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EXPLORING THE ICT INTEGRATION BY TVET TEACHERS IN CHINA: A SYSTEMATIC REVIEW

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ABSTRACT

The integration of Information and Communication Technology (ICT) in Technical and Vocational Education and Training (TVET) is a critical driver for modernizing education and enhancing teaching practices. However, in China, ICT integration faces unique challenges, including inadequate infrastructure, insufficient teacher training, and limited pedagogical frameworks. This study investigates the extent of ICT integration by TVET teachers, identifies key barriers, and highlights emerging best practices. Using a Systematic Literature Review (SLR) of 44 studies from the last decade (2015–2024), analyzed via the PRISMA framework, the findings reveal progress in ICT integration, with persistent challenges. Guided by TPACK, TPB, and BDT, this study emphasizes the importance of improving teachers' technological and pedagogical competencies, addressing digital literacy gaps, and implementing data-driven strategies. Recommendations include targeted teacher training, enhanced institutional support, and strategic frameworks tailored to vocational education needs to ensure sustainable ICT integration.

Keywords: ICT Integration, TVET Teachers, Systematic Literature Review, TPACK, PRISMA, Teacher Training

Introduction

1.1 Background

Information and Communication Technology (ICT) encompasses various tools and systems, including computers, mobile devices, and network technologies, designed to facilitate communication, data sharing, and collaboration (Azonuche, 2020). In educational contexts, ICT acts as a transformative force, bridging theoretical knowledge and practical skills, enhancing resource accessibility, and promoting collaborative learning (Asongu & Odhiambo, 2020; Ahmad et al., 2021). Particularly within Technical and Vocational Education and Training (TVET), the strategic integration of ICT is essential for aligning vocational education with global economic demands and evolving industry standards (Badawi et al., 2021). ICT adoption across educational levels is recognized as critical for preparing students to navigate and succeed in increasingly digitalized workplaces (Shah et al., 2022).

In China, national strategies such as "Education 2030" and the country's broader digital transformation initiatives have underscored the importance of integrating ICT within TVET curricula (UNESCO, 2018). Nonetheless, despite significant investment and policy support, multiple challenges persist, including regional disparities in digital infrastructure, insufficient professional training for teachers, and limited pedagogical frameworks specifically tailored to vocational contexts (Chen & Bin, 2024). Additionally, gaps remain regarding understanding how ICT integration concretely impacts teaching effectiveness, student motivation, and the linkage between theoretical instruction and practical skill acquisition (Han et al., 2020).

The literature on ICT integration in TVET highlights notable advancements in educational technology applications, such as blended learning, virtual reality (VR), mobile learning, and simulation-based instruction (Chen & Liu, 2021; Shi et al., 2021; Yao, 2021). Empirical studies from various countries have shown these methods significantly enhance learning outcomes, engagement, and skill acquisition. For instance, blended learning models utilizing online and offline instructional elements have demonstrated enhanced student interaction and learning effectiveness compared to traditional approaches (Jiang, 2022; Yang, 2024). Likewise, Massive Open Online Courses (MOOCs) and VR-based simulations have proven effective in fostering higher-order cognitive skills, aligning well with the principles outlined in Bloom’s Digital Taxonomy (BDT) (Churches, 2008; Ji, 2016b; Zeng & Wang, 2022).

Despite these positive outcomes, existing research reveals significant limitations and failures in ICT integration initiatives. Common issues include inadequate teacher preparedness, insufficient institutional support, technological infrastructure deficits, and low adoption rates among educators (Han et al., 2020; Ma, 2019). Furthermore, studies suggest that successful ICT integration depends heavily on teachers' competencies in technology, pedagogy, and content knowledge—areas comprehensively captured by the Technological Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler, 2006). Equally important are teachers' behavioral intentions and motivations, influenced by attitudes, subjective norms, and perceived control—elements effectively addressed by the Theory of Planned Behavior (TPB) (Ajzen, 1991; Richard et al., 2023).

A systematic synthesis of existing literature thus indicates several critical gaps: First, there is limited understanding of how these identified competencies and psychological factors collectively influence TVET teachers' actual integration of ICT into their teaching practices. Second, there is inadequate exploration of effective pedagogical frameworks that specifically address vocational education contexts, aligning technological applications with vocational learning outcomes. Third, despite extensive empirical evidence from global contexts, there remains insufficient comparative analysis of China's TVET experiences with international best practices, restricting the applicability and generalizability of findings.

Problem Statement

Based on the above synthesis, this study addresses these identified gaps by systematically examining how Chinese TVET teachers integrate ICT into teaching and learning, identifying specific barriers, and exploring effective interventions or best-practice models. Guided explicitly by integrating the TPACK, TPB, and BDT frameworks, this research aims to provide actionable insights into enhancing ICT integration, thereby informing targeted professional development strategies, institutional policy-making, and ultimately improving vocational education outcomes. Despite a growing body of research highlighting the benefits of ICT in education, several studies also reveal substantial challenges and limitations in real-world implementation. For instance, Han et al. (2020) found that many teachers lack the pedagogical skills and confidence to integrate ICT meaningfully, resulting in superficial use of digital tools. Ma (2019) reported that in some institutions, ICT integration was policy-driven but poorly executed, leading to tokenistic usage and minimal pedagogical transformation.

Moreover, studies such as Ouyang (2017) and Cai & Qian (2021) emphasized regional disparities, where schools in underdeveloped provinces struggle with outdated infrastructure, low digital literacy, and limited institutional support. Even when training programs are offered, they often fail to address teachers' specific subject needs or long-term development (Chen & Liu, 2021). These findings underscore that ICT adoption is not merely a technical issue but a systemic and cultural one, deeply embedded in institutional capacity, teacher belief systems, and policy alignment.

Integrated Theoretical Framework

To comprehensively explore ICT integration by TVET teachers, this study systematically integrates the three complementary theoretical frameworks—Technological Pedagogical Content Knowledge (TPACK), Theory of Planned Behavior (TPB), and Bloom's Digital Taxonomy (BDT). As outlined by TPACK, teachers must integrate technological, pedagogical, and content knowledge to create effective learning environments (Mishra & Koehler, 2006). Meanwhile, TPB highlights the importance of teachers' behavioral intentions, shaped by supportive attitudes, subjective norms, and perceived control, in successfully adopting ICT in their classrooms (Ajzen, 1991). Each framework addresses distinct yet interrelated dimensions critical to understanding and enhancing ICT integration:

TPACK provides a framework to examine the interplay among technological knowledge, pedagogical skills, and content mastery required for effective teaching practice.

TPB offers insights into teachers' psychological readiness and willingness to adopt ICT, emphasizing their attitudes, subjective norms, and perceived behavioral control.

BDT provides criteria for evaluating how ICT tools align with cognitive learning objectives, focusing on the development of higher-order thinking skills such as analysis, evaluation, and creation, particularly pertinent to vocational education contexts.

Figure 1 visually represents how these theories integrate, forming a coherent analytical framework guiding this review. TPACK establishes a foundation by defining required competencies; TPB elucidates motivational and behavioral dimensions influencing teachers' adoption of technology; and BDT assesses educational outcomes related to cognitive skill advancement. This integrated model ensures a holistic approach, facilitating a detailed analysis of ICT integration processes, barriers, and effective practices among TVET teachers in China.

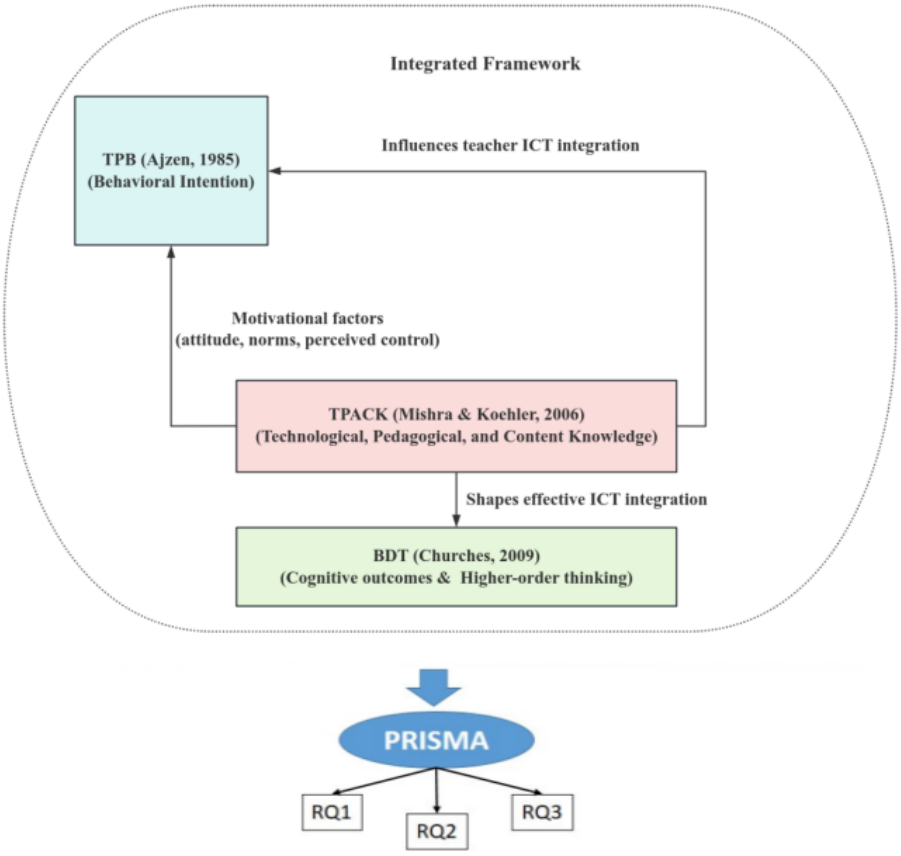

Figure 1: Integrated Framework of the Study

Building on the theoretical framework outlined in the previous section, this study situates the integration of ICT in Chinese TVET within the broader global context, emphasizing its role in addressing the economic and educational demands of the 21st century.

The integration of ICT in vocational education is critical for addressing the demands of a rapidly evolving global economy. TVET serves as a cornerstone of economic growth and workforce development, contributing to industrial innovation and reducing unemployment (Saud et al.,

2011). Nations such as Jamaica, China, Malaysia, and India have leveraged TVET to enhance employment opportunities and drive socioeconomic progress (Brewer & Comyn, 2015). At its core, TVET equips learners with the skills and competencies necessary to succeed in industrial environments while fostering entrepreneurial potential. However, the successful integration of ICT in TVET requires effective teacher preparation and professional development, underscoring the importance of frameworks like TPACK and TPB in guiding technology adoption and utilization.

Recent empirical studies highlight the transformative potential of ICT in TVET settings, providing practical insights into the application of TPACK, TPB, and BDT. United Nations Educational, Scientific, and Cultural Organization (UNESCO) identifies teaching and learning as key areas for ICT implementation, emphasizing its role in fostering cognitive, affective, and psychomotor objectives (Chris, 2005). From the BDT perspective, ICT tools have proven effective in promoting higher-order cognitive skills such as analysis, evaluation, and creation (Churches, 2008). For instance, blended learning approaches, which integrate ICT with traditional methods, have shown greater effectiveness in improving teaching outcomes compared to solely ICT-enabled methods, particularly in the cognitive domain (Yasak & Alias, 2015).

Moreover, studies in Bangladesh highlight the practical application of TPACK, where teachers integrate technological, pedagogical, and content knowledge to improve teaching quality, time efficiency, and learning outcomes (Shamim & Raihan, 2016). Similarly, research in Ghana underscores the behavioral factors outlined in TPB, demonstrating that teachers' mastery of ICT tools and technology-mediated pedagogical strategies depends on their attitudes, perceived control, and supportive norms within their teaching environments (Richard et al., 2023).

These findings underscore the central role of teachers in ICT integration. The ability of teachers to effectively embrace and adapt technology is critical for enhancing their instructional competencies and improving educational outcomes in TVET (Cabero-Almenara et al., 2021). In the Chinese context, aligning teachers' competencies with the principles of TPACK and addressing behavioral barriers identified by TPB can provide actionable pathways to overcome existing challenges. This study builds on these insights to explore ICT integration by TVET teachers in China and identify best practices for fostering sustainable development in vocational education.

Research Questions

This study adopts a systematic literature review (SLR) to investigate ICT integration in Chinese TVET, focusing on three core research questions:

(1) What is the status of the integration of ICT in teaching and learning by TVET teachers in China?

(2) What barriers or challenges hinder the integration of ICT into teaching and learning among Chinese TVET teachers?

(3) What interventions or best practice models have been developed or identified towards promoting the integrate of ICTs among TVET teachers in China?

By addressing these questions, the study aims to provide a comprehensive understanding of ICT integration in vocational education and offer actionable recommendations for enhancing teaching and learning outcomes.

Methods

This study adopted the Preferred Reporting Items for Systematic Reviews (PRISMA) framework to conduct an SLR aimed at addressing the research questions. The PRISMA framework was chosen for its rigorous approach to ensure transparency and consistency in systematic reviews. The process began with the development of a comprehensive search strategy, incorporating Boolean operators and relevant keywords to retrieve studies from selected databases. A structured selection process was then applied, including screening by title, abstract, and full text. To ensure reliability and validity, meticulous documentation of each step, including inclusion and exclusion criteria, was maintained, and the quality of selected studies was assessed based on predefined benchmarks.

This study adopted a systematic approach to keyword selection to ensure comprehensive coverage of relevant literature, emphasizing the inclusion of diverse terminologies relevant to ICT integration in China's TVET context. Recognizing the variety of terms used to describe TVET in the region, the search strategy incorporated alternatives such as "vocational," "TVET," "technical education," "higher vocational college," and "Technical and Vocational Education and Training." Given the multifaceted nature of ICT, a broad range of keywords was employed to capture its different dimensions, including "ICT," "technology integration," "AI," "VR," "telecommunication," "online," "online teaching," "artificial intelligence," "e-learning," "virtual," "blended mode," "digital tools," "digital technology," "tech," "computer technology," "technology," and "digital." This comprehensive search string was designed to maximize the retrieval of relevant studies across databases.

Additional keywords such as "model," "framework," "intervention," and "best practice" were incorporated into the search strategy to identify best practices in ICT integration. Boolean operators "AND" and "OR" were systematically employed to combine these keywords, enabling the retrieval of a comprehensive and targeted set of studies. This approach ensured that the search captured studies focusing on ICT integration models, frameworks, and effective interventions in vocational education. By leveraging these operators, the strategy optimized both the breadth and depth of the search across the selected databases.

Two major academic databases, Scopus and Web of Science (WoS), were selected to ensure the inclusion of a broad and comprehensive range of relevant literature. These databases were chosen based on three primary considerations: their extensive coverage of ICT and TVET-related literature, their inclusion of high-impact journals to ensure high-quality sources, and their ability to provide extensive access to full-text articles. The initial search phase yielded a total of 537 records from Scopus and 28,075 records from WoS, reflecting the substantial coverage of these databases.

Meanwhile, to refine the extensive set of records retrieved during the initial search, a systematic application of inclusion and exclusion criteria was conducted to ensure relevance to the study's objectives. Firstly, only studies published within the last ten years (2015–2024) were included to capture the most recent trends and practices in ICT integration. Secondly, publications were limited to those written in English to ensure accessibility and consistency in analysis. Thirdly,

only peer-reviewed journal articles, conference proceedings, and book chapters were considered, as these sources typically undergo rigorous review processes, ensuring reliability. Finally, the scope of the review was narrowed to studies conducted within the context of China, aligning with the research objectives.

The application of these criteria resulted in the selection of 368 records from Scopus and 410 records from WoS. Table 1 presents a detailed summary of the inclusion and exclusion process.

Table 1: Inclusion/Exclusion Criteria for the Study

Criteria	For Inclusion	For Exclusion
Time period	2015-2024	< 2015
Language	English	Other than English
Type of literature	Journal articles, conference proceedings and book chapters	Books, review, conference review, editorial, retracted, thesis
Country	China	Other than China

A comprehensive database was developed using Microsoft Excel to systematically manage the details of the literature retrieved from Scopus and WoS. The screening process was conducted in multiple stages to ensure a systematic refinement of the records.

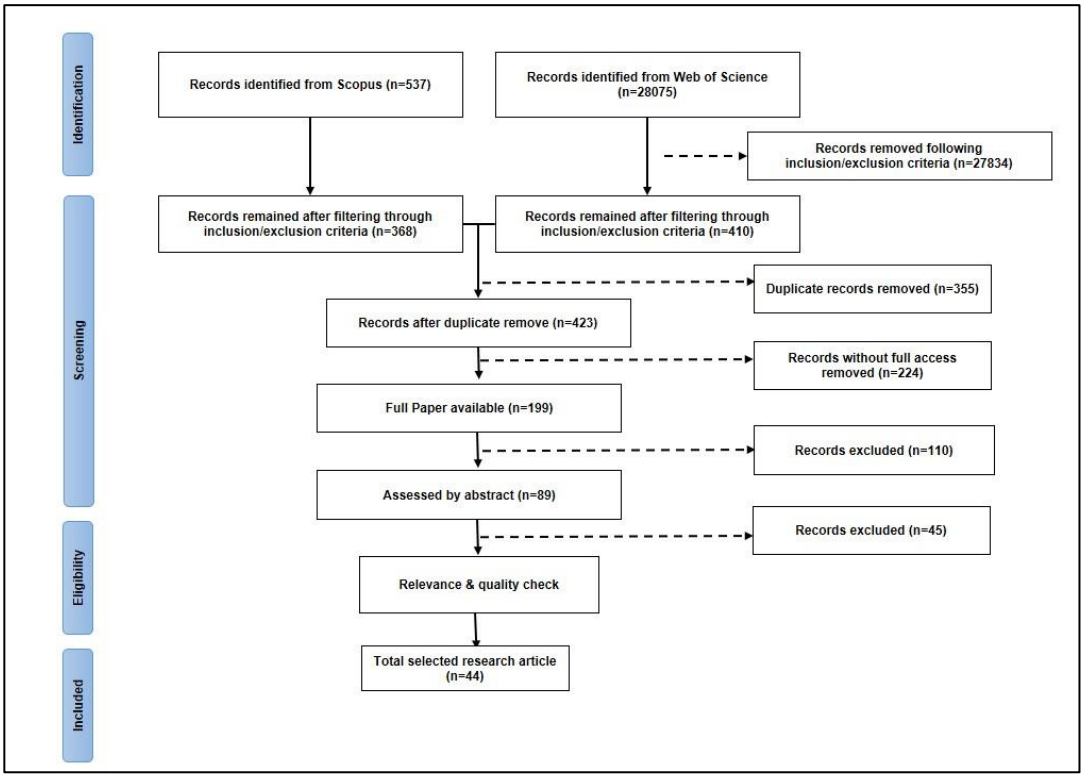

Figure 2: Summary of Systematic Review

In the first stage, duplicate entries within the database were identified and removed. In the second stage, only studies with full-text access were retained, resulting in 199 records. In the

third stage, the abstracts of the remaining records were reviewed to assess their relevance to the research questions, leading to a shortlist of 89 pieces of literature. Finally, in the fourth stage, full-text papers were thoroughly analyzed against the research objectives, culminating in the selection of 44 studies for the systematic review.

The complete screening process, aligned with the PRISMA framework, is visually summarized in Figure 2.

Data from the 44 full-text articles were extracted, tabulated, and systematically organized in an Excel sheet. Key information, including the year of publication, study objectives, keywords, research design, and subject area, was documented to facilitate classification. These articles were then categorized according to the research questions (RQ1, RQ2, and RQ3) and supported by evidence from the analyzed studies (**see Table 2 in the appendix**).

The extracted data were then analyzed thematically, guided by the theoretical frameworks of TPACK, TPB, and BDT.

2.1 Data Analysis

The extracted data from the selected studies were systematically analyzed through a thematic analysis approach, explicitly guided by an integrated theoretical framework comprising TPACK, TPB, and BDT. The analytical process involved several iterative steps:

Initial Coding and Classification: Firstly, each study was reviewed to identify key themes related to ICT integration within the TVET context. Initial codes were assigned to relevant text segments based on predefined constructs from the theoretical frameworks:

TPACK-related codes captured references to teachers' technological, pedagogical, and content knowledge, focusing on competencies and instructional practices.

TPB-related codes focused on teachers' behavioral intentions, attitudes, subjective norms, and perceived behavioral control regarding ICT adoption.

BDT-related codes highlighted cognitive dimensions, assessing how ICT use facilitated higher-order thinking skills like analysis, evaluation, and creation.

Thematic Organization: The initially coded segments were then grouped into coherent themes and sub-themes according to their theoretical alignment. This helped in clearly demonstrating how each theme corresponded to specific theoretical constructs, ensuring logical consistency.

Cross-Verification and Integration: Themes identified through TPACK, TPB, and BDT lenses were cross-verified for consistency and comprehensiveness. This integration step confirmed that the themes collectively reflected the multifaceted nature of ICT integration—encompassing competency development (TPACK), behavioral and motivational influences (TPB), and cognitive outcomes (BDT).

Final Synthesis and Reporting: Finally, themes were synthesized into a structured narrative directly addressing the research questions. The reporting explicitly articulated how the integrated theoretical framework informed the interpretation of the findings, highlighting the interplay among teachers' competencies, behavioral factors, and pedagogical effectiveness, thus providing robust and theoretically grounded answers to the research questions.

Results

3.1 Overview of the Studies

This investigation synthesized findings from the TVET field to evaluate the extent and efficacy of ICT integration by TVET teachers in China. The study analyzed literature published over the last decade (2015–2024) to examine the current status, prevailing practices, and perceived barriers related to ICT use in vocational education. Among the 44 identified studies, the majority were published in 2021 (n = 9) and 2024 (n = 9), followed by 2023 (n = 7) and 2022 (n = 6). The fewest studies were published in 2018 (n = 2) and 2020 (n = 2), and no relevant publications were identified in 2015.

Figure 3 illustrates that research on ICT integration in Chinese TVET has significantly increased since 2021, coinciding with the COVID-19 pandemic's impact on education. This surge reflects a growing emphasis on technology-enabled teaching strategies in response to the shift towards online and hybrid learning environments. From a theoretical perspective, this trend aligns with the TPACK framework, which underscores the importance of integrating technological, pedagogical, and content knowledge to adapt to rapidly changing educational demands. The pandemic also highlighted the relevance of TPB constructs, such as perceived behavioral control and subjective norms, in influencing teachers' adoption of ICT during challenging circumstances. Furthermore, the increased focus on digital tools aligns with Bloom's Digital Taxonomy, as the use of ICT facilitated higher-order cognitive skills, such as problem-solving and critical thinking, in TVET programs.

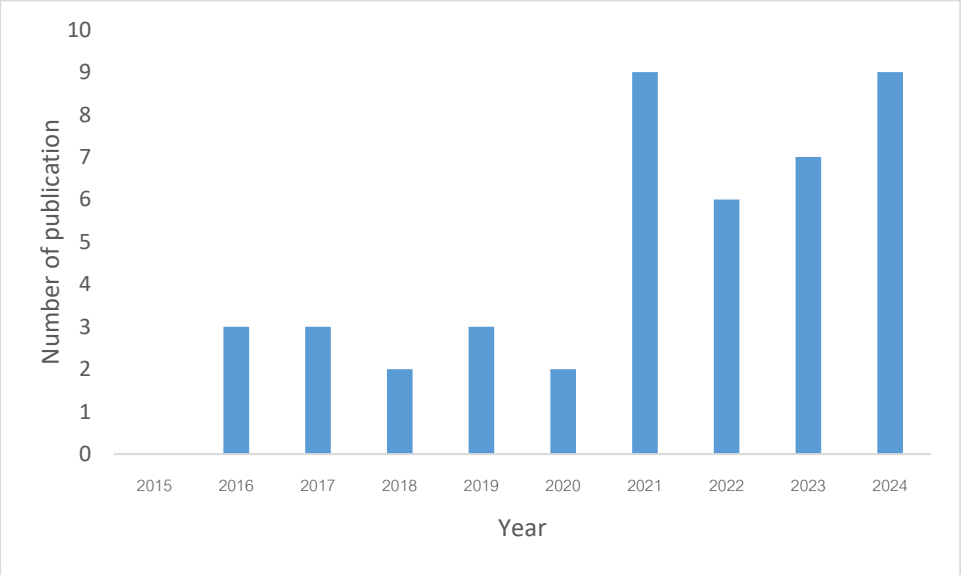

Figure 3: Publication on ICT Integration by TVET Teachers within Last Ten Years

Most of the 44 reviewed studies were journal articles (n = 33), with a smaller proportion comprising book chapters (n = 3, 7%), as shown in Figure 4. The dominance of journal articles reflects the prevalence of peer-reviewed empirical research in the field, ensuring the reliability and academic rigor of the included literature.

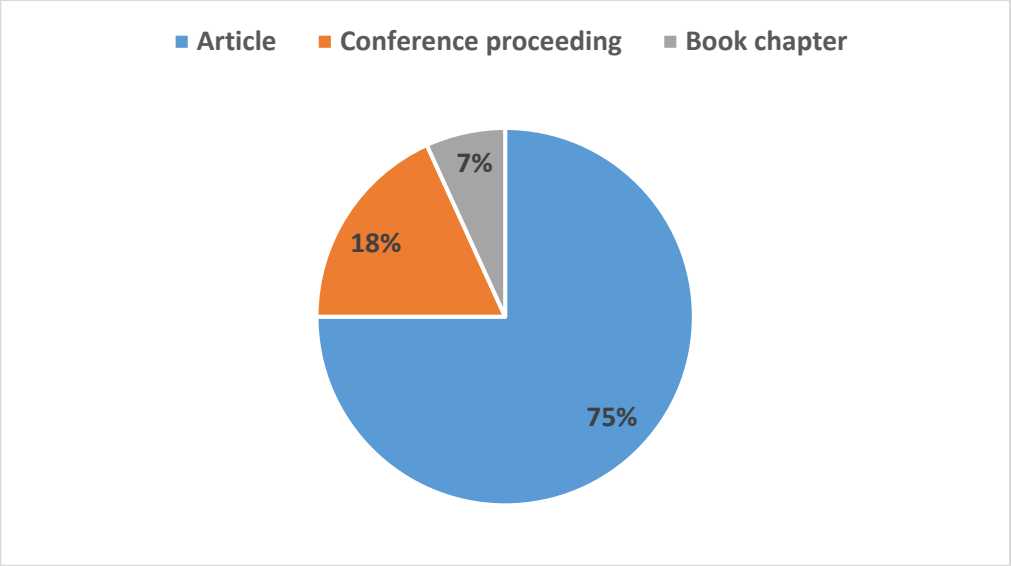

Figure 4: Types of Publications

In terms of research methodology, most studies employed quantitative approaches (n = 18), followed by qualitative methods (n = 10) and mixed methods (n = 8). A few studies also utilized hybrid methods, experimental designs, or case studies, reflecting the diverse methodological approaches adopted to explore ICT integration in TVET teaching (Figure 5). Notably, some studies focused on developing models or frameworks for effective ICT integration, aligning with the TPACK framework, which emphasizes the intersection of technology, pedagogy, and content knowledge in guiding teachers' practices. This indicates a growing interest in practical applications and actionable strategies to address challenges in ICT integration within the TVET context.

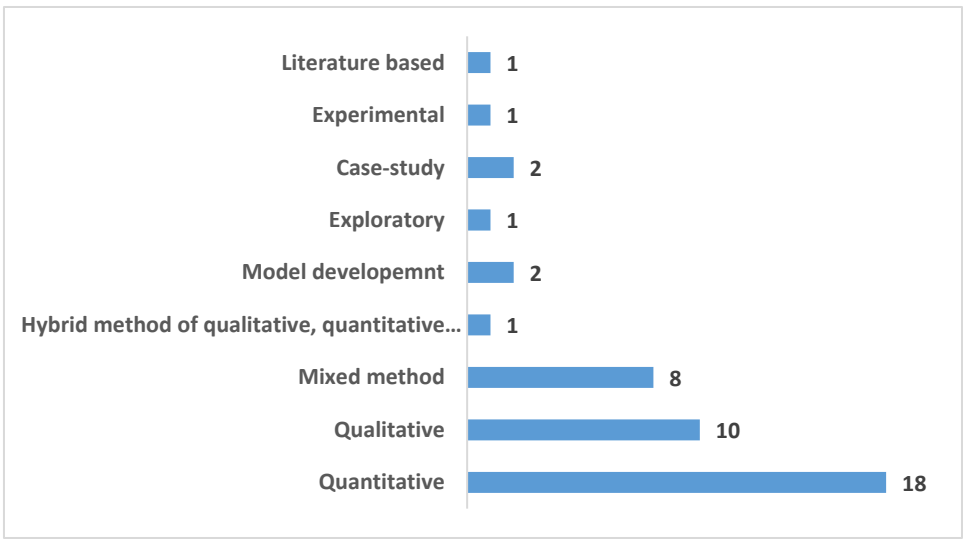

Figure 5: Types of Research Studies

In terms of subject areas, the studies were predominantly categorized as either general (n = 12) or multidisciplinary (n = 13), as illustrated in Figure 6. This broad scope reflects the versatility of ICT integration, with its applications spanning multiple disciplines and educational contexts.

From the perspective of TPB, this diversity suggests that subjective norms and perceived behavioral control may vary significantly across different subject areas, influencing teachers' adoption and effective use of ICT tools. Furthermore, the emphasis on multidisciplinary approaches aligns with BDT, highlighting the potential of ICT to address cognitive, affective, and psychomotor learning objectives across diverse educational scenarios.

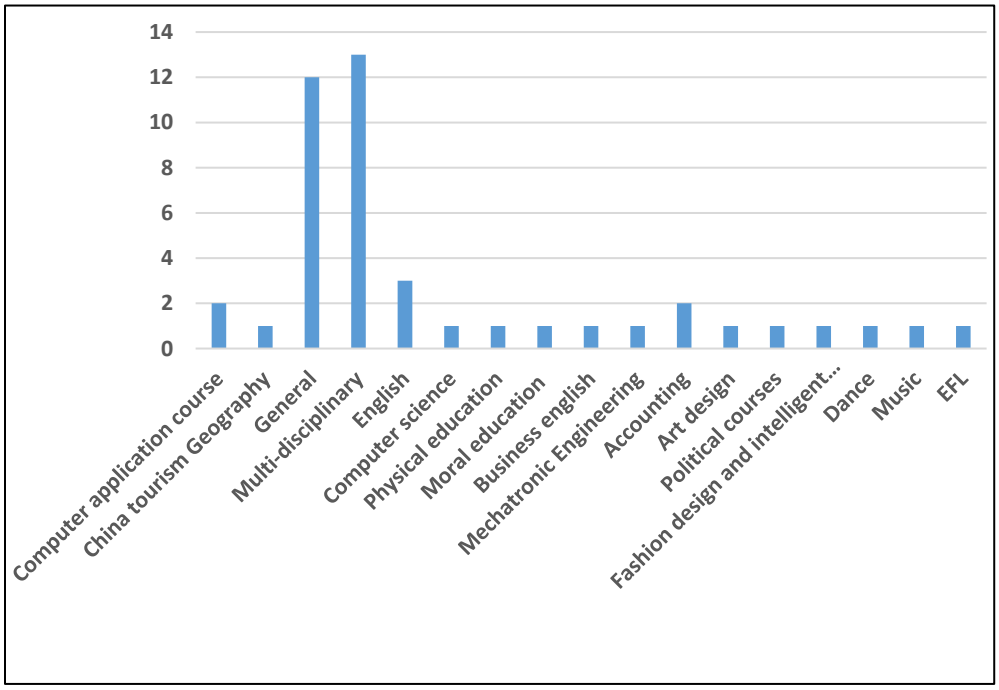

Figure 6: Subject Area-wise Research Distribution

In alignment with the research objectives, the findings have been systematically organized into sub-themes under three overarching themes, each directly addressing one of the research questions: (1) the current status of ICT integration in TVET, (2) the barriers and challenges faced by educators, and (3) the best practices and models for effective ICT utilization. This thematic classification provides a structured and focused framework for analyzing the data and ensures a comprehensive exploration of ICT integration in Chinese TVET. The details of these findings are presented in the following sections.

Current State of ICT Integration by TVET Teachers in China

The current state of ICT integration by TVET teachers in China reveals a dynamic landscape shaped by diverse teaching approaches, technological innovations, and institutional practices. This section presents findings from the reviewed literature, highlighting key dimensions of ICT integration, including blended learning strategies, the adoption of Massive Open Online Courses (MOOCs) and other educational resources, mobile learning, virtual reality applications, gamification, and other innovative interventions. These findings not only demonstrate the breadth of ICT adoption in Chinese TVET but also underscore the transformative potential and ongoing challenges associated with its implementation. The following subsections provide a detailed exploration of these dimensions.

Blended Learning Approaches: Blended learning in Chinese TVET has demonstrated significant potential across multiple dimensions, as evidenced by various studies. For instance,

the application of the Analysis, Design, Development, Implementation, and Evaluation (ADDIE) model in English courses at Shandong Vocational College of Industry has been shown to enhance both teaching quality and student engagement (Yao, 2021). Beyond individual case studies, blended learning offers broader advantages, including fostering interactivity, independent learning, teamwork skills, and curiosity, all of which contribute to improved educational quality (Shen, 2024). These findings align with the TPACK framework, where effective integration of technological and pedagogical knowledge enables teachers to design more interactive and learner-centered instructional environments.

The adoption of blended learning has been notably accelerated by the COVID-19 pandemic, particularly through Small Private Online Courses (SPOCs). Key factors influencing English as a Foreign Language (EFL) instructors' (n = 63) utilization of blended learning strategies include satisfaction with curricular platforms, institutional support, evaluation mechanisms, and teachers' motivation and value perception of SPOC-based teaching (Jiang, 2022). These factors highlight the importance of TPB constructs, such as perceived behavioral control and subjective norms, in facilitating the adoption of new teaching methods during periods of rapid change.

In addition, a novel assessment model for evaluating the effectiveness of blended learning has demonstrated that blended courses align well with learners' expectations. These courses significantly enhance learning outcomes, provide real-time feedback, and deliver precise evaluations (Yang, 2024). Such findings underscore the alignment of blended learning with BDT, particularly in fostering higher-order cognitive skills such as analysis and evaluation. This reinforces the idea that blended learning surpasses traditional methods in fostering student engagement and academic achievement.

MOOCs and Educational Resources: The integration of MOOCs in Chinese TVET presents both significant opportunities and notable challenges. Recent studies demonstrate that MOOCs significantly enhance student motivation, learning efficiency, and resource utilization among vocational college students (n = 60) while also supporting lesson planning and improving instructional quality (Ji, 2016b). These benefits are particularly evident in their ability to foster higher-order cognitive skills, such as analysis, evaluation, and creative problem-solving. For instance, interactive features like real-time quizzes, peer-reviewed assignments, and scenario-based simulations enable students to apply theoretical knowledge in practical contexts, a critical aspect of vocational training. By offering diverse learning resources and promoting independent inquiry, MOOCs align closely with the principles of BDT, preparing students for complex problem-solving tasks required in professional environments.

However, challenges persist, particularly in teacher adoption. Educators have expressed uncertainties about the effectiveness of MOOCs and concerns regarding the transition to new pedagogical approaches (Ji, 2016b). This highlights the need for greater institutional support, particularly in providing training and resources to help teachers effectively integrate MOOCs into their practices. Without such support, the full potential of MOOCs in advancing TVET reform cannot be realized.

The dual potential and limitations of MOOCs emphasize the importance of standardized, high-quality MOOCs tailored to industry demands and capable of preparing students with professional competencies. As dynamic supplementary resources, MOOCs integrate interactive features and assignments into existing curricula. However, their success hinges on robust faculty

training programs and feedback mechanisms, which address diverse learning styles and enable educators to adapt their teaching practices effectively (Ma, 2019).

Mobile Learning, Virtual Learning, and Gamification: The landscape of TVET classrooms in China is undergoing a profound transformation driven by rapid advancements in ICT. Mobile learning has emerged as a widely adopted tool for enhancing student engagement and learning outcomes. For instance, integrating mobile internet terminals into physical education lessons significantly improved both student behavior and interest in education (Shi et al., 2021). Similarly, the app Superstar Learning Pass, developed for computer science education, demonstrated that blended learning approaches facilitated by mobile technology not only enhance academic performance but also foster positive student attitudes compared to traditional methods (Liu et al., 2019). However, challenges remain. Research on mobile apps in moral education revealed conflicting perceptions—students showed enthusiasm, while teachers were indifferent, and parents largely opposed their use. These challenges highlight the importance of TPB, as teachers' attitudes, subjective norms, and perceived behavioral control directly influence their willingness and confidence to adopt mobile learning (Liu & Xu, 2021). Furthermore, from a TPACK perspective, successful integration of mobile learning requires teachers to effectively combine technological knowledge with pedagogy and content to address diverse educational goals.

Virtual reality (VR) offers another promising avenue for enhancing TVET. The use of virtualization tools, such as VMware Workstation Pro, in vocational teaching facilitates simulation-based learning and the development of key competencies (Chen & Liu, 2021). Similarly, VR in art education improves engagement, creativity, and practical skills such as dance choreography (Zeng & Wang, 2022; Yang, 2023). However, VR's effectiveness relies heavily on implementation strategies. While it is effective for short-term information acquisition, research suggests that long-term retention is better supported by textual cues (Zhang et al., 2023a). These findings underscore the importance of teacher preparation and strategic support, aligning with TPACK, which emphasizes the need for teachers to skillfully integrate VR technology into curriculum design. Additionally, teachers' confidence and behavioral intentions, as described in TPB, are critical for overcoming challenges related to VR adoption.

Gamification holds substantial potential for addressing passive learning behaviors in TVET. The incorporation of game-like elements into curricula fosters interaction, engagement, and academic achievement (Wang et al., 2017). Features like leaderboards, reward systems, and interactive simulations motivate students and create a dynamic learning environment. These outcomes align with BDT, as gamification supports higher-order cognitive processes like problem-solving and critical thinking. However, successful integration requires teachers to have a deep understanding of the pedagogical principles behind gamification, which TPACK highlights as the intersection of technology and pedagogy. Moreover, teachers' perceptions of gamification's value, as described in TPB, play a pivotal role in determining its adoption and effectiveness.

Collectively, ICT applications such as mobile learning, VR, and gamification have been widely adopted by Chinese TVET educators. These technologies significantly improve learner engagement, performance, and educational experiences, signaling a shift towards more interactive teaching strategies. Hence, to fully realize their potential, robust teacher training

programs, institutional support, and research into best practices for integrating these technologies are essential.

Other Technology Interventions: Several studies have examined the impact of ICT interventions on TVET in China, showcasing a variety of innovative practices and outcomes. For instance, Emergency Remote Teaching (ERT) during the COVID-19 pandemic demonstrated how universities effectively leveraged online platforms and software to adapt to the crisis. Teachers developed tailored digital materials, guiding organizations to establish resilient systems for future emergencies (Jing et al., 2023). These practices highlight the importance of perceived behavioral control from TPB, as teachers' confidence in their ability to adapt during crises is critical to their success. Additionally, TPACK emphasizes the need for teachers to integrate technological and pedagogical knowledge effectively, particularly when designing digital materials for emergency scenarios.

The transformative role of artificial intelligence (AI) and multimedia resources in fostering creativity and musical understanding has also been explored. Findings revealed a 25% increase in innovation levels and a 30% improvement in rhythm recognition among higher vocational college students, showcasing the potential of digital teaching aids in enhancing music pedagogy (Shi, 2024). These results align with TPACK, as they illustrate how teachers can integrate technology with domain-specific pedagogy to enhance learning outcomes.

Multimedia teaching has further demonstrated its effectiveness in English instruction at vocational colleges by enhancing learning personalization and engagement. Techniques such as role-play and multimedia materials enable students to interact more dynamically with content, fostering an engaging learning environment (Ji, 2016a). Additionally, multimedia networks have been employed to bridge the gap between business English skills demanded by employers and vocational education practices. For instance, experimental programs integrating "simulated practice" and "in-field training" have improved students' communication, teamwork, and practical English skills while also fostering internship opportunities (Cheng & Liu, 2021). These applications reflect the intersection of technology and content knowledge within TPACK, enabling teachers to address real-world vocational needs.

Project-based learning has also emerged as an effective approach for teaching subjects like fashion design and intelligent manufacturing. Networked virtual systems for project management instruction have demonstrated significant advantages over traditional methods, enhancing interactivity and practical application (Pan & Xia, 2023). Similarly, the application of Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) technology in evaluating online instruction revealed a strong correlation between robust training, effective evaluation methods, and high assessment ratings (Zheng, 2023). These findings highlight the importance of institutional support and training in equipping teachers with the skills necessary for integrating innovative technologies into their pedagogy programs.

Furthermore, a large-scale survey by Han et al. (2020) involving 1,300 vocational institutions and 11,000 high schools shed light on the widespread adoption of online instruction during the pandemic. Most schools have adequate infrastructure, with over half of the resources comprising temporary digital tools developed by teachers and teams. Notably, 78% of teachers reported that technology enhanced their teaching capacity, while 47% of students experienced enriched learning outcomes. The popularity of live broadcasting, with over 90% of teachers creating original materials, underscores the growing reliance on digital platforms in vocational education.

These findings align with TPB, as they emphasize how teachers' attitudes and external support influence their adoption of ICT tools, particularly during periods of rapid change.

Collectively, ICT interventions such as ERT, AI-enhanced learning, multimedia teaching, and project-based approaches have significantly transformed TVET in China. By fostering innovation, enhancing engagement, and addressing vocational needs, these technologies underscore the critical role of ICT in modernizing vocational education. Therefore, to fully realize their potential, it is essential to provide robust training for teachers, develop standardized resources, and promote sustained institutional support.

Standards of ICT Competency: Investigations into the ICT competency levels of TVET teachers in China reveal notable progress while highlighting critical areas for further development. IT instruction competence, as examined through the TPACK, underscores the transformative impact of skillfully integrating digital technology with pedagogy and content knowledge on teaching effectiveness (Xu et al., 2024). This framework emphasizes that effective ICT integration is not merely about technological familiarity but about aligning digital tools with pedagogical strategies and curriculum objectives to enhance learning outcomes.

Despite these advancements, challenges remain. A significant knowledge gap exists regarding green technology, particularly its alignment with industry demands and its incorporation into curriculum development. This gap hinders the ability of TVET programs to prepare students for evolving market requirements (Li et al., 2023). From a TPACK perspective, this challenge reflects the need for teachers to acquire not only technological knowledge but also domain-specific expertise to meet the demands of emerging industries.

In addition, teacher support plays a pivotal role in fostering ICT competency. Studies highlight a positive relationship between effective teacher-student interactions and both student digital literacy and the perceived usefulness of technology (Chen & Ma, 2022). These findings align with TPB, as external support and resources significantly influence teachers' attitudes, perceived behavioral control, and ultimately, their ability to integrate ICT into their teaching practices. However, many teachers still report a lack of sufficient training, which undermines their confidence in using internet-based services and other ICT tools effectively.

Collectively, these studies emphasize the urgent need for sustainable professional development programs and strategic curriculum adjustments to address existing gaps. By providing targeted training, fostering institutional support, and aligning ICT competencies with industry standards, Chinese TVET educators can better equip students for an ICT-driven future. These initiatives must prioritize the integration of emerging technologies, such as green technology, into teaching practices, ensuring that TVET remains relevant in a rapidly changing global economy.

Factors Influencing ICT Adoption: ICT integration among TVET teachers in China is shaped by a complex interplay of internal and external factors. Key internal factors, such as computer self-efficacy, perceived ease of use, and perceived utility, have been identified as critical predictors of ICT adoption and satisfaction among vocational college teachers (Bin et al., 2020). These findings align with the Technology Acceptance Model (TAM), which emphasizes that teachers are more likely to adopt ICT when they perceive it as useful and easy to use. From the perspective of TPB, internal beliefs, including teachers' psychological comfort with technology and their attitudes toward its value, play a pivotal role in shaping behavioral intentions and actual

usage (Yang et al., 2023). Strengthening these internal competencies is essential to fostering a culture of effective ICT integration in educational settings.

External support is equally critical in driving ICT adoption. Studies highlight that institutional factors, such as access to teaching resources, course design support, and professional development opportunities, significantly impact teachers' confidence and willingness to use ICT (Han et al., 2018). Gender disparities and variations in job roles, such as teaching assistants facing unique challenges, further underscore the need for tailored support that addresses the diverse needs of faculty members. These findings emphasize that external support must go beyond providing resources; it should also include mentoring, technical assistance, and clear institutional policies that encourage technology use.

Moreover, external factors influencing ICT adoption have been extensively explored through TAM, reinforcing that perceived usefulness and ease of use are the most significant determinants of adoption (Wang & Han, 2018). However, studies have also revealed that perceived helpfulness alone is insufficient to drive actual usage, underscoring the need for more comprehensive support systems that address barriers to implementation (Bin et al., 2020). This includes ongoing professional development programs that equip teachers with the skills and confidence necessary to integrate ICT effectively into their teaching practices.

Therefore, to address these challenges, a dual-pronged approach is essential. First, efforts must focus on enhancing teachers' internal beliefs and technology proficiency through holistic pedagogical development. Initiatives such as competition-based training programs can encourage skill enhancement and foster the sharing of best practices within the teaching community. Second, robust external support must be provided, tailored to the specific roles and needs of educators within the TVET system. By simultaneously addressing internal and external factors, Chinese TVET educators can be better equipped to meet the demands of modern vocational education, ensuring sustainable and effective ICT integration (Zhou et al., 2023).

Case Studies on Effective Integration of ICT: Several Chinese TVET institutions have demonstrated successful models of ICT integration, showcasing innovative practices in teaching, training, and professional development. Shenzhen Polytechnic, for instance, developed the Integrated Competency Training Model in 2018 to enhance resourcefulness, teaching effectiveness, and instructional design among vocational educators (Zhang et al., 2023b). This model incorporates advanced technology-supported elements, including smart teaching platforms, XR-based learning environments, facial recognition systems, and big data-enabled classrooms. These technologies create adaptable learning environments and foster technical and vocational skills, aligning with the TPACK framework, which highlights the integration of technological, pedagogical, and content knowledge in modern teaching practices.

Chengdu Vocational and Technical College (CVTC) has similarly prioritized ICT integration by introducing 38 programs to enhance teachers' digital proficiency and align with regional business needs (Zhang et al., 2023b). The college established the Faculty ICT Competency Standards, focusing on five core areas: accountability, curriculum, instruction, assessment/tools, and innovative research. These standards provide a structured framework for professional development, with training programs addressing practical topics such as creating electronic textbooks, designing PowerPoint presentations, and developing micro-lessons. CVTC's success underscores the importance of institutional support in fostering teacher proficiency and aligns

with the principles of TPB, as external support and perceived ease of use directly influence ICT adoption.

Another notable example is the Wuxi Vocational Institute of Commerce, which transformed its traditional curriculum into an ICT-based framework (Cai & Qian, 2021). The institute features a digital virtual campus equipped with data centers, universal authentication systems, and cluster computing centers. Its infrastructure includes over 200 multimedia classrooms and 40 multi-use spaces for webinars, chats, and videoconferences. Additionally, Wuxi developed the E-Classroom, a blended learning platform designed to enhance interactive and efficient teaching practices. These efforts reflect the application of both TPACK and BDT, as they integrate advanced digital tools to support higher-order cognitive skills and improve teaching outcomes.

Shouguan Vocational School, established in 2016, has adopted a data-driven strategy to address teachers' professional development (Zhang et al., 2023b). The school emphasizes continuous professional growth through teaching contests and whole-school training sessions, complemented by external trainers introducing interactive teaching methods. Since 2017, Shouguan has fostered a community of practice, organizing teaching competitions and supporting teachers in developing exams, forums, online resources, and survey tools. Digital teaching proficiency has become a key evaluation criterion for academic personnel, solidifying the school's reputation as a leader in innovative teacher training. These practices align with TPB, as they address teachers' attitudes, subjective norms, and perceived behavioral control, creating a supportive environment for ICT adoption.

These case studies illustrate the diverse and effective strategies employed by Chinese TVET institutions to integrate ICT into teaching and professional development. By leveraging advanced technologies and structured training programs, these institutions have set benchmarks for fostering digital competency and modernizing vocational education. Hence, to further enhance these efforts, institutions must continue to align training initiatives with industry demands, provide sustainable support systems, and promote best practices that encourage widespread adoption of ICT.

Barriers and Challenges Faced by TVET Teachers when Integrating ICT

Despite the growing emphasis on ICT integration in TVET, teachers face a range of barriers that hinder effective implementation. These challenges span technological limitations, training deficits, privacy concerns, and institutional gaps.

Outdated and Insufficient Technologies: A study by Ouyang (2017) revealed that outdated multimedia technologies and low-quality courseware in higher vocational education in China significantly impede the integration of ICT into curricula. These deficits, coupled with insufficient teacher-student interaction, limit the effectiveness of network technologies. Similarly, Cai and Qian (2021) identified critical issues with the E-Classroom Education Platform (ECEP) at Wuxi Vocational Institute of Commerce, including buffering, inadequate bandwidth, and slow internet speeds. These findings align with the TPACK framework, which underscores that ICT integration requires not only technological availability but also the infrastructure that supports seamless and interactive learning environments.

Lack of Training and Support: The lack of robust teacher training programs and digital resource platforms further exacerbates the challenges of ICT adoption. For example, the quality

and competitiveness of MOOCs in China have been criticized, particularly during the COVID-19 pandemic, when vocational teachers struggled with emergency remote teaching. Challenges included low-immersive experiences, ineffective live-streaming capabilities, and limited interactive functions, compounded by a lack of intelligent learning tools and insufficient software resources (Ma, 2019; Jing et al., 2023). These issues highlight the importance of TPB, as inadequate training and external support negatively impact teachers perceived behavioral control and their confidence in adopting ICT.

Teacher and Student Preparedness: A large-scale study involving 17,009 teachers across 110 vocational institutes during the COVID-19 pandemic revealed significant deficiencies in online learning readiness (Han et al., 2020). Key barriers included teachers' insufficient ICT knowledge and skills, students' poor e-learning practices, and limited institutional support. These findings emphasize that successful ICT integration requires addressing both teachers' internal competencies, as outlined in TPACK, and external environmental factors, as emphasized by TPB, to create a supportive ecosystem for technology adoption.

Privacy and Security Concerns: The integration of ICT also raises significant privacy and security issues. Studies have identified risks such as data misuse, privacy breaches, and ethical challenges associated with big data technologies and wearable devices. For instance, contemporary multimedia instructions for accounting courses have raised concerns about personal information being compromised during storage and processing (Yu, 2022; Cai & Qian, 2021). These challenges necessitate the development of robust policies and technologies to safeguard data integrity and ensure ethical ICT integration.

Pedagogical and Practical Challenges: Teachers often encounter practical difficulties when attempting to integrate ICT into their teaching practices. For example, creating multimedia presentations for accounting courses has increased the time required for data analysis and comparison, negatively impacting students' learning experiences (Yu, 2022). Similarly, inefficiencies in live streaming, such as limited interactivity and low immersion, further hinder the effectiveness of remote teaching (Jing et al., 2023). These challenges highlight the need for professional development programs that align with TPACK, enabling teachers to effectively combine technological tools with pedagogical strategies.

Institutional and Policy Gaps: Institutional and policy deficiencies further compound the challenges of ICT integration in TVET. Key issues include the lack of continuous research on online learning, rigid assessment methods, and insufficient reward structures for teachers. Many institutions also failed to establish long-term virtual teams or dedicated units for online learning, resulting in temporary and superficial ICT integration (Han et al., 2020). Addressing these gaps requires sustained institutional commitment and strategic policy reforms that promote continuous innovation in ICT adoption.

Collectively, these barriers underscore the multifaceted nature of ICT integration challenges in Chinese TVET. Addressing these issues will require a combination of robust infrastructure, teacher training aligned with TPACK, and institutional support that fosters confidence and motivation, as emphasized by TPB. Additionally, comprehensive policies that prioritize sustainable ICT integration and safeguard data privacy will be essential for achieving meaningful progress.

Strategies and Practices for Enhancing ICT Integration by TVET Teachers

Several strategies and practices have been proposed to address the barriers hindering ICT integration in TVET, focusing on updating teaching technologies, integrating ICT into curricular instruction, and strengthening campus information ecosystems. These approaches emphasize the importance of teacher training, innovative learning models, and personalized support systems.

Raising Awareness and Knowledge: Raising awareness and enhancing TVET teachers' knowledge of contemporary technologies is a critical step in promoting effective ICT integration. For instance, the integration of virtual reality technology (VRT) into curriculum design has been identified as a way to strengthen teachers' competencies and enhance students' interactive skills (Jiang & Lai, 2016). Similarly, Mobile Assisted Language Teaching (MALT) has shown potential in improving instruction, particularly in English lessons. However, teachers must actively address negative perceptions of mobile technology among economically disadvantaged students, emphasizing its benefits and providing guidance to foster equitable access (Wu, 2019). From a TPACK perspective, these practices demonstrate the importance of equipping teachers with the knowledge and skills to seamlessly integrate emerging technologies with pedagogy and content.

Blended and Hybrid Learning Models: Blended and hybrid learning models have been widely proposed to improve technology integration in education. For example, the i-Experiment Teaching Model combines online platforms, course materials, and big data analytics to create a blended learning environment that promotes inquiry and collaboration (Zhang et al., 2015). Similarly, the three-stage asynchronous flipped classroom model incorporates pre-class online learning, in-class interactive activities, and post-class consolidation to enhance student performance, collaboration, and engagement (He, 2020). In language education, the MOOC+SPOC hybrid model integrates the strengths of both platforms, focusing on interaction, feedback mechanisms, and the effective utilization of learning materials, resulting in increased student interest and improved outcomes (Qiu, 2022). These models align with TPB, as they address both teachers' perceived ease of use and usefulness of blended learning tools, enhancing their adoption and application.

Professional Development and Competency Frameworks: Professional development programs rooted in well-defined competency frameworks are essential for fostering ICT integration. For instance, a teaching competency framework for vocational teachers emphasizes professional knowledge, information literacy, and the ability to develop innovative educational resources (Diao & Yang, 2021). Similarly, the Teaching Competency Scale for TVET teachers highlights the role of digital literacy in developing instructional resources and integrating technology into teaching (Diao & Hu, 2022). These frameworks provide a foundation for lifelong learning and aim to align teacher training with the principles of TPACK, ensuring teachers are prepared to integrate technology effectively into their pedagogy programs.

Innovative Teaching and Learning Platforms: Developing innovative platforms has been a critical strategy for enhancing ICT integration. For example, the i-Experiment platform creates a unified online-offline environment to support blended learning (Zhang et al., 2015). Additionally, an action-oriented internet teaching platform incorporates collaborative filtering and real-world work processes to personalize instruction and improve outcomes (Li, 2022; Miao

et al., 2021). These platforms emphasize the TPACK framework, enabling teachers to effectively utilize technology for personalized and action-oriented learning.

Personalized and Data-Driven Approaches: ICT integration in vocational education benefits significantly from personalized and data-driven approaches. For instance, a deep learning-based system for vocational teacher development facilitates tailored training programs by analyzing teaching experience, academic achievements, and student feedback (Zhang et al., 2024). Similarly, for "double-qualified" teachers in higher vocational schools, a four-dimensional digital cultivation model enhances digital application levels and correlates classroom performance with work evaluations (Dai, 2024). These approaches reflect the principles of TPB, as they address teachers' behavioral intentions and confidence by providing individualized guidance and robust feedback mechanisms.

Collectively, these strategies highlight the importance of a holistic approach to ICT integration, combining teacher training, innovative teaching models, competency frameworks, and personalized support systems. By aligning these practices with the TPACK and TPB frameworks, Chinese TVET educators can better prepare both teachers and students for an ICT-driven future.

Findings, Implications, and Recommendations

This study identified three key themes regarding ICT integration in Chinese TVET settings, based on a thematic analysis of 44 studies:

4.1 Findings

Increasing Adoption of ICT Tools in Pedagogical Practice: TVET teachers in China are progressively adopting ICT tools such as blended learning platforms, MOOCs, virtual laboratories, and simulation-based instruction. These technologies have been reported to enhance student engagement, learning flexibility, and instructional effectiveness (Yang, 2024; Ji, 2016b; He, 2020). For instance, MOOCs were noted to improve access and learning efficiency (Zhang et al., 2023a), while VR-based tools and gamification significantly increased student motivation and supported vocational skill development (Zeng & Wang, 2022; Wang et al., 2017). However, adoption remains uneven across institutions and disciplines, reflecting disparities in resource availability, pedagogical adaptability, and support structures (Chen & Liu, 2021; Ma, 2019).

Barriers Hindering Effective Integration: Despite growing use, systemic barriers continue to hinder effective ICT integration. These include insufficient digital infrastructure, limited teacher training, lack of technical support, and weak institutional policy enforcement (Han et al., 2020; Jing et al., 2023). Teachers in rural or underdeveloped regions particularly struggle with confidence and competence in utilizing ICT tools (Ouyang, 2017; Cai & Qian, 2021). The lack of sustained professional development and the absence of ICT-related incentives further limit meaningful implementation (Ma, 2019; Chen & Bin, 2024).

Emerging Practices and Competency Frameworks: Promising practices have emerged, particularly in institutions that employ structured training based on the TPACK framework or integrate AI-driven personalized learning support (Zhang et al., 2023b; Dai, 2024). For example,

Chengdu Vocational and Technical College's competency standard system offers a scalable model of digital upskilling for teachers. Other institutions adopted peer-mentoring and hybrid learning platforms, such as SPOCs and flipped classrooms, which align instructional design with vocational learning goals (He, 2020; Qiu, 2022).

Key Technologies Supporting Vocational Learning: Several ICT tools identified in this review stood out for their distinctive potential to enhance vocational education through immersive and practical learning experiences. Virtual reality (VR), simulation platforms, and gamification systems emerged as particularly impactful in the TVET context. These technologies offer immersive environments that simulate real-life vocational tasks, allowing students to develop procedural and problem-solving skills in safe and repeatable settings (Zeng & Wang, 2022; Wang et al., 2017). For instance, VR-assisted welding simulations or healthcare training modules enable learners to engage in high-fidelity practice without access to expensive or hazardous equipment. From a pedagogical perspective, these tools align well with Bloom's Digital Taxonomy, especially at the "applying," "analyzing," and "creating" levels, by encouraging active learning and critical thinking. Their integration also requires a solid foundation of technological-pedagogical knowledge, reinforcing the importance of sustained TPACK development for vocational educators.

Implications

The findings of this review have several implications for theory development, policy implementation, and instructional practices in the context of ICT integration within Chinese TVET.

Theoretical Implications: This study demonstrates the value of integrating TPACK, TPB, and BDT as a multi-dimensional lens for examining ICT integration. The use of TPACK effectively captures the complexity of teachers' technological and pedagogical competence (Zhang et al., 2023b), while TPB explains motivational discrepancies, including low perceived behavioral control and inadequate institutional norms (Han et al., 2020; Jing et al., 2023). BDT enables assessment of cognitive engagement levels and reveals that most ICT applications in TVET are still concentrated on lower-order cognitive tasks such as "remembering" and "understanding," with limited use for "evaluating" and "creating" (Zeng & Wang, 2022; Qiu, 2022).

The combination of these frameworks provides a more nuanced understanding of ICT integration that goes beyond technical implementation, offering a structured means of capturing not only what teachers do with technology, but also why and how they do it, and to what pedagogical effect.

Contextual Relevance: National policies such as the "Education Informatization 2.0" plan and "Smart Education of China" initiative have played a pivotal role in driving ICT integration across TVET institutions. However, the review reveals a noticeable gap between policy goals and implementation outcomes. While policies advocate for widespread digital transformation, many schools face challenges in translating these goals into actionable strategies, particularly due to infrastructural limitations, unclear implementation guidelines, and the absence of monitoring or incentive mechanisms (Chen & Bin, 2024; Jing et al., 2023).

In some cases, policy implementation has been interpreted as a checklist task rather than a pedagogical reform, leading to superficial adoption of ICT tools. To maximize policy

effectiveness, stronger feedback loops, localized adaptation, and school-level ownership of policy goals are necessary. Institutional leaders must be empowered not only to enforce policy compliance but also to contextualize national goals in their specific vocational settings.

Practical Implications: For practitioners, the findings suggest that effective ICT integration requires not just technical training but also attitude-oriented and collaborative professional development. Programs that foster peer mentorship and reflect real classroom needs—such as the "ICT Teaching Application Capability Training" in Chengdu—are more likely to succeed (Zhang et al., 2023b; Dai, 2024).

For institutional leaders, building supportive environments through recognition mechanisms, technical support teams, and flexible digital policies can significantly boost teacher engagement and innovation (Jing et al., 2023; He, 2020).

For policymakers, the review reveals a policy-practice gap: while macro-level policies are progressive, they often fail to translate into operational strategies at the school level. Stronger vertical coordination and feedback loops are essential to enhance implementation fidelity (Ouyang, 2017; Cai & Qian, 2021).

Limitations and Future Research: This review is limited by its reliance on secondary data, with most included studies conducted in eastern and central regions. Empirical fieldwork—such as teacher interviews, classroom observations, or longitudinal tracking—would strengthen future research. Moreover, comparative studies between different provinces or across national contexts would help to contextualize China's ICT integration efforts globally and test the generalizability of the proposed framework.

Recommendations

Based on the findings and their theoretical and practical implications, the following evidence-based and actionable recommendations are proposed for key stakeholders including teachers, institutional leaders, and policymakers.

Develop Integrated and Personalized Professional Development: Training programs should be grounded in the TPACK framework while also addressing behavioral and motivational dimensions outlined in the TPB model. This includes not only technical skills training but also reflective activities that enhance teachers' confidence, perceived control, and positive attitudes toward ICT use. Successful examples, such as the competency-based ICT training in Chengdu Vocational and Technical College, illustrate the benefits of structured, tiered learning pathways (Zhang et al., 2023b; Dai, 2024).

Moreover, personalization using AI or data-driven adaptive learning can tailor professional development to individual teachers' needs, improving both engagement and outcomes (Dai, 2024).

Establish Regionally Differentiated ICT Integration Strategies: Given the uneven distribution of resources and support across China, it is essential to develop region-specific ICT strategies. Local education authorities should be empowered to implement flexible policies and allocate targeted resources based on regional conditions (Chen & Bin, 2024). Prior studies have shown that rigid, centralized approaches often fail in underdeveloped areas due to infrastructure and personnel limitations (Ouyang, 2017; Cai & Qian, 2021).

Strengthen School-Based Support and Recognition Systems: Institutional leaders should establish support structures that encourage experimentation and sustained ICT use. These include creating digital innovation teams, offering incentives for technology-enhanced teaching, and facilitating peer collaboration through communities of practice (He, 2020; Jing et al., 2023). Without institutional-level reinforcement, even well-designed national policies may not produce meaningful change at the classroom level.

Promote Cognitive Depth in Technology Use: Teachers should be encouraged and supported to use ICT not only for content delivery, but also for developing students' higher-order thinking skills—such as critical analysis, evaluation, and creative problem-solving—as emphasized in Bloom's Digital Taxonomy. Tools like VR simulation, project-based platforms, and gamified learning environments should be integrated strategically into lessons (Zeng & Wang, 2022; Qiu, 2022).

Appendices

Table 2: Data Extraction Table

Sl. No.	Authors	Title	Year	Source title	Cited by	Document Type	Source	Description	Design	Subject area	Addressing RQ
1	Ji Z.	Application and empirical investigation of new MOOC teaching system in computer application course	2016	Journal of Emerging Technologies in Learning	11	Article	Scopus	MOOC teaching system	Quantitative	Computer application course	RQ1
2	Jiang, G., & Lai, B.	Virtual Reality Technology in Higher Vocational Education "China Tourism Geography" Teaching Application	2016	Advances in Social Science, Education and Humanities	3	Conference proceeding	Web of Science	Application of VR in geography teaching	Qualitative	China tourism Geography	RQ3
3	Shaogang Z.; Shunping W.; Xuan Z.; Mobin W.	Research on the i-Experiment Teaching Model in Vocational Education	2016	Proceedings - 2015 International	1	Conference proceeding	Scopus	Model development	Qualitative	General	RQ3
4	Ouyang W.	Application strategy of modern network technology in higher vocational teaching activities	2017	Eurasia Journal of Mathematics, Science and Technology Education	2	Article	Scopus	Application of modern network technology in higher vocational education (HVE)	Mixed method	Multi-disciplinary	RQ2
5	Wang F.; Wang Y.; Hu X.	Gamification teaching reform for higher vocational education in China: A case study on Layout and Management of Distribution Center	2017	International Journal of Emerging Technologies in Learning	12	Article	Scopus	Gamification teaching reform	Mixed method	General	RQ1
6	Ji X.	Study on internet information technology in English teaching in higher vocational college	2017	Proceedings - 2016 8th International Conference on Information Technology in Medicine and Education, ITME 2016	2	Conference proceeding	Scopus	Model development	Qualitative	English	RQ1
7	Han, JY; Yin, HB; Wang, JJ	A case study of faculty perceptions of teaching support and teaching efficacy in China: characteristics and relationships	2018	HIGHER EDUCATION	22	Article	Scopus	Perception of teachers	Quantitative	Multi-disciplinary	RQ1
8	Wang, W; Han, X	Some factors influencing teachers' intention to use ICT in teaching in Secondary Vocational Schools in China	2018	Seventh International Conference of Educational Innovation through Technology (EITT)	2	Conference proceeding	Web of Science	Factors influencing teachers' use of ICT	Quantitative	General	RQ1
9	Wu R.	The effectiveness of malt on vocational college english teaching	2019	Journal of Language Teaching and Research	0	Article	Scopus	Effective use of MALT in english teaching	Quantitative	Multi-disciplinary	RQ3
10	Ma, W	Development and Application of Mooc in Higher Vocational Education under the Background of Informatization	2019	3rd International Conference on Advancement of the Theory and Practices in Education (ICATPE 2019)	0	Conference proceeding	Web of Science	Application of MOOC in higher vocational institutes	Qualitative	General	RQ1, RQ2
11	Liu, Q., Yang, H., Ba, S., Wang, Y., & Zhao, W.	Blended learning Using Mobile APP in Secondary Vocational Instruction: Design and Implementation	2019	Proceedings of the 10th international conference on e-education, e-business, e-management and e-learning	1	Conference proceeding	Scopus	Using mobile app in blended app	Quantitative	Computer science	RQ1

Sl. No.	Authors	Title	Year	Source title	Cited by	Document Type	Source	Description	Design	Subject area	Addressing RQ
12	Bin E.; Islam A.Y.M.A.; Gu X.; Spector J.M.; Wang F.	A study of Chinese technical and vocational college teachers' adoption and gratification in new technologies	2020	British Journal of Educational Technology	25	Article	Scopus	Factors influencing TVET teachers' adoption and appreciation of ICT	Quantitative	Multi-disciplinary	RQ1
13	He, J	Construction of three-stage asynchronous instructional mode of blended flipped classroom based on Mobile learning platform	2020	EDUCATION AND INFORMATION TECHNOLOGIES	12	Article	Web of Science	Construction of "three-stage asynchronous" instructional mode of blended flipped classroom based on Mobile learning platform	Hybrid method of qualitative, quantitative and action research	General	RQ3
14	Diao J.-F.; Yang J.	Multiple-role perspective on assessing teaching ability: reframing TVET teachers' competency in the information age	2021	Journal of Educational Technology Development and Exchange	5	Article	Scopus	To establish a framework, criteria, and assessing instrument for vocational teachers' teaching competency in using ICT	Quantitative	Multi-disciplinary	RQ3
15	Shi X.; Li X.; Wu Y.	The application of computer-aided teaching and mobile internet terminal in college physical education	2021	Computer-Aided Design and Applications	11	Article	Scopus	Effect of computer-assisted teaching in PE	Quantitative	Physical education	RQ1
16	Liu G.; Xu Y.	Application of mobile app in moral education course teaching based on intelligent internet of things	2021	Mobile Information Systems	3	Article	Scopus	using mobile app in moral education	Mixed method	Moral education	RQ1
17	Han X.; Zhou Q.; Shi W.; Yang S.	Online Learning in Vocational Education of China during COVID-19: Achievements, Challenges, and Future Developments	2021	Journal of Educational Technology Development and Exchange	16	Article	Scopus	analysis of online education during covid-19	Mixed method	Multi-disciplinary	RQ2
18	Cheng X.; Liu K.	Application of Multimedia Networks in Business English Teaching in Vocational College	2021	Journal of Healthcare Engineering	16	Article	Scopus	Effective use of multimedia network in English teaching	Mixed method	Business english	RQ1
19	Yao, Y	Blended teaching reform of higher vocational education based on addie teaching design model.	2021	Journal of Frontiers of Society, Science and Technology	5	Article	Web of Science	Developing teaching model for blended mode teaching in English	Model developemnt	English	RQ1
20	Chen, T.; Liu, H	Research and Practice of Online and Offline Hybrid Teaching of Virtualization Technology Course in Higher Vocational Colleges	2021	6th International Conference on Education Reform and Modern Management (ERMM 2021)	3	Conference proceeding	Scopus	Teaching mode of virtualization technology	Qualitative	General	RQ1
21	Cai, J., & Qian, X.	Effect of new ICTs on vocational education in China: A case study of Wuxi Vocational Institute of Commerce.	2021	Business Innovation with New ICT in the Asia-Pacific: Case Studies	1	Book chapter	Scopus	Case study on Wuxi Vocational Institute of Commerce	Qualitative	General	RQ1, RQ2
22	Miao Y.; Li Y.; Du X.; Pu M.	Scripting an integrated learning and work process to scaffold online action-oriented learning	2021	IEEE Global Engineering Education Conference, EDUCON	0	Conference proceeding	Scopus	Providing online scaffolding	Mixed method	Mechatronic Engineering	RQ3

Sl. No.	Authors	Title	Year	Source title	Cited by	Document Type	Source	Description	Design	Subject area	Addressing RQ
23	Qiu X.	Blended Teaching Mode of Higher Vocational English Based on MOOC+SPOC	2022	Wireless Communications and Mobile Computing	4	Article	Scopus	Using MOOC+ SPOC for english writing	Quantitative	English	RQ3
24	Yu H.	Research on Multimedia Teaching and Teaching Reform Innovation of Accounting Major in Higher Vocational Colleges under the Background of Big Data and Internet of Things	2022	Wireless Communications and Mobile Computing	3	Article	Scopus	Multimedia Teaching and Teaching Reform Innovation of Accounting Major in Higher Vocational Colleges under the Background of Big Data and Internet of Things	Quantitative	Accounting	RQ2
25	Zeng Z.; Wang Q.	Integration of Virtual Reality CAD Technology and Classroom Teac hing for Higher Vocational College Art Design Major	2022	Computer-Aided Design and Applications	0	Article	Scopus	Using VR in art teaching	Exploratory	Art design	RQ1
26	Chen, QY; Ma, Y	The influence of teacher support on vocational college students' information literacy: The mediating role of network perceived usefulness and information and communication technology self-efficacy	2022	FRONTIERS IN PSYCHOLOGY	1	Article	Web of Science	Effect of teachers' support on Digital literacy	Quantitative	Multi-disciplinary	RQ1
27	Li J.	Exploration on the Action-Oriented Teaching Mode of Higher Vocational Political Courses under the Background of Internet + Education	2022	Advances in Multimedia	3	Article	Scopus	Design of a Personalized online education platform	Quantitative	Political courses	RQ3
28	Diao, J., & Hu, K	Preparing TVET teachers for sustainable development in the information age: Development and application of the TVET teachers' teaching competency scale.	2022	Sustainability	2	Article	Web of Science	Developing scale to measure TVET teachers' competency	Quantitative	Multi-disciplinary	RQ3
29	Li H.; Khattak S.I.; Lu X.; Khan A.	Greening the Way Forward: A Qualitative Assessment of Green Technology Integration and Prospects in a Chinese Technical and Vocational Institute	2023	Sustainability (Switzerland)	1	Article	Scopus	Teachers' competency in green technology	Qualitative	Multi-disciplinary	RQ1
30	Yang C.; Guo R.; Cui Y.	What Affects Vocational Teachers' Acceptance and Use of ICT in Teaching? A Large-Scale Survey of Higher Vocational College Teachers in China	2023	Behavioral Sciences	6	Article	Scopus	Factors affecting teachers' acceptance and use of ICT	Quantitative	Multi-disciplinary	RQ1
31	Pan L.; Xia Z.	Reform and Practice of Project-Based Teaching Mode Based on Online Open Course Platform	2023	International Journal of Emerging Technologies in Learning	0	Article	Scopus	Integration of technology, PBL	Case-study	Fashion design and intelligent manufacturing	RQ1
32	Zheng Y.	Evaluation of Online Teaching Effect of Vocational College Teachers Based on TOPSIS Technology and the Hierarchical Chi-Square Model	2023	International Journal of Emerging Technologies in Learning	0	Article	Scopus	Teachers' online eaching quality evaluation	Quantitative	Multi-disciplinary	RQ1
33	Jing, YH; Chen, XJ; Zhu, KK; Shen, SS; Wang, CL	The Implementation Path and Problems Encountered During Emergency Remote Teaching in Vocational Colleges: A Qualitative Study in China	2023	SAGE OPEN	0	Article	Web of Science	Implementation and challenges experienced by teachers during remote teaching	Qualitative	Multi-disciplinary	RQ1, RQ2

Sl. No.	Authors	Title	Year	Source title	Cited by	Document Type	Source	Description	Design	Subject area	Addressing RQ
34	Zhang, T., Zhou, Q., Yang, C., Bai, X., Han, X., Cui, G., & Wang, Y.	Exemplars of Good Practice	2023	Handbook of Technical and Vocational Teacher Professional Development in the Digital Age	2	Book chapter	Scopus	Case studies	Case-study	General	RQ1
35	Zhou Q.; Diao J.; Wang Y.; Chen M.; Yang C.; Li M.; Wang J.; Yi K.; Han X.; Cui G.; Zhang T.	Strategies for Developing TVET Teachers' Professional Competencies	2023	Springer Briefs in Education	0	Book chapter	Scopus	TVET teachers' professional development	Qualitative	General	RQ1
36	Dai J.	Research on the digital cultivation form of "double-qualified" teachers team in higher vocational colleges and universities under the perspective of industry-teaching integration	2024	Applied Mathematics and Nonlinear Sciences	0	Article	Scopus	Teaching model	Quantitative	General	RQ3
37	Shen J.	Development of Online and Offline Mixed Teaching Materials for Higher Vocational Education Under the Background of Internet	2024	International Journal of e-Collaboration	0	Article	Scopus	Blended teaching materials	Model developemnt	Accounting	RQ1
38	Yang J.	Reform and Innovation of Dance Choreography Teaching Based on Virtual Environment Technology	2024	Applied Mathematics and Nonlinear Sciences	0	Article	Scopus	Virtual teaching	Experimental	Dance	RQ1
39	Shi S.	Research on the Innovation Path of Music Education in Higher Vocational Colleges and Universities in the Context of the New Era	2024	Applied Mathematics and Nonlinear Sciences	0	Article	Scopus	Digital teaching using AI and multimedia	Mixed method	Music	RQ1
40	Xu S.; Chen P.; Zhang G.	Exploring Informatizaon Instructional Core Competence of Higher Vocational College Teacher for Professional Development	2024	Journal of Educational and Social Research	0	Article	Scopus	Teachers' technology competeny	Literature based	General	RQ1
41	Zhang Y.; Sun X.; Yu J.	Transformative Technologies in the Evaluation of a Vocational Education System	2024	Journal of Web Engineering	0	Article	Scopus	Teachers' professional development	Mixed method	Multi-disciplinary	RQ3
42	Jiang L.	Factors influencing EFL teachers' implementation of SPOC-based blended learning in higher vocational colleges in China: A study based on grounded theory	2024	Interactive Learning Environments	11	Article	Scopus	Factors affecting teachers' implementation of blended technique	Qualitative	EFL	RQ1
43	Zhang H.; Zhang Y.; Xu T.; Zhou Y.	Effects of VR instructional approaches and textual cues on performance, cognitive load, and learning experience	2024	Educational Technology Research and Development	1	Article	Scopus	The effects of VR instructional approaches and textual cues on learning.	Quantitative	Computer Application course	RQ1
44	Yang X.	Analyzing the efficacy of Higher Vocational Online-Offline Blended Teaching using Koch's Model	2024	Applied Mathematics and Nonlinear Sciences	0	Article	Scopus	Analysis of the online and offline blended teaching effect of the school using evaluation model	Quantitative	General	RQ1

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