Article

A Practical Study on Vocational English Teaching Based on the TPACK-SLA-AI Integrated Framework

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Abstract: Aiming at the problems existing in current applied English teaching in vocational colleges, such as fragmented application of technology and the disconnection between students' competence and vocational requirements, this study constructs a four-dimensional collaborative TPACK-SLA-AI integration model. The model is grounded in the technological pedagogical content knowledge (TPACK) framework and systematically integrates second language acquisition (SLA) principles with the affordances of artificial intelligence (AI) technology. Adopting a quasi-experimental research design, the study involves 120 Applied English majors from a vocational college and implements a 16-week teaching intervention. Taking the cultivation of translation competence as the entry point, the model explores the in-depth mechanism of technology-enabled vocational English teaching through the coordinated interaction of the technology layer, pedagogy layer, content layer, and SLA support layer. Quantitative and qualitative findings reveal that the effectiveness of technology-enhanced instruction depends on the dynamic collaboration of technology, pedagogy, content, and SLA laws, rather than on technology use in isolation. The integrated framework optimizes learning processes, improves students' vocationally oriented language performance, and enhances the alignment between classroom outcomes and workplace needs. The proposed model thus provides a feasible path with both theoretical depth and practical validity for the reform of vocational English teaching. Future research can further expand the integrated application of diverse AI tools, conduct long-term longitudinal studies, and deepen the discussion on teachers' professional development and reflective practice in AI-supported environments.

Keywords: tpack; second language acquisition; artificial intelligence; vocational english; language teaching

Received: 18 January 2026
Revised: 13 March 2026
Accepted: 25 March 2026
Published: 30 March 2026

1. Introduction

National initiatives such as "accelerating the development of the digital economy" and "launching the 'Artificial Intelligence Plus' initiative" have outlined the direction for integrating technology into education. Current educational informatization policies strongly encourage teachers to innovate teaching models using Information and Communication Technology (ICT). However, in the teaching practice of Applied English in vocational colleges, challenges persist, including fragmented and superficial applications of technology. Most teachers merely incorporate AI tools as "auxiliary tools" within traditional teaching processes, failing to achieve a deep synergy among technology, pedagogy, and subject content [1]. This disconnect between students' English proficiency and occupational requirements hinders the achievement of vocational education goals emphasizing the "integration of work and study."

Research in the field of Second Language Acquisition (SLA) highlights the essential role of the "Input-Interaction-Output" loop in enhancing language competence. The intelligent feedback and scenario simulation capabilities of AI technology offer new opportunities to implement this loop effectively [2]. By designing a vocational English teaching experiment under the TPACK framework and analyzing the experimental

outcomes, this paper argues that the success of technology-empowered teaching relies on the four-dimensional synergy of technology, pedagogy, content, and SLA principles rather than on technology alone. This model provides a practical and theoretically grounded approach to reforming vocational English teaching.

2. Literature review

2.1. The TPACK framework

Twenty years after the concept of Pedagogical Content Knowledge (PCK) was proposed, the Technological Pedagogical Content Knowledge (TPACK) framework was formally introduced, quickly becoming one of the most influential theoretical models in the field of educational technology. Building on PCK, the TPACK framework incorporates Technological Knowledge (TK) as the third core dimension, emphasizing the dynamic interactive relationship among technology, pedagogy, and subject content, rather than viewing technology integration in isolation [3]. Since its introduction, the TPACK framework has undergone continuous enrichment and expansion, and has been widely applied in various educational fields, becoming a core theoretical guide for exploring technology-integrated teaching practices.

In the early stages of TPACK research, the framework was further supplemented and improved, clarifying the connotation and mutual relationship of each knowledge dimension [4]. It was emphasized that TPACK is not a simple superposition of CK, PK, and TK, but a dynamic integration of the three, requiring teachers to flexibly adjust the combination of various knowledge according to specific teaching scenarios. With the in-depth development of educational informatization, numerous empirical studies have been conducted around the TPACK framework, exploring its application effects in different disciplines and teaching stages. For instance, in the field of language teaching, the application of TPACK in English language teaching has gained increasing attention, with steady growth in related studies, and Asia has emerged as a dominant region in this field.

In terms of the measurement and development of TPACK, continuous explorations have been made. Empirical research has provided a theoretical basis for the development of TPACK measurement tools. In recent years, with the popularization of artificial intelligence technology, the integration of TPACK and AI has become a new research hotspot. The concept of AI-TPACK has been proposed, exploring how to integrate AI technology into the TPACK framework to promote the development of teachers' professional competence. Additionally, lesson study has been identified as an effective intervention strategy to promote teachers' TPACK development, offering contextualized learning opportunities for teachers and helping them establish new cognitions about technology-integrated teaching.

However, current TPACK research still faces some challenges. A systematic review of TPACK-related studies revealed that the framework still has theoretical ambiguity, with significant differences in the operational definition and measurement tools of each knowledge dimension, leading to concerns about measurement validity. Furthermore, most TPACK studies focus on the measurement of teachers' knowledge levels, with insufficient attention to the relationship between TPACK and students' learning outcomes, as well as its mechanisms in real teaching scenarios [4]. As educational digitization deepens, the TPACK framework is expected to continue evolving, with its application in personalized teaching, intelligent teaching, and other fields becoming the focus of future research.

The framework consists of three core knowledge domains: Content Knowledge (CK), Pedagogical Knowledge (PK), and Technological Knowledge (TK), as well as four composite knowledge domains formed by their interweaving: Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and Technological Pedagogical Content Knowledge (TPACK), totaling seven knowledge domains. The core proposition of this framework is that effective

technology integration is not a simple addition of technological tools, but requires teachers to form a comprehensive understanding of the above seven knowledge dimensions and creatively apply them according to specific teaching situations [5] (As shown in Figure 1).

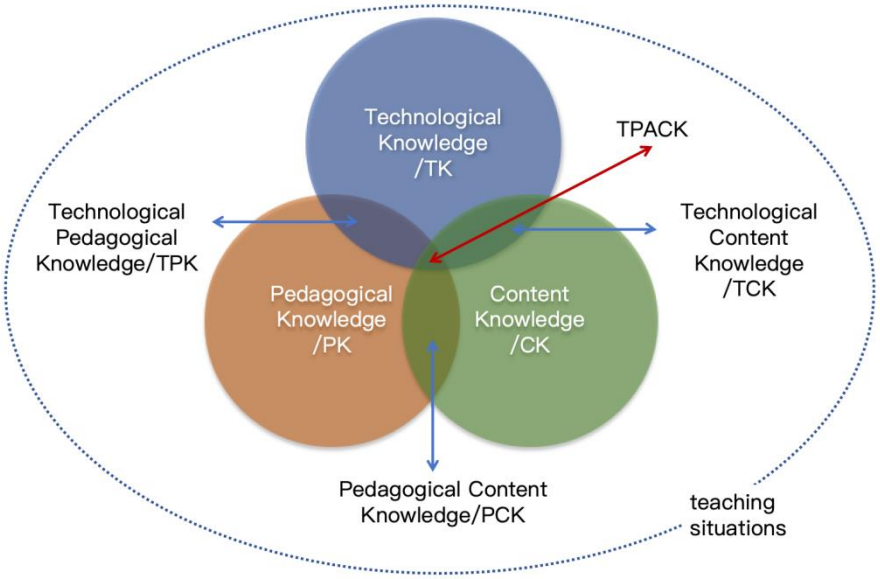

Figure 1. The TPACK Framework

2.2. Vocational English teaching

Research on vocational English teaching has a long history, and its development context is closely linked to the evolution of English for Specific Purposes (ESP) theory. Foundational work in ESP emphasized that language teaching should serve learners' specific needs and goals, an idea that has profoundly influenced subsequent vocational English research. During this period, research on vocational English teaching mainly focused on textbook development, vocabulary teaching, and the analysis of discourse characteristics in specific industries such as business, tourism, and medical care, with Communicative Language Teaching and Task-Based Language Teaching as the dominant teaching methods [4].

Entering the 21st century, the development of information technology has injected new vitality into vocational English teaching [4]. Researchers began to pay attention to the application of multimedia, corpus, and network technology in vocational English teaching. At the same time, research on Computer-Assisted Language Learning (CALL) provided technical support for vocational English teaching, exploring how to create immersive vocational English learning environments through online learning platforms, virtual simulation software, and interactive multimedia. However, most studies in this stage focused on testing the application effect of technical tools, and few in-depth discussions were conducted on the integration mechanism between technology, vocational English teaching methods, and vocational subject content. Technology was often regarded as an auxiliary means of teaching rather than an organic component deeply integrated with teaching.

In recent years, the breakthrough development of artificial intelligence technology is reshaping the research agenda of vocational English teaching. The emergence of intelligent language learning systems has made personalized learning path recommendation, immediate feedback, and adaptive practice possible. Despite the broad prospects of AI-empowered vocational English teaching, existing research still has obvious limitations: most studies focus on verifying the effectiveness of AI tools, lacking systematic discussion on the integration mechanism of AI technology, second language

acquisition rules, and vocational content knowledge; most research designs are short-term experiments, with insufficient attention paid to the long-term effects and influencing factors of AI-supported vocational English learning; more importantly, the core issue of how to cultivate teachers' vocational English teaching competence in the AI environment has not been fully valued [6].

3. Research design

3.1. Design of the experimental model

Focusing on the dimension of translation competence cultivation in vocational English teaching, this study employs a quasi-experimental research design to investigate the impact of the TPACK-SLA-AI integration model on enhancing vocational college students' English translation competence and overall vocational English proficiency [2]. The experimental model is structured on the premise that translation competence serves as a critical entry point for vocational English teaching. It is not only a fundamental skill in vocational contexts such as foreign trade correspondence and business contracts but also a key metric for evaluating the transformation of language input into effective output. Furthermore, improvements in translation competence can extend to broader vocational English abilities, including listening, speaking, reading, and writing. The specific experimental model is illustrated in Figure 2.

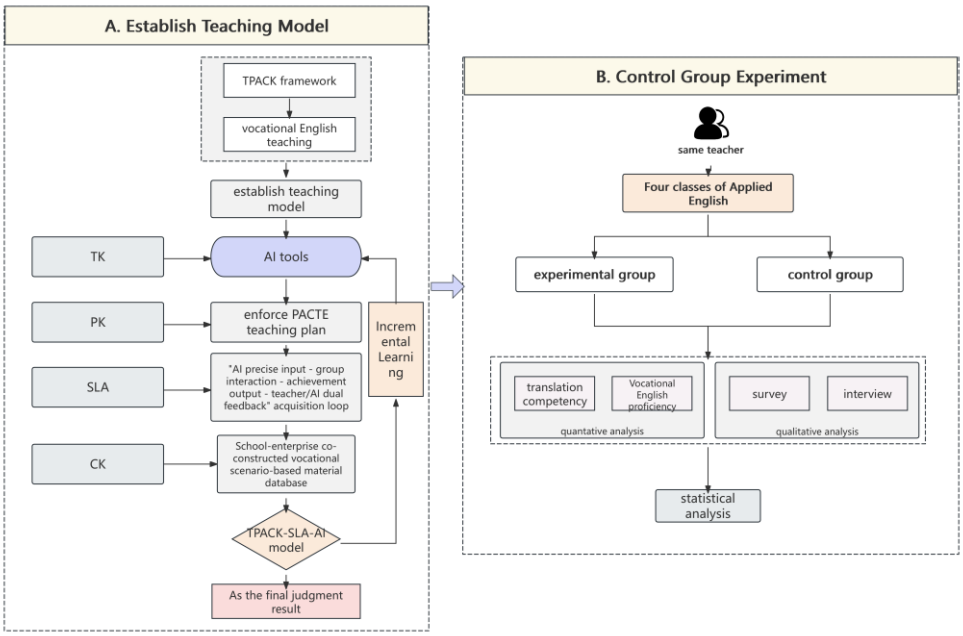

Figure 2. Design of the Experimental Model

3.2. Research subjects

This study selected four natural classes of second-year students majoring in Applied English from a vocational college as the research subjects. These classes were randomly divided into an experimental group and a control group, with two classes in each group, totaling approximately 125 students. All participants had completed one year of foundational English learning, possessed basic language competence, and were in a critical stage of vocational English skill development. The experimental period spanned one semester (16 weeks). The experimental group participated in two class hours of vocational English courses per week, which were designed and implemented based on the TPACK-SLA-AI integration model, while the control group followed the original teaching arrangement. To ensure consistency, the same teacher conducted lessons for both groups, minimizing the influence of teacher-related variables on the experimental outcomes [7].

3.3. Research methods

The experimental implementation was divided into five stages: preparation stage, pre-test stage, intervention stage, post-test stage, and delayed post-test stage. The preparation stage primarily involved the digital processing of the school-enterprise co-constructed material database, the configuration and debugging of AI translation tools, the detailed design of the PACTE teaching plan, and the training of experimental teachers. During the pre-test stage, both groups of students were assessed for translation competence and vocational English proficiency to ensure the two groups were comparable at the start of the experiment. The intervention stage spanned 16 weeks, during which the experimental group followed the four-dimensional synergy mechanism, with learning behavior data recorded throughout the process, while the control group adhered to conventional teaching methods.

The post-test stage was conducted within one week after the intervention concluded, utilizing the same test tools as the pre-test, supplemented by a learning experience questionnaire. The delayed post-test was carried out four weeks after the intervention to evaluate the sustainability of the teaching effect.

The data collected in the study included translation test scores (pre-test, post-test, delayed post-test), vocational English proficiency test scores (pre-test, post-test), learning experience questionnaires, and semi-structured interview texts. Quantitative data were analyzed using SPSS for descriptive statistics, independent samples t-tests, paired samples t-tests, and analysis of covariance to examine inter-group differences between the experimental and control groups, as well as pre-post changes within the experimental group. Qualitative data were analyzed using the content analysis method, with interview texts and open-ended questionnaire responses coded and categorized to uncover learners' perceptions of the model-based teaching and the underlying mechanisms of their competence development [8].

4. Empirical analysis

4.1. Quantitative analysis

To evaluate the teaching effectiveness of the TPACK-SLA-AI integration model, translation competence tests and vocational English proficiency tests were conducted on the experimental group and the control group after the study's completion. The results of the independent samples t-test are presented in Table 1.

Table 1. Group comparison results (n=125)

Test Dimension	Control class	Experimental class	t	P
Translation competence	77.2 ± 0.8	83.2 ± 0.63	6.233	0.001
Vocational English proficiency	83.2 ± 0.92	86.8 ± 0.77	5.769	0.001

When comparing the improvement ranges of the two dimensions, it is evident that the enhancement in translation competence surpassed that of vocational English proficiency. This outcome aligns with expectations, as translation competence, being the direct training target, experienced the most significant benefits. Furthermore, through the input-output loop and task-driven mechanism, its positive effects extended to other language skills, including listening, speaking, reading, and writing. The TPACK-SLA-AI integration model demonstrates its effectiveness in improving vocational English teaching outcomes. The notable improvement in translation competence holds practical significance in vocational education, enabling learners to more accurately handle real workplace texts such as foreign trade correspondence and product specifications, directly addressing future job requirements. The concurrent improvement in vocational English proficiency suggests that the teaching design, which uses translation as the entry point, did not restrict learners' language development. Instead, it facilitated the coordinated development of comprehensive language competence through the acquisition loop of "AI-precise input - group interaction - achievement output - dual feedback."

4.2. Qualitative analysis

To thoroughly examine the mechanism underlying the TPACK-SLA-AI integration model, semi-structured interviews were conducted with 12 students from the experimental group following the study [2]. Additionally, content analysis was applied to responses from open-ended questionnaires completed by all students in the experimental group. Through a systematic three-level coding process, four core themes were identified.

4.2.1. AI tools: from "auxiliary" to "scaffold"

The interviewed students generally recognized the supporting role of AI translation tools in the learning process, but their functional positioning underwent a cognitive transformation from "replacement" to "auxiliary" and eventually to "scaffold."

Initially, students reported simply copying and pasting translations from AI tools, believing that this eliminated the need to learn translation skills. However, when required to translate independently before using AI for verification, they discovered that AI translations were not entirely accurate, particularly with complex clauses in business contracts. Over time, they adapted their approach to involve translating independently, using AI for verification, and then making manual revisions.

This transformation holds significant educational value: students avoided developing a reliance on AI and instead cultivated a "human-machine collaboration" strategy [9]. One student likened AI to an ever-available teaching assistant, useful for checking grammar and ensuring accurate terminology, while emphasizing that final decisions remained their own responsibility. This demonstrates that the "AI initial translation + manual revision" approach effectively fostered students' metacognitive skills, rather than encouraging mere technological substitution.

4.2.2. Real tasks: the "bridge" connecting classrooms and the workplace

The PACTE project-based teaching method is centered on real enterprise translation tasks, and this approach has greatly improved students' engagement and sense of purpose in learning [10, 11].

Previously, English classes primarily involved memorizing vocabulary and completing exercises, leaving students uncertain about the practical application of their learning [4]. In contrast, working on a product manual required by an actual company provided a tangible goal. The teacher explained that high-quality translations might be adopted by the enterprise. Students collaborated to research terminology extensively, even consulting manuals of similar products online for reference. Completing the final product instilled a strong sense of accomplishment.

Numerous participants highlighted that the "authenticity" of the tasks enhanced their learning engagement beyond traditional coursework. One respondent noted that, despite the challenges, the experience felt like performing meaningful work rather than routine assignments. This observation underscores the primary benefit of project-based learning—real-world tasks can inspire intrinsic motivation and foster deeper learning [12].

4.2.3. Workplace material database: from "learning English" to "using English to do things"

The school-enterprise co-constructed vocational scenario-based material database provided students with extensive reference resources, enabling them to establish a connection between "corpus - scenario - task."

One student highlighted the practicality of the material database, emphasizing the value of real business emails and contract examples. Previously reliant on templates for email writing, the student now examines authentic emails in the database to understand tone, format, and common expressions. This shift fosters a transition from merely learning the language to acquiring skills for conducting foreign trade.

Another student noted that comparing personal translations with reference translations provided by the enterprise in the database revealed gaps not only in language

proficiency but also in understanding industry practices [2]. This underscores the database's role in fostering "genre awareness" and "industry norm awareness" within a professional context.

4.2.4. Dual feedback mechanism: complementarity between immediacy and depth

The integration of teacher feedback and AI feedback is considered one of the most effective designs in the learning process.

AI feedback is rapid, allowing immediate correction of grammar errors, although its corrections can occasionally be inaccurate or overly simplistic. Teacher feedback, while slower, addresses deeper issues in translation reasoning, such as questioning specific approaches and considering contextual requirements. The combination of these feedback types ensures both efficiency and depth [13].

Many students highlighted that the promptness of AI feedback alleviates the sense of stagnation during the writing process, while the depth of teacher feedback encourages advanced reflection [7, 11]. For instance, AI identifies errors, whereas teachers explain the reasons behind those errors and provide guidance on improvement.

5. Conclusion

This study developed a "four-dimensional synergy" TPACK-SLA-AI integration model based on the TPACK framework and validated its effectiveness in vocational English translation teaching through a teaching experiment. The findings indicate that the integration of AI technology, project-based teaching methods, vocational scenario materials, and second language acquisition principles can significantly enhance students' translation competence and overall vocational English proficiency, while also improving their classroom learning experience. The proposed model extends the theoretical application of the TPACK framework in vocational education and second language teaching, shifting the focus from simple technological layering to a deeper mechanism of multidimensional synergy. Practically, it offers a feasible pathway for reforming English teaching in vocational colleges by bridging the gap between academic learning and workplace requirements. This is achieved through a collaboratively developed material database, balancing learning efficiency and depth with dual feedback from AI and educators, and fostering intrinsic motivation through task-driven teaching approaches.

Looking ahead, the rapid advancement of generative artificial intelligence is expected to drive further transformation in vocational English teaching. Future research could explore several directions: first, investigate the integrated use of diverse AI tools, such as chatbots, virtual reality, and intelligent writing assistants, to assess their suitability for various teaching scenarios and their respective impacts on learning outcomes; second, conduct longitudinal studies to evaluate the sustainability of the model's effectiveness, including its potential attenuation over time, while considering the diverse developmental trajectories of learners with varying initial competencies; third, focus on teacher-level research to examine the evolving roles of educators as AI becomes more deeply embedded in education, as well as the dynamic development of teachers' TPACK knowledge in response to ongoing technological advancements.

Funding: This paper was supported by Zhejiang Business and Technology Institute Science & Technology Project (No.KYND202519).

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