensive, which helps with initial adoption but fails to support sustained development. After mastering basic operations, teachers often need deeper case-based discussions, peer exchanges, and follow-up guidance. Training outcomes are rarely tracked systematically.

Shallow research collaboration. Although center staff participate in research projects, their role remains largely that of technical assistants rather than forming a deep collaborative model. If technical support staff could engage as research collaborators, deeper interaction would offer richer professional growth opportunities.

Inadequate incentive systems. The effectiveness of instructional support services heavily depends on teachers' willingness to participate actively and continuously. Yet effective incentives are lacking. The time teachers invest in training, course development, and competition participation is not adequately reflected in teaching workload calculations or promotion criteria.

Recommendations for Optimizing Instructional Support Services

Build a discipline-differentiated precision support system. Establish a faculty liaison system in which center staff are assigned to specific departments to gain an in-depth understanding of each discipline's characteristics. Develop modular training courses that break down TPACK-related competencies into optional modules.

Establish sustainable teacher development support mechanisms. Create a closed loop of training, application, feedback, and deepening. After training, set up a practical follow-up period using classroom observations and post-class interviews. Form teacher learning communities for peer-supported learning.

Promote the transformation of technical support staff into educational technology partners. Strengthen training in educational research methods for center staff, equipping them with basic skills to participate in faculty research. Establish pairing mechanisms for long-term collaboration on specific teaching or research issues.

Improve incentive systems and institutional safeguards. Incorporate faculty participation in course development, teaching competitions, and technology training into teaching workload calculations. Include teachers' information technology competence and related achievements as important indicators in promotion evaluations. Strengthen coordination among the instructional support center, faculty development center, and academic affairs office.

CONCLUSION

Summary of Findings

Using the TPACK framework as its theoretical foundation and a case study of a university teaching informatization support center, this research systematically explored the pathways and mechanisms through which instructional support services enhance university teachers' information technology application competence.

The study identifies four core pathways: technology empowerment (primarily affecting TK), curriculum-driven support (targeting TPK and TCK), competition-led encouragement (driving comprehensive TPACK application), and research collaboration (expanding technological knowledge in research contexts). These pathways are interwoven and mutually reinforcing, collectively advancing teachers' overall TPACK competence.

Current instructional support services face challenges of insufficient precision, underdeveloped long-term mechanisms, shallow research collaboration, and weak incentive systems. Optimizing these services requires building discipline-differentiated support systems, establishing sustainable development mechanisms, transforming technical staff into educational technology partners, and refining incentive structures.

The theoretical contribution lies in shifting the research perspective from a teacher-centered view to a support-service orientation, revealing the micro-mechanisms by which instructional support services foster TPACK development. Practically, university instructional support units should go beyond technical assurance and expand into the role of faculty development partners, building precise, sustainable, and collaborative support systems.

Limitations

This study has several limitations. First, it is a single-case study; the findings may not be directly generalizable to other institutional contexts. Second, the analysis relies on institutional documents and work records rather than interviews or surveys with teachers, so the voice of faculty—their subjective experiences and perceptions—is missing. Third, the study lacks quantitative measures to assess the differential effectiveness of each pathway. Fourth, the case university is a coastal, province-level institution in China; its specific socio-economic and administrative context may shape the observed patterns. Future research could overcome these limitations by using multi-case designs, collecting teacher feedback through interviews or questionnaires, and developing instruments to measure pathway outcomes.

Ethical Considerations

Ethical Approval: This study did not involve human participants, private data, or animal experiments. All analyses were based on theoretical discussion, literature review, and teaching practice summary. Therefore, ethical approval was not required.

Conflict of Interest: The author declares no conflict of interest.

Data Availability

Statement: No new data were created or analyzed in this study. Data sharing is not applicable.

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