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RESEARCH ARTICLE

Cross-disciplinary Learning in Business English Education: Evaluating the Impact of Service Learning on Interdisciplinary Skills Development

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ABSTRACT

In the era of the digital economy, interdisciplinary competencies have emerged as crucial objectives in cultivating high-caliber talent. Nevertheless, contemporary Business English education faces several challenges, including the theory-practice disconnect, fragmentation of disciplinary knowledge, and inadequate mechanisms for fostering interdisciplinary capabilities. To address these challenges, this study employs service learning as an entry point to investigate its mechanisms in promoting students' interdisciplinary competency development within Business English education. Service learning, which integrates academic studies with social practice through the core principle of "learning by doing and doing by learning," provides students with task-driven learning experiences in authentic contexts, facilitating comprehensive development in knowledge transfer, systems thinking, collaborative capabilities, and metacognitive competencies. Based on theoretical frameworks of interdisciplinary learning and service learning, this research designs and implements service learning pedagogical projects, employing quantitative research methodologies through surveys and data analysis to empirically evaluate the model's effectiveness in enhancing students' interdisciplinary competencies and comprehensive language abilities. The findings demonstrate that the service learning model effectively addresses the insufficient practical components in traditional Business English instruction, significantly improving students' performance in knowledge transfer, systems thinking, team collaboration, and reflective capabilities, while simultaneously enhancing comprehensive language skills in listening, speaking, reading, and writing. This research not only provides theoretical foundations for optimizing Business English curriculum design but also offers practical references for innovative applications of service learning in language education.

INTRODUCTION

Interdisciplinary competency development, founded on knowledge interconnection, skill transfer, and cognitive integration, is a process that promotes knowledge fusion and innovation across multiple disciplines through the development of core capabilities such as systems thinking, critical analysis, and knowledge integration (Claus & Wiese, 2019). Since the new millennium, major technological, economic, and social challenges facing human society have exhibited high degrees of

complexity, comprehensiveness, and interdisciplinary nature. Within the new paradigm of knowledge economy development, interdisciplinary competencies have emerged as a crucial driving force in reshaping the global talent competition landscape. Business English, as an applied discipline, should not limit its educational objectives to merely enhancing language proficiency but should also cultivate students' practical capabilities, innovative thinking, and cross-cultural understanding in business environments (Ivana, 2021). However, current Business English education commonly faces challenges such as the disconnection between theory and practice, fragmentation of disciplinary knowledge, and the absence of effective mechanisms for developing interdisciplinary competencies. How to promote students' comprehensive development of interdisciplinary competencies through effective pedagogical models has become an urgent issue in Business English education (Barus & Simanjuntak, 2020; Romi, 2024).

Interdisciplinary learning, based on the unity of knowledge, integration of learning, and multidimensionality of understanding, is a learning process that achieves multidisciplinary integration and deep comprehension through knowledge connection, cognitive transfer, and problem-oriented core elements, thereby constructing new cognitive structures. Its essence lies in integrating multidisciplinary knowledge to enhance students' comprehensive capabilities through understanding and resolving complex real-world problems (Gao et al., 2020; Jam et al., 2011). Business English, as a discipline that integrates language learning with business practice, inherently requires learners to possess abilities that transcend disciplinary boundaries to address increasingly complex challenges in cross-cultural communication and multidimensional decision-making in business environments. Incorporating interdisciplinary learning into Business English education can cultivate students' ability to integrate language skills with professional knowledge, thus better adapting to complex workplace environments (Xie, 2024). Although academia generally acknowledges the theoretical value of interdisciplinary learning, its specific operational mechanisms and implementation pathways in Business English teaching practice remain unclear.

Service learning, founded on mutual symbiosis, practical orientation, and social responsibility, is a learning process that combines academic learning with social practice through experiential learning, community engagement, and reflective internalization to achieve capability construction, problem-solving, and value creation (Kiely, 2005). The service learning model provides an implementation framework for interdisciplinary learning in Business English education. Service learning emphasizes placing students in authentic social scenarios, integrating academic learning with social service, encouraging students to transform classroom knowledge into practical applications while developing various interdisciplinary competencies such as critical thinking and collaborative capabilities. The pedagogical model centered on "learning by doing and doing by learning" effectively addresses the insufficient practical components in traditional classroom instruction, enabling students to simultaneously enhance their language proficiency and interdisciplinary competencies in authentic contexts. Existing research demonstrates that service learning holds advantages in promoting students' comprehensive capability development, such as enhancing social responsibility, cultural awareness, and practical problem-solving abilities (Yorio & Ye, 2012). In language education, service learning can facilitate better language skill acquisition and cultivate multicultural understanding through authentic language use environments (Caldwell, 2007). However, existing research has not systematically explored the mechanisms of service learning in promoting interdisciplinary competency development within Business English education contexts, lacking empirical validation of its pathways and implementation effects.

Service learning, with its unique pedagogical model, combines student learning activities with social environments, providing a dynamic and contextualized platform for interdisciplinary learning. For instance, students apply language skills, team collaboration abilities, and critical thinking capabilities simultaneously while completing complex tasks in community service or enterprise cooperation projects (Bettencourt, 2015). These practical activities not only promote students' language learning initiative but also expand their practical application abilities across different disciplinary knowledge. However, current research on service learning applications in Business English teaching primarily

focuses on language skill improvement, lacking in-depth theoretical exploration and empirical analysis regarding the promotion of students' interdisciplinary competency development.

Given these considerations, this study employs service learning as an entry point to explore its role in promoting students' interdisciplinary competency development within Business English education. Through constructing a theoretical framework that integrates theories of interdisciplinary learning and service learning, this study designs and implements service learning projects to investigate their impact mechanisms on core interdisciplinary competencies such as knowledge transfer, systems thinking, and collaborative capabilities. Employing quantitative research methodologies, combined with surveys and data analysis, this study empirically validates the implementation effects of service learning projects. The innovation of this research lies in its systematic exploration of how service learning serves as a practical pathway in Business English education, providing theoretical foundations and practical guidance for cultivating students' interdisciplinary competencies, while addressing the current theory-practice disconnect in Business English education and offering a reference framework for curriculum reform.

1 LITERATURE REVIEW

1.1 Theoretical Foundations of Interdisciplinary Learning

Interdisciplinary learning focuses on the integration and interaction between disciplines, where students construct new perspectives on specific issues or contexts by combining knowledge from multiple disciplines (Stentoft, 2017). The theoretical foundations of interdisciplinary learning derive from constructivist learning theory and complexity science. Constructivist learning theory emphasizes that learners actively construct knowledge by integrating new information with existing knowledge systems, forming more profound and systematic understanding of the world (Hein, 1991; Bada & Olusegun, 2015). In interdisciplinary learning, knowledge from different disciplines does not exist in isolation but constructs new cognitive frameworks through interconnections (Spelt et al., 2009). In Business English instruction, language knowledge must be integrated with business contexts for students to flexibly apply language skills in authentic business scenarios. For instance, integrating marketing or management knowledge enhances the professionalism and contextual adaptability of language expression (Xie, 2024). Complexity science provides theoretical justification for understanding complex problems in interdisciplinary learning, asserting that contemporary societal issues possess multidimensional complexity that cannot be resolved through single-discipline knowledge and methods alone (Phelan, 2001). Interdisciplinary learning helps learners comprehensively understand complex phenomena and cultivates systems thinking and integrated analytical capabilities through the integration of multidisciplinary knowledge and methods (MacLeod, 2018).

In this research, interdisciplinary learning manifests as the organic combination of knowledge integration, capability transfer, and practice orientation. Knowledge integration involves combining language learning with business knowledge, enabling students to familiarize themselves with business background knowledge while learning language, utilizing language skills as tools for conveying professional information to meet international business scenario requirements (Xue et al., 2020). Capability transfer focuses on how language proficiency, critical thinking, and collaborative capabilities transfer from learning domains to practical application domains, with problem-solving abilities in business practice reciprocally enhancing language learning (Ivanitskaya et al., 2002). Practice orientation emphasizes resolving complex problems in authentic contexts, such as applying language skills and business knowledge to address practical issues (Brassler & Dettmers, 2017).

1.2 Theoretical Foundations of Service Learning Model

Service learning model originated from John Dewey's educational philosophy of "learning by doing" and gradually developed and systematized in American civic education and community service programs during the 1960s. Dewey advocated combining education with social practice, emphasizing the promotion of students' understanding and application of knowledge through practical action (Dewey, 1974). In 1970, Robert Sigmon proposed the definition of service learning, considering it an

"educational method that combines service with learning," with the core aim of achieving dual objectives through community service and academic learning activities: social value innovation and student capability development (Sigmon, 1970). Service learning emphasizes "mutual symbiosis," where students gain deep learning of knowledge and comprehensive capability development through practice in authentic scenarios while serving society, representing a deep integration of practice orientation, social responsibility cultivation, and service with learning.

Service learning is widely applied in fields such as language learning and education, enhancing students' language application abilities and cultural sensitivity through community projects or cross-cultural exchange activities (Sun & Yang, 2015). In Business English teaching, students combine language skills with business knowledge through participation in corporate consulting or market research projects, improving critical thinking, writing abilities, and problem-solving skills in authentic contexts.

1.3 Theoretical Mechanisms of Service Learning in Promoting Interdisciplinary Competency Development

Service learning creates a dynamic cycle of knowledge integration, practical application, and reflective enhancement by combining academic learning with social service, breaking disciplinary boundaries (Bringle & Hatcher, 1996). The core logic of service learning in promoting interdisciplinary competency development is that students face complex and multidimensional problems in authentic contexts, requiring the interaction and transfer of multidisciplinary knowledge for problem-solving. Meanwhile, driven by problem-oriented practicality, service learning cultivates students' systems thinking, critical thinking, and collaborative capabilities through multidisciplinary cooperation. Through reflective learning mechanisms, service learning transforms practical experience into internalized knowledge, deepening students' metacognitive abilities and interdisciplinary thinking, constructing an integrated capability system that unifies knowledge and action (Eyler, 2002).

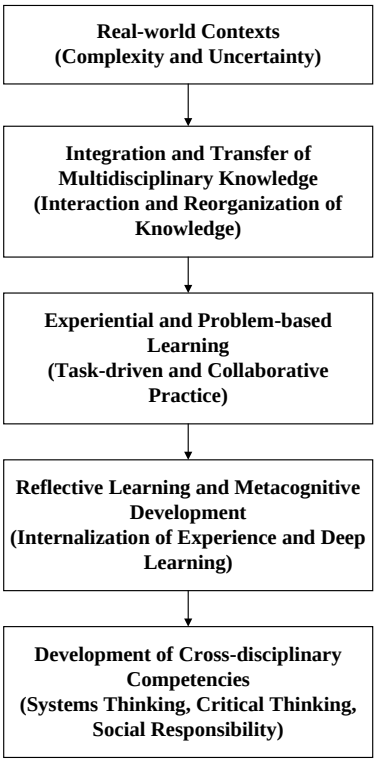

Figure 1.1 The Theoretical Logic of Service-Learning in Promoting Interdisciplinary Competency Development

Service learning achieves contextualized application of knowledge through dynamic integration and reorganization of multidisciplinary knowledge. Based on constructivist learning theory, students integrate knowledge across disciplines including language, social sciences, and economics during practice, forming multidimensional cognitive structures in authentic contexts (Bada & Olusegun, 2015; Chuang, 2021). Knowledge transfer is not merely a simple accumulation of knowledge but promotes students' cognitive reconstruction and creative problem-solving abilities in interdisciplinary contexts through interactions in complex situations.

Service learning drives interdisciplinary collaboration and complex problem-solving through problem-oriented practical learning. Based on systems thinking theory, students face multidimensional challenges in authentic contexts, transcending disciplinary boundaries to integrate diverse knowledge including language, analysis, and culture (Gerholz et al., 2018; Kjeldsen, 2015). Reflective learning in service learning serves as a core mechanism for knowledge internalization and metacognitive development. Drawing from experiential learning theory, students transform practical experience into transferable interdisciplinary knowledge through a cyclical process of "doing-thinking-internalizing" (Yardley et al., 2012; Kolb et al., 2014).

Service learning provides emotional and ethical foundations for interdisciplinary competency development by stimulating students' sense of social responsibility through social practice (Culhane et al., 2018). When directly addressing social needs, students integrate diverse knowledge into solutions, achieving synchronized development of cognitive abilities and values. Service learning is not merely a teaching model but an educational practice method that promotes students' comprehensive development across cognitive, capability, and value dimensions.

2 RESEARCH DESIGN AND METHODOLOGY

2.1 Research Framework

This study employs a quasi-experimental design utilizing a pre-test—intervention—post-test approach to compare the differences in interdisciplinary competency development between experimental and control groups, thereby evaluating the effectiveness of service learning in Business English education. The experimental group receives service learning-based pedagogical intervention, engaging in interdisciplinary service projects within authentic contexts, while the control group undergoes traditional classroom instruction. Through comparing the competency changes between the two groups before and after intervention, this study aims to validate the advantages of service learning in enhancing knowledge transfer capability, systems thinking ability, collaborative competence, and metacognitive skills.

2.1.1 Pre-test Phase

Prior to the formal pedagogical intervention, baseline assessments are administered to both experimental and control groups to evaluate their initial interdisciplinary competency levels and verify the equivalence between groups at the study's commencement. The pre-test employs standardized scales and task designs, primarily measuring four core dimensions: knowledge transfer capability, systems thinking ability, collaborative competence, and metacognitive skills, alongside Business English proficiency assessment.

2.1.2 Intervention Phase

The pedagogical intervention phase, constituting the core component of this research, spans ten weeks during which the experimental and control groups receive distinct instructional approaches, ensuring the intervention design fully demonstrates the contrast between service learning and traditional pedagogical models.

The experimental group's instructional model, grounded in service learning principles, organizes students into small groups for engagement in interdisciplinary tasks within authentic contexts. For instance, students develop bilingual promotional materials for community enterprises or devise cultural promotion strategies for non-profit organizations, requiring the integration of language

expression, business analysis, and sociocultural context knowledge to enhance knowledge transfer capability and systems thinking ability. Instructors assume the roles of facilitators and feedback providers, offering periodic guidance to assist students in problem identification, needs analysis, and solution optimization, while providing reflective learning opportunities to facilitate the internalization of learning experiences.

The control group follows a traditional classroom instruction model, maintaining consistent content coverage with the experimental group but emphasizing single-discipline knowledge transmission. Students consolidate Business English knowledge through individual assignments and standardized tests without engaging in interdisciplinary tasks in authentic contexts.

Both groups receive identical instructional duration and knowledge coverage within the same teaching period, with instructional methodology serving as the sole variable in the intervention design, ensuring that comparative results between the experimental and control groups reflect the actual effectiveness of the service learning pedagogical model.

2.1.3 Post-test Phase

Following the pedagogical intervention, post-tests are administered to both experimental and control groups to assess the enhancement of interdisciplinary competencies. The post-test utilizes identical assessment instruments and task designs as the pre-test, ensuring data comparability and consistency. The assessment focuses on changes across four dimensions: knowledge transfer, systems thinking, collaborative competence, and metacognitive skills, conducting longitudinal comparisons with pre-test results to analyze the magnitude of competency development within each group.

2.2 Research Participants

The study participants comprise 60 third-year English majors from a Chinese university, randomly assigned to experimental and control groups of 30 students each. The selection of third-year English majors is predicated on three key factors: firstly, they possess adequate linguistic and professional competencies for engaging in interdisciplinary service learning; secondly, their cognitive levels and professional aptitude have reached sufficient maturity for knowledge transfer and problem-solving; thirdly, their flexible course schedules accommodate service learning project commitments.

To ensure sample representativeness and inter-group equilibrium, stratified random sampling is employed across three dimensions: gender, academic performance, and social practice experience. The gender ratio is maintained at 1:1 (15 males and 15 females per group); academic performance is balanced across high (30%), medium (50%), and low (20%) achievement levels; social practice experience is randomly distributed with 70% experienced and 30% inexperienced participants.

Pre-test evaluations of interdisciplinary competencies and Business English proficiency reveal no statistically significant differences between groups ($p > 0.05$), validating initial inter-group equilibrium. The research strictly adheres to educational research ethics, with all participants providing voluntary informed consent. The research team ensures participant privacy protection and confirms that the research process imposes no additional burden on students.

2.3 Pedagogical Intervention Design

2.3.1 Service Learning Model

The intervention strategy is designed around four core dimensions—knowledge transfer, systems thinking, collaborative competence, and metacognitive skills—with the primary objective of enhancing students' interdisciplinary competencies through service learning. The service learning project design, as the central component of intervention, aims to facilitate multidisciplinary knowledge integration and transfer through authentic task engagement (Scott, 2008). In the instructional support and guidance phase, the instructor's role transitions from traditional knowledge transmitter to learning facilitator, implementing multi-faceted pedagogical interventions to support students in completing complex tasks.

Regarding knowledge transfer, the intervention strategy guides students through a progression from near transfer (knowledge application in classroom contexts) to far transfer (knowledge integration in open-ended social contexts). For systems thinking development, project tasks require students to identify multidimensional characteristics of complex problems, utilizing causal diagrams and concept maps to analyze dynamic relationships and design comprehensive solutions that balance linguistic expression, cultural adaptability, and business objectives.

In terms of collaborative competence, the strategy incorporates role assignment and rotation within groups to cultivate team communication and task allocation skills, supplemented by regular team reflection meetings to help students identify and resolve collaboration challenges. For metacognitive skill development, instructors employ feedback and questioning techniques to guide students in continuous reflection on strategy utilization and problem-solving methods during task execution, facilitating learning process optimization through reflection.

The 10-week service learning intervention strategy is structured as shown in Table 2-2.

Table 2-2 Service Learning Intervention Protocol

Week	Intervention Content	Implementation Steps	Goals
Week 1	Project Introduction and Team Formation	① Introduce the concept and objectives of service-learning ② Partner organization explains their needs ③ Students form groups and clarify roles and responsibilities	Students understand the dual objectives of service-learning (social value creation + skill development) and identify the direction of service
Weeks 2-3	Needs Assessment and Problem Analysis	① Conduct research: interviews, surveys, or on-site observations ② Use analytical tools (e.g., SWOT) to identify problems	Students interact with service recipients through research to understand complex real-world problems
Weeks 4-5	Solution Design	① Integrate multidisciplinary knowledge to design solutions ② Submit a draft and receive feedback from mentors and partners	Students propose innovative solutions by combining academic knowledge with practical needs
Week 6	Simulation and Solution Adjustment	① Test the feasibility of the solution through simulation ② Optimize the solution based on feedback	Students identify issues during simulation and adjust solutions to improve their applicability and operability
Weeks 7-9	Solution Implementation and Service Practice	① Implement the solution: e.g., helping communities organize events, creating bilingual materials, or conducting market promotion for businesses ② Record issues and response strategies during the service process	Students create social value in real-world contexts while developing skills in knowledge transfer, collaboration, and problem-solving
Week 10	Outcome Presentation and Reflection	① Submit the final report and presentation materials ② Reflect on the achievements of the service and learning process, and complete a skill enhancement assessment	Students summarize and showcase their service and learning outcomes, reflecting on their skill development

2.3.2 Traditional Teaching Model

The control group follows a traditional teaching model characterized by instructor-led classroom lectures, where students acquire Business English knowledge through textbook learning and complete corresponding exercises and case analyses. The instructional content primarily

encompasses Business English linguistic features, business communication techniques, and case discussions, emphasizing knowledge transmission and consolidation while lacking practical application in authentic contexts and multidisciplinary knowledge integration.

2.4 Data Collection

2.4.1 Measurement Tools

This study employs validated assessment instruments targeting four core dimensions of interdisciplinary competency—knowledge transfer capability, systems thinking ability, collaborative competence, and metacognitive skills—ensuring measurement validity and reliability meet academic research standards.

Table 2-1 Measurement Dimensions of Interdisciplinary Competencies

Dimension	Description	Measurement Indicators	Scale Source
Knowledge Transfer	The ability of students to apply knowledge from different disciplines (e.g., language, business, culture) to solve problems in new contexts.	Far Transfer Near Transfer	Perkins & Salomon（1992）
Systems Thinking	The ability of students to analyze complex problems from a holistic and multidimensional perspective, identify key elements and interactions, and propose comprehensive solutions.	Dynamic Thinking Causal Loops Holistic Thinking Structural Thinking Delayed Effects	Davis & Sumara（2006）
Collaborative Competence	The ability of students to communicate effectively, divide work reasonably, integrate resources, and complete tasks collaboratively in a team.	Communication Skills Team Collaboration Conflict Management Joint Decision-Making Responsibility Sharing	Bedwell et al.，（2012）
Metacognitive Ability	The ability of students to be aware of and regulate their own learning processes, including planning, monitoring, and reflection.	Knowledge Dimension Regulation Dimension	Schraw & ennison(1994)

The Business English proficiency assessment comprehensively evaluates students' linguistic competence across four components: listening, reading, writing, and business scenario application. The assessment content aligns with the Business English Curriculum Guidelines and incorporates authentic business contexts: the listening component measures business information comprehension (30 points); the reading section evaluates business text analysis capability (30 points); the writing component assesses linguistic expression and business writing proficiency (20 points); and the business scenario application section examines practical language application through situational simulations (20 points). The assessment content undergoes multiple rounds of review by two Business English instructors and two educational measurement specialists to ensure scientific rigor and practical relevance.

The measurement instruments employed in this study have undergone rigorous reliability and validity testing. Regarding reliability, the interdisciplinary competency assessment questionnaire

demonstrates high internal consistency (Cronbach's α = 0.89), while the Business English proficiency test exhibits strong test-retest reliability (r = 0.91). In terms of validity, the content validity index reaches 0.92, with factor loadings exceeding 0.70 in structural validity analysis. The interdisciplinary competency assessment questionnaire correlates significantly with academic performance (r = 0.78), and the Business English proficiency test shows strong correlation with practical performance (r = 0.81). These validation results confirm the instruments' scientific accuracy in assessing students' interdisciplinary competencies and Business English proficiency.

2.4.2 Data Collection Points

To effectively evaluate the impact of service learning on students' interdisciplinary competency development, data collection occurs at two key points:

Pre-test (Baseline Assessment): Prior to the commencement of the service learning project, baseline measurements of interdisciplinary competencies are conducted for both experimental and control groups, assessing initial levels of knowledge transfer capability, systems thinking ability, collaborative competence, and metacognitive skills.

Post-test (Project Completion Assessment): During the first week following project completion, both groups undergo reassessment to collect post-intervention data, enabling comparison of changes across the four competency dimensions.

3 Data Analysis

3.1 Descriptive Statistical Analysis

To investigate the impact of the service learning model on students' interdisciplinary competencies and Business English proficiency, descriptive statistical analysis of means and standard deviations is conducted for both experimental and control groups' pre-test and post-test results, facilitating preliminary comparison of group performance across different stages.

In the pre-test, minimal differences in means and standard deviations across the four dimensions between experimental and control groups indicate comparable initial competency levels. In the post-test, the experimental group demonstrates significantly higher means across all dimensions compared to the control group, suggesting a positive effect of the service learning model on interdisciplinary competency development among experimental group participants. Statistical data is presented in Table 3-1.

Table 3-1 Comparison of Mean Scores and Standard Deviations in Pre-test and Post-test for Interdisciplinary Competencies

Dimension	Phase	Experimental Group(M+SD)	Control Group(M+SD)
Knowledge Transfer	Pre-test	3.45±0.52	3.42±0.50
	Post-test	4.21±0.48	3.58±0.51
Systems Thinking	Pre-test	3.36±0.55	3.39±0.53
	Post-test	4.12±0.46	3.60±0.49
Collaborative Competence	Pre-test	3.50±0.57	3.48±0.56
	Post-test	4.25±0.50	3.61±0.55
Metacognitive Ability	Pre-test	3.41±0.54	3.43±0.53
	Post-test	4.18±0.47	3.62±0.52

The Business English proficiency assessment encompasses four components: listening, reading, writing, and business scenario application. In the pre-test, minimal differences in means and standard deviations across these four components between experimental and control groups indicate comparable initial language proficiency levels. In the post-test, the experimental group demonstrates significantly higher means across all four components compared to the control group, indicating that the service learning model substantially enhances comprehensive Business English

application capabilities among experimental group participants. Statistical data is presented in Table 3-2.

Table 3-2 Comparison of Mean Scores and Standard Deviations in Pre-test and Post-test for Business English Proficiency

Dimension	Phase	Experimental Group(M+SD)	Control Group(M+SD)
Knowledge Transfer	Pre-test	72.35±4.25	72.40±4.18
	Post-test	82.45±3.98	74.30±4.12
Systems Thinking	Pre-test	74.10±4.32	74.15±4.20
	Post-test	84.20±4.01	76.25±4.28
Collaborative Competence	Pre-test	73.45±4.30	73.50±4.25
	Post-test	83.75±3.95	75.10±4.35
Metacognitive Ability	Pre-test	75.55±4.15	75.60±4.10
	Post-test	85.30±3.90	77.20±4.18

The comparable means and standard deviations between experimental and control groups during the pre-test phase demonstrate balanced initial competency levels. In the post-test phase, experimental group participants exhibit significant improvement across all four dimensions of interdisciplinary competencies and all four components of Business English proficiency, with means notably exceeding those of the control group.

3.2 Independent Samples t-test

To assess the statistical significance of the service learning model's intervention effects, independent samples t-tests were conducted to analyze differences in interdisciplinary competencies and Business English proficiency between the experimental and control groups during the post-test phase.

Independent samples t-tests conducted across the four dimensions of interdisciplinary competencies revealed statistically significant differences between the two groups' post-test means ($p<0.05$). The analysis results are presented in Table 3-3. The data demonstrates that the experimental group exhibited significantly higher means across all four dimensions compared to the control group, with substantial statistical significance observed in knowledge transfer ($t=4.89$, $p<0.005$, $d=1.26$), systems thinking ($t=4.43$, $p<0.05$, $d=1.14$), collaborative competence ($t=5.02$, $p<0.005$, $d=1.29$), and metacognitive skills ($t=4.74$, $p<0.001$, $d=1.22$). The effect sizes (Cohen's d) exceeded 1 across all dimensions, indicating that the service learning model exerted a robust intervention effect on the enhancement of interdisciplinary competencies among experimental group participants.

Table 3-3 Independent Samples t-test Results for Post-test Interdisciplinary Competencies

Dimension	Experimental Group(M)	Control Group(M)	t-value	df	p-value	Effect Size (Cohen's d)
Knowledge Transfer	4.21	3.58	4.89	58	0.002	1.26
Systems Thinking	4.12	3.60	4.43	58	0.013	1.14
Collaborative Competence	4.25	3.61	5.02	58	0.004	1.29
Metacognitive Ability	4.18	3.62	4.74	58	0.000	1.22

Independent samples t-tests were administered across the four components of Business English proficiency (listening, reading, writing, and business scenario application) between experimental and control groups during the post-test phase. The results revealed statistically significant differences in post-test means across all components ($p<0.05$). The analysis results are presented in Table 3-4. The experimental group demonstrated markedly higher means across all components compared to the control group, with substantial statistical significance observed in listening ($t=7.29$,

p<0.005, d=1.88), reading (t=6.54, p<0.001, d=1.69), writing (t=6.82, p<0.005, d=1.76), and business scenario application (t=7.01, p<0.001, d=1.81). The effect sizes (Cohen's d) exceeded 1.5 across all components, indicating that the service learning model produced an exceptionally robust intervention effect on the enhancement of Business English proficiency among experimental group participants.

Table 3-4 Independent Samples t-test Results for Post-test Interdisciplinary Competencies

Dimension	Experimental Group(M)	Control Group(M)	t-value	df	p-value	Effect Size (Cohen's d)
Listening Comprehension	82.45	74.30	7.29	58	0.003	1.88
Reading Comprehension	84.20	76.25	6.54	58	0.000	1.69
Writing Proficiency	83.75	75.10	6.82	58	0.002	1.76
Business Context Application	85.30	77.20	7.01	58	0.000	1.81

3.3 Paired Samples t-test

To evaluate the magnitude of improvement in interdisciplinary competencies and Business English proficiency among experimental group participants, paired samples t-tests were conducted to analyze score changes between pre-test and post-test measurements. This analysis examined the impact of the service learning model on various competencies by comparing student performance at two time points.

The experimental group demonstrated statistically significant differences (p<0.05) between pre-test and post-test scores across all four dimensions of interdisciplinary competencies (knowledge transfer, systems thinking, collaborative competence, and metacognitive skills). Results are presented in Table 3-5. The experimental group exhibited substantial improvements in mean scores across all four dimensions: knowledge transfer increased from 3.45 to 4.21 (t=9.12, p<0.001), systems thinking from 3.36 to 4.12 (t=8.54, p<0.001), collaborative competence from 3.50 to 4.25 (t=9.43, p<0.001), and metacognitive skills from 3.41 to 4.18 (t=9.06, p<0.001). The average improvement across all dimensions exceeded 21%, indicating that the service learning model significantly enhanced interdisciplinary competencies among experimental group participants.

Table 3-5 Paired Samples t-test Results for Pre-test and Post-test Interdisciplinary Competencies (Experimental Group, N = 30)

Dimension	Pre-testM)	Post-test(M)	t-value	df	p-value	Improvement Rate (%)
Knowledge Transfer	3.45	4.21	9.12	29	0.000	22.03
Systems Thinking	3.36	4.12	8.54	29	0.000	22.62
Collaborative Competence	3.50	4.25	9.43	29	0.000	21.43
Metacognitive Ability	3.41	4.18	9.06	29	0.000	22.58

The experimental group demonstrated statistically significant differences (p<0.05) between pre-test and post-test scores across all four components of Business English proficiency (listening, reading, writing, and business scenario application). Results are presented in Table 3-6. The experimental group exhibited substantial improvements in mean scores across all components: listening increased from 72.35 to 82.45 (t=12.10, p<0.001), reading from 74.10 to 84.20 (t=11.58, p<0.001), writing from 73.45 to 83.75 (t=11.92, p<0.001), and business scenario application from 75.55 to 85.30 (t=11.79, p<0.001). The average improvement across all components ranged between 12-14%, indicating that

the service learning model significantly enhanced comprehensive Business English application capabilities among experimental group participants.

Table 3-6 Paired Samples t-test Results for Pre-test and Post-test Business English Proficiency (Experimental Group, N = 30)

Dimension	Pre-test(M)	Post-test(M)	t-value	df	p-value	Improvement Rate (%)
Listening Comprehension	72.35	82.45	12.10	29	0.000	13.97
Reading Comprehension	74.10	84.20	11.58	29	0.000	13.62
Writing Proficiency	73.45	83.75	11.92	29	0.000	14.02
Business Context Application	75.55	85.30	11.79	29	0.000	12.91

The data analysis results demonstrate that the service learning model exerts significant positive effects on students' interdisciplinary competencies and Business English proficiency. Through descriptive statistical analysis, independent samples t-tests, and paired samples t-tests, it is evident that the experimental group participants achieved significantly higher competency levels compared to the control group in post-test measurements, with substantial improvements between pre-test and post-test scores, validating both the intervention effectiveness and educational value of the service learning model.

4 DISCUSSION OF RESULTS

4.1 Enhancement Effects of Service Learning Model on Interdisciplinary Competencies

4.1.1 Knowledge Transfer

The service learning model significantly enhances students' knowledge transfer capabilities by embedding classroom knowledge within practical real-world projects. The experimental group demonstrated significantly higher post-test means in knowledge transfer compared to pre-test scores (increasing from 3.45 to 4.21, a 22.03% improvement, $t=9.12$, $p<0.001$) and significantly exceeded the control group's post-test means (independent $t=4.89$, $p=0.002$, Cohen's $d=1.26$). The results indicate that service learning provides opportunities for theory-practice integration, enabling students to apply classroom knowledge in practical contexts. In service learning projects, students must apply interdisciplinary knowledge (including language expression and problem analysis) to specific community or business challenges, thereby deepening their understanding and transfer capabilities (Wang et al., 2019). Compared to traditional learning models, context-based learning better stimulates students' ability to integrate multi-domain knowledge, validating the core mechanism of knowledge transfer through practice-enhanced knowledge extensibility and adaptability.

4.1.2 Systems Thinking

The service learning model plays a crucial role in developing students' systems thinking abilities, specifically their capacity to analyze complex situations and propose comprehensive solutions. Data reveals that the experimental group's post-test means in systems thinking increased from 3.36 to 4.12 (22.62% improvement, $t=8.54$, $p<0.001$), surpassing the control group's post-test means (independent $t=4.43$, $p=0.013$, Cohen's $d=1.14$). In service learning projects, students confront complex real-world problems, such as analyzing stakeholder needs in business projects or developing resource optimization strategies (Lasker, 2019). Compared to traditional knowledge-intensive learning models, service learning encourages students to establish holistic thinking frameworks during task execution, identify interrelationships among variables, and design problem-solving solutions.

4.1.3 Collaborative Competence

The team-based task design in service learning projects effectively enhanced students' collaborative awareness and capabilities, as evidenced by the data results. The experimental group's post-test means in collaborative competence increased from 3.50 to 4.25 (21.43% improvement, $t=9.43$, $p<0.001$), significantly exceeding the control group's post-test means (independent $t=5.02$, $p=0.004$, Cohen's $d=1.29$). In the service learning model, students must engage in teamwork, share responsibilities, and complete projects through communication and coordination (Peterson & Schaffer, 1999). Authentic collaborative environments help students recognize the positive impact of responsibility allocation, communication efficiency, and conflict resolution (Sevin et al., 2016). For instance, when students encounter differing opinions during community service, they must negotiate consensus while demonstrating individual contributions toward team objectives.

4.1.4 Metacognitive Skills

The service learning model facilitates significant enhancement in students' metacognitive capabilities. The experimental group demonstrated a substantial increase in metacognitive skills, with post-test means rising from 3.41 to 4.18 (22.58% improvement, $t=9.06$, $p<0.001$), significantly exceeding the control group's post-test means (independent $t=4.74$, $p<0.001$, Cohen's $d=1.22$). A distinctive feature of service learning projects lies in their multiple feedback cycles, where students evaluate learning strategies, task completion status, and optimization approaches through post-practice reflection. After completing project reports or presentations, students must analyze their successful experiences and areas for improvement, while formulating future enhancement strategies. This reflective learning process not only enhances students' understanding of learning objectives but also cultivates self-regulatory awareness, enabling them to flexibly adjust learning methods in response to environmental changes (SHIN, 2024).

4.2 Facilitative Effects of Service Learning Model on Business English Learning

The service learning model integrates Business English into practical contexts, providing students with frequent language interaction opportunities. Data analysis reveals that the experimental group's post-test means in business scenario application significantly exceeded the control group (85.30 vs. 77.20, $p<0.001$), showing a 12.91% improvement. Authentic tasks such as business negotiations and business plan writing encourage students to actively adapt to language contexts, enhance communication effectiveness, and transform language learning from traditional input to dynamic output and feedback processes. The service learning model integrates listening, speaking, reading, and writing skills within real projects, significantly enhancing students' comprehensive language abilities. The experimental group demonstrated significantly higher post-test means across all four components (listening, reading, writing, and business scenario application) compared to the control group, with effect sizes exceeding 1.5. Through diverse tasks such as community interviews, professional report analysis, plan writing, and team discussions, students achieve coordinated development of language skills and effective transfer among different language competencies.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The research findings demonstrate that the service learning model significantly enhances both interdisciplinary competencies and language learning outcomes among Business English majors, fully reflecting its educational value. Regarding interdisciplinary competencies, the service learning model effectively promotes knowledge transfer (22.03% improvement) and systems thinking abilities (22.62% improvement) through practical real-world tasks, helping students integrate multi-domain knowledge and propose comprehensive solutions in complex situations. Additionally, team-based task design significantly enhances collaborative competence (21.43% improvement), while

multiple reflection and feedback cycles strengthen metacognitive skills (22.58% improvement), developing students' self-regulatory awareness and capabilities during task execution. In terms of language learning, the service learning model integrates listening, speaking, reading, and writing skills within authentic business contexts, providing frequent language use opportunities and achieving significant improvements across all skills (12-14% average improvement), particularly demonstrating strong communication effectiveness in business scenario applications (Cohen's d=1.81). The research indicates that the service learning model effectively combines theoretical learning with practical application while fostering comprehensive development through multi-dimensional competency cultivation.

5.2 Recommendations

5.2.1 Design Task-Driven Authentic Business Learning Projects

To effectively promote the service learning model, Business English programs should design task-driven projects that emphasize authenticity and practicality, closely integrating language learning with real business scenarios (Lee & Park, 2020). Teaching tasks should center around practical problems, such as conducting market research with enterprises, writing business plans, or simulating business negotiations, ensuring students can apply language skills, solve problems, and deepen interdisciplinary competencies in authentic contexts (Derakhshan et al., 2021). Additionally, institutions should establish school-enterprise cooperation platforms to broaden service learning resource channels and provide diverse practical opportunities. Project design must consider both task complexity and diversity, aligning with students' language development stages while maintaining sufficient challenge to stimulate initiative and innovation.

5.2.2 Transform Teacher's Role from Knowledge Provider to Facilitator and Resource Integrator

In implementing the service learning model, teachers should transition from traditional knowledge providers to learning process facilitators, task designers, and resource coordinators (Resch & Schrittesser, 2023; Swaminathan, 2023). Teachers need to guide students in understanding task objectives, breaking down complex problems, and developing actionable plans. They must coordinate resources between educational institutions and external organizations to ensure smooth implementation of practical activities. Furthermore, teachers should provide constructive feedback after task completion, helping students reflect on their successes and areas for improvement. To fulfill this role effectively, teachers must possess project design capabilities, interdisciplinary knowledge backgrounds, and communication skills for enterprise engagement, while mastering effective guidance and assessment methods to ensure service learning quality (Yang et al., 2020).

5.2.3 Develop Supporting Reflective Learning and Assessment Mechanisms

Teachers should guide students through reflective practices such as journals, case analyses, or project summaries to conduct deep reflection on their achievements and shortcomings, enhancing metacognitive abilities and learning strategies (Adler-Kassner et al., 2023). Additionally, teaching assessment should transcend traditional examination models by adopting diverse evaluation methods, including task-based performance assessment, team collaboration evaluation, and self and peer assessment, to comprehensively measure student progress in knowledge transfer, systems thinking, collaborative competence, and language application skills (Jenkins & Sheehey, 2022).

5.3 Research Significance and Practical Implications

The service learning model demonstrates substantial theoretical value and practical significance in Business English pedagogical reform, establishing novel cognitive pathways for innovative language teaching paradigms. Through embedding language acquisition within authentic business contexts, this model effectively transcends the cognitive limitations inherent in traditional teaching methodologies, where language application remains divorced from theoretical learning. It facilitates the synchronized development of linguistic competence and professional expertise, propelling

Business English education toward a competency-oriented paradigm from conventional knowledge transmission.

In the contemporary landscape of knowledge economy and globalization, the service learning model holds paramount significance for interdisciplinary talent cultivation. Through task-driven and project-based implementations, this model not only significantly enhances students' knowledge transfer, systems thinking, collaborative capabilities, and metacognitive competencies but also cultivates core competitive advantages in rapid adaptation and problem-solving within complex multicultural environments. This pedagogical model represents not merely an effective pathway for Business English teaching reform but establishes a crucial practical paradigm for nurturing high-caliber professionals with international perspective, practical competencies, and innovative spirit, bearing profound theoretical implications for innovative developments in higher education.

5.4 Research Limitations and Future Directions

The current study's limited sample size (30 participants each in experimental and control groups) and relatively brief experimental duration of 10 weeks constrain the validation of the service learning model's long-term effectiveness and universal applicability. Future research should expand the sample population, encompass student cohorts from diverse educational backgrounds and geographical regions, and extend the experimental duration to comprehensively examine the sustained impact and cumulative effects of service learning.

The measurement instruments, predominantly comprising quantitative indicators, inadequately capture individualized student experiences within service learning, such as affective responses in cross-cultural contexts, cultural sensitivity development, and critical thinking enhancement. Future investigations should incorporate qualitative methodologies, including interviews, observations, and reflective journal analyses, to illuminate the underlying mechanisms and impact pathways of service learning.

Furthermore, while this study focuses on Business English instruction, the potential of the service learning model extends to other domains of language education, including Academic English, Tourism English, and general foreign language instruction, particularly in developing cross-cultural communication competence, practical skills, and critical thinking abilities. Future research should explore its efficacy across various stages and domains of language instruction, providing theoretical foundations and operational frameworks for diverse pedagogical practices.

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