Article

Practice and Exploration of a BOPPPS Blended Teaching Model Using the Chaoxing Learning Platform in the Course Civil Engineering Construction Technology and Organization (Bilingual)

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Abstract: Civil Engineering Construction Technology and Organization is a core course for civil engineering majors, and its bilingual instruction undertakes the dual mission of imparting professional knowledge and fostering international competence. To address persistent challenges in traditional classroom teaching, such as low student participation, weak application of professional English, and a lack of data-driven support for formative assessment, the BOPPPS effective teaching structure model was introduced into the course. Relying on the Chaoxing Learning Platform, a smart teaching tool, a blended bilingual teaching model featuring online cognition, offline deepening, and online enrichment was constructed. By reorganizing course resources, teaching activities, and the assessment system, the six phases of BOPPPS were systematically integrated with the diverse functions of the Chaoxing platform, forming a closed-loop instructional framework that comprises pre-class terminology pre-assessment and scenario introduction, in-class bilingual participatory learning, and post-class stratified post-assessment and reflective summary. A one-semester teaching innovation was implemented with third-year civil engineering students at Anhui University of Science and Technology as participants. The effectiveness of the proposed model was evaluated through grade comparisons, platform behavior analysis, and a structured questionnaire survey. The results demonstrate that students in the blended teaching group significantly outperformed those in the traditional teaching group in terms of learning interest, classroom interaction, autonomous learning ability, and overall academic performance. The BOPPPS-based blended teaching model supported by the information platform effectively stimulates learning motivation, strengthens bilingual application and construction organization analysis skills, and provides an actionable practical pathway for the advancement of bilingual engineering courses.

Keywords: boppps model; blended teaching; bilingual education; chaoxing platform; civil engineering education

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1. Introduction

With the deepening of the Belt and Road Initiative and the accelerated international expansion of China's construction industry, there is an increasingly urgent demand for interdisciplinary talents in civil engineering who possess international vision and cross-cultural communication skills. Civil Engineering Construction Technology and Organization is a core course that expounds the principles of construction processes, selection of construction methods, and design of resource organization. It is highly practical, comprehensive, and densely packed with specialized terminology, requiring students not only to acquire key construction techniques for each sub-discipline but also to develop foundational competencies in compiling construction organization plans and

conducting on-site management. When instruction is delivered in a bilingual Chinese–English mode, students must comprehend complex construction procedures and technical specifications while simultaneously internalizing professional English expressions, which significantly increases cognitive load [1]. Traditional bilingual teaching largely follows a one-way lecturing model of "English slides with Chinese explanations," characterized by limited classroom participation, rudimentary formative assessment, and uniform teaching resources that struggle to vividly present dynamic scenarios such as machinery operation and process overlapping, and a lack of bilingual digital resources that support autonomous learning.

Educational informatization provides new approaches to address these challenges. The Chaoxing Learning Platform, as a widely used smart teaching platform, offers features such as course creation, resource distribution, sign-in, quick response, topic discussion, group tasks, and learning data statistics, enabling full-process coverage before, during, and after class and serving as a technical foundation for collecting and analyzing process data. Meanwhile, the BOPPPS model, grounded in constructivist learning theory, divides the teaching process into six phases—bridge-in, objective, pre-assessment, participatory learning, post-assessment, and summary—emphasizing instructional integrity, interactivity, and closed-loop feedback, thus providing a clear operational framework for course design. At the bilingual level, the course adopts the 4Cs framework of Content and Language Integrated Learning, advocating the integration of content, communication, cognition, and culture, so that English functions as a tool for acquiring disciplinary knowledge and engaging in authentic communication, thereby avoiding the separation of language learning from subject matter [2, 3]. By organically combining these theories and tools—with BOPPPS as the teaching structure, blended learning as the functional allocation principle, Content and Language Integrated Learning as the bilingual essence, and the Chaoxing platform as the technological enabler—a blended teaching model tailored to bilingual civil engineering courses can be developed, potentially addressing the persistent limitations of traditional classrooms from both structural and instrumental perspectives.

This study aims to construct a BOPPPS-based blended teaching model using the Chaoxing Learning Platform and apply it to the course Civil Engineering Construction Technology and Organization (Bilingual). Through systematic instructional design and practical implementation, it seeks to stimulate students' initiative in bilingual learning and classroom participation, deepen their understanding of construction technology principles, and enhance their ability to use professional English, achieve precise and data-driven formative assessment, and develop a scalable information-based bilingual teaching approach [1, 4]. The study integrates the BOPPPS model, blended learning theory, and Content and Language Integrated Learning concepts, thereby extending the theoretical application boundaries of bilingual teaching models in engineering education.

Regarding BOPPPS and blended teaching, existing research has accumulated a wealth of experience. The BOPPPS model has been applied across multiple disciplines including medicine, nursing, and engineering, and domestic studies have confirmed its positive effects in courses such as Advanced Mathematics and College Physics; however, exploration in bilingual civil engineering teaching, especially in construction-related courses, remains limited. In terms of blended teaching, numerous cases exist of integrating online and offline instruction using platforms like Chaoxing Learning Platform and Rain Classroom. Nevertheless, there is still a lack of detailed research on precisely aligning the specific needs of bilingual civil engineering construction courses—such as "acquisition of construction terminology" and "case studies on organizational design"—with platform functionalities. Existing initiatives in bilingual civil engineering teaching often focus on single dimensions, such as resource development or pedagogical strategies, without a systematic design that holistically considers teaching structure, information tools, and bilingual objectives [5, 6]. Therefore, integrating the structured process of BOPPPS with the data capabilities of the Chaoxing platform to construct a

bilingual teaching pathway spanning "before class–in class–after class" precisely addresses a gap in current research.

Grounded in the course Civil Engineering Construction Technology and Organization (Bilingual), this study focuses on designing six-phase teaching activities and a bilingual resource system, and conducts a comparative practice over a complete teaching cycle. The participants were four parallel classes of third-year civil engineering students (2022 cohort) at Anhui University of Science and Technology, randomly assigned to a blended teaching group (78 students) and a traditional teaching group (72 students). The blended group received BOPPPS-based blended bilingual instruction via the Chaoxing Learning Platform, while the traditional group was taught using conventional multimedia-assisted bilingual instruction. After the course, both groups took the same closed-book examination and a specialized bilingual proficiency test; additionally, a questionnaire survey was administered to the blended group, and behavioral data from the Chaoxing platform backend were exported for comprehensive evaluation [7, 8].

2. Design of Boppps Blended Bilingual Teaching Based on the Chaoxing Learning Platform

2.1. Overall Course Design Philosophy

Civil Engineering Construction Technology and Organization (Bilingual) is a 40-credit-hour course covering earthworks, foundation engineering, masonry engineering, concrete structural engineering, prestressed engineering, structural installation engineering, as well as modules on construction organization fundamentals, flow-line construction, network planning techniques, and unit construction organization design [9]. Adhering to the philosophy of "student-centeredness with parallel advancement of bilingual competence and engineering application," the course content was reorganized into a series of teaching units. Each unit progresses through three phases: "online cognition before class—offline deepening in class—online reinforcement after class." Before class, the emphasis is on terminology preview and conceptual preparation; in class, bilingual in-depth processing is carried out based on the six-step BOPPPS model; after class, assignments, tests, and supplementary materials are used to consolidate application and promote reflection. The Chaoxing Learning Platform functions as a digital bridge throughout the entire process, supporting resource distribution, interaction facilitation, data recording, and immediate feedback. Regarding bilingual objectives, the course follows the principle of "progressive infiltration." In the early stage, substantial Chinese support is allowed for comprehension, with English focused on core terminology, definitions, and simple process descriptions; in the middle stage, the proportion of English case reading and small-group English discussions is gradually increased; in the later stage, students are required to attempt writing summaries of construction plans in English and delivering brief reports, ultimately achieving the goals of being able to read English construction specifications and explain basic construction process steps in English.

2.2. Construction of Bilingual Teaching Resources

Centering on the key points of the course, the teaching team systematically constructed a digital bilingual resource repository and uploaded all materials to the Chaoxing Learning Platform course portal. For critical processes in each chapter, 15–20-minute bilingual micro-lecture videos were produced, including topics such as "Working Modes of Front-Shovel and Backhoe Excavators" and "Construction Process of Slurry Wall Bored Piles," incorporating embedded animations and pop-up quizzes to enhance self-directed learning effectiveness. Concurrently, over 20 simulation animations of construction processes and video clips from real engineering projects were curated and processed with English narration, visually illustrating dynamic aspects such as machinery coordination and spatial arrangement to address limitations inherent in static textbook formats. To support terminology mastery, a bilingual glossary comprising approximately 300 terms was developed, with each entry providing phonetic symbols, Chinese definitions, and representative English example sentences; the glossary was formatted as

a searchable shared document and organized by chapter on the learning platform [10]. Additionally, Chinese–English synopses of 10 representative engineering cases—including a super-high-rise concrete pumping scheme and a bridge cantilever construction organization plan—were selected and supplemented with guiding questions for in-class discussion and post-class extension activities. A bilingual test bank was also established, containing over 400 objective questions and more than 20 comprehensive items covering calculation, short-answer, and drawing tasks, all featuring Chinese–English question stems. Pre-assessment papers for each chapter and post-assessment papers for each unit were preconfigured to facilitate formative evaluation.

2.3. Implementation Strategy for Integrating the Six Phases of Boppps with the Chaoxing Platform

Figure 1 illustrates the implementation process of the online-and-offline blended teaching model based on the integration of BOPPPS teaching with the Chaoxing Learning Platform. The entire teaching process takes the six core phases of the BOPPPS model as its framework and organically connects online and offline instruction through the platform. In the pre-class stage, online self-directed learning predominates. Two days in advance, teachers push bilingual learning resources and pre-assessment tasks via the platform. Students complete independent preview of the knowledge points accordingly and submit feedback, while teachers precisely adjust the starting point and depth of classroom instruction based on the statistical data from the pre-assessment [11]. In the in-class stage, the offline classroom serves as the primary venue for implementing the core phases of BOPPPS. First, a 1–2-minute bilingual video or graphic material is used to introduce a contextual scenario—such as engineering incidents involving foundation pit instability or an overview of advanced formwork systems employed in high-rise construction—accompanied by two open-ended questions to stimulate critical thinking and accomplish the bridge-in. Next, the bilingual learning objectives for the session are clearly listed on the chapter homepage, and students click a confirmation button to clarify their learning direction. Participatory learning is the core of the in-class session. The teacher first delivers an intensive explanation of key processes in English, supplemented by Chinese clarifications for difficult points, interspersed with the quick-response and random-selection questioning functions of the Chaoxing platform. Subsequently, students are divided into groups of six to eight. Mini English-language cases are distributed through the platform (e.g., "Honeycombing appears on the column surface after form removal; please propose a repair procedure and discuss preventive measures"). After bilingual group discussions, representatives briefly present their plans in English, while other groups provide supplements and raise questions. For tasks such as the division of flow-line construction sections and the drawing of network diagrams, students quickly sketch their solutions, take photos, and upload them to the group task area on the platform for peer evaluation. When playing simulation animations such as layered vibration of concrete pouring, the video is paused for questions, and the platform's screen projection function is used to display word clouds or conduct instant polls, resulting in high-density teacher–student interaction. In the post-class stage, the process returns to the online platform. Teachers release chapter post-assessments (containing objective questions and small-scale comprehensive analysis questions); the system automatically grades the objective questions, while the subjective questions are evaluated by the teacher to promptly verify the degree of goal attainment. At the same time, students submit a reflective summary paragraph of no fewer than 200 words in English or a mind map on the platform. Teachers push bilingual summary micro-videos on key and difficult points and continue answering questions in the discussion forum, thereby forming a complete knowledge cycle of "online pre-assessment–offline internalization–online post-consolidation."

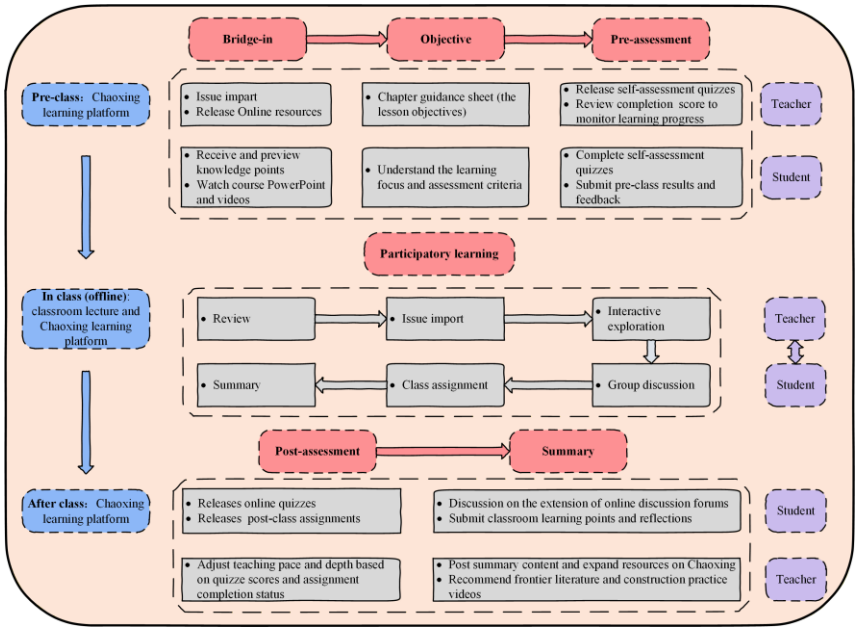

Figure 1. Online--offline Blended Teaching Model Based on the Integration of Boppps Teaching with the Chaoxing Learning Platform.

2.4. Pathway for Integrating Bilingual Competence Development

Beyond the continuous integration of bilingual training across all stages of the BOPPPS framework, the course embedded structured competence-building activities [1]. A weekly "terminology check-in" task required students to complete Chinese–English translation and spelling of five discipline-specific terms via the Chaoxing platform's daily practice module, reinforcing professional vocabulary acquisition. Periodic "English construction log writing" exercises presented students with authentic on-site scenarios and guided them to compose entries in English following standard industry formats, thus aligning language production with real-world engineering practice. Midway through the semester, a "Mini Technical Presentation" was conducted: student groups selected construction-related topics, developed English-language PowerPoint slides, and delivered five-minute oral presentations. The Chaoxing platform's live streaming and playback features supported peer evaluation and instructor feedback. Collectively, these tasks addressed listening, speaking, reading, and writing skills, fostering progressive internalization of professional English proficiency through consistent, context-embedded application.

3. Teaching Practice and Effect Analysis

3.1. Participants and Context

This study was conducted during the spring semester of the 2024–2025 academic year at the School of Civil Engineering, Anhui University of Science and Technology. The blended teaching group consisted of Classes 8 and 9 from the 2022 civil engineering cohort, totaling 78 students; the traditional teaching group comprised Classes 10 and 11, totaling 72 students. Both groups had completed prerequisite courses including Civil Engineering Materials and Mechanics of Materials, and both achieved a CET-4 pass rate of approximately 75%. A pre-test confirmed no statistically significant difference between the groups, supporting their comparability. The blended teaching group implemented the BOPPPS model delivered via the Chaoxing Learning Platform, while the traditional teaching group followed the same textbook and bilingual courseware but relied on conventional classroom lectures, paper-based assignments, and roll-call questioning for interaction. The course spanned 40 credit hours, with all instruction delivered by the authors and the same instructional team to ensure consistency in content, pacing, and assessment standards.

3.2. Data Collection and Evaluation Methods

To comprehensively assess teaching effectiveness, data were collected and analyzed across three dimensions: academic performance, platform behavioral data, and questionnaire surveys supplemented by interviews.

Academic performance was evaluated through an overall grade comprising pre-class preparation (10%), classroom participation (10%), post-class assignments (10%), and a final closed-book examination (70%). The examination, scored out of 100 points, consisted of terminology translation questions (10 points), objective questions (40 points), and comprehensive analysis questions (50 points). To ensure objectivity and fairness, the examination paper was prepared by instructors not involved in delivering the course.

Platform behavioral data were extracted from the Chaoxing Learning Platform backend for the blended teaching group, capturing indicators including task completion rate, discussion forum posts, platform access frequency, and video viewing duration to reflect online learning participation and engagement levels [12, 13].

A self-developed 'Questionnaire on Satisfaction and Perceived Effectiveness of BOPPPS Blended Teaching Based on the Chaoxing Platform' was administered at semester end to the blended teaching group, covering participation, bilingual competence development, and platform usability [14]. Of 78 distributed questionnaires, 76 were returned, yielding an effective response rate of 97.4%. Additionally, semi-structured interviews were conducted with 10 randomly selected students and 3 classroom observers to gather qualitative insights that complement and contextualize the quantitative findings.

3.3. Analysis of Teaching Effectiveness

3.3.1. Comparison of Academic Performance

Table 1 presents the performance statistics for the traditional and blended teaching groups. In terms of the final written examination scores, the average score of the blended group was 77.4 (converted to 54.2 after applying the 70% weighting), while that of the traditional group was 71.2 (converted to 49.8). An independent-samples t-test confirmed a statistically significant difference between the two groups ($p < 0.01$). Regarding the overall grade—including formative assessments—the blended group achieved a mean score of 79.8, compared with 71.6 for the traditional group, representing an 8.2-point advantage.

Table 1. Comparison of Student Performance between the Traditional and Blended Teaching Groups

Assessment component	Weight	Traditional group	Blended group	Significance
Pre-class preparation	10	7.2 ± 0.9	8.8 ± 0.7	$p < 0.001$
Classroom participation	10	7.0 ± 1.0	8.5 ± 0.9	$p < 0.001$
Post-class assignments	10	7.6 ± 0.8	8.3 ± 0.7	$p < 0.01$
Final examination	70	49.8 ± 5.6	54.2 ± 5.0	$p < 0.01$
Overall grade	100	71.6 ± 5.2	79.8 ± 4.8	$p < 0.01$

Across all formative assessment components, the blended group consistently outperformed the traditional group: pre-class preparation averaged 8.8 ± 0.7 versus 7.2 ± 0.9 ($p < 0.001$); classroom participation averaged 8.5 ± 0.9 versus 7.0 ± 1.0 ($p < 0.001$); and post-class assignments averaged 8.3 ± 0.7 versus 7.6 ± 0.8 ($p < 0.01$). These results indicate that the BOPPPS blended teaching model effectively enhances pre-class knowledge acquisition, in-class engagement, and post-class consolidation and application [6].

3.3.2. Analysis of Platform Learning Behaviors

Behavioral data from the blended teaching group on the Chaoxing Learning Platform indicated high levels of engagement. A total of 82 task points were released for the course, with an average student completion rate of 95.1%. The chapter video replay rate stood at 25%, suggesting students proactively reviewed challenging content. In the thematic discussion forum, students posted an average of 10.4 times and replied an average of 7.2 times per person; peak activity occurred between 22:00 and 23:00, reflecting sustained

post-class participation and demonstrating how online discussion extended learning beyond scheduled class time and physical space. Pre-class pre-assessments were completed, on average, within 4.2 hours of release, with a participation rate of 98%, thereby supporting timely, targeted in-class instruction. During face-to-face sessions, interactive functions—including quick-response polling and random student selection—were employed over 100 times collectively, resulting in each student being engaged an average of 2.7 times, fostering a dynamic and moderately paced bilingual learning environment [15].

3.3.3. Questionnaire Survey and Interview Results

The questionnaire results indicated that students held a highly positive overall attitude toward the "BOPPPS + Chaoxing" bilingual teaching model. As shown in Figure 2(a), 76.9% of students expressed willingness or strong willingness to continue with the current teaching model, while only 10.3% selected "neutral"; no respondents chose "unwilling," reflecting high acceptability and scalability potential. Regarding learning motivation, Figure 2(b) shows that 51.3% rated the model as "very helpful" and 35.9% as "fairly helpful," yielding a combined proportion of 87.2%; only 11.5% responded "neutral." This aligns closely with the 95.1% task completion rate observed in platform behavioral data, suggesting that the structured BOPPPS framework and Chaoxing's real-time feedback functionality jointly support the cultivation of intrinsic learning motivation [13].

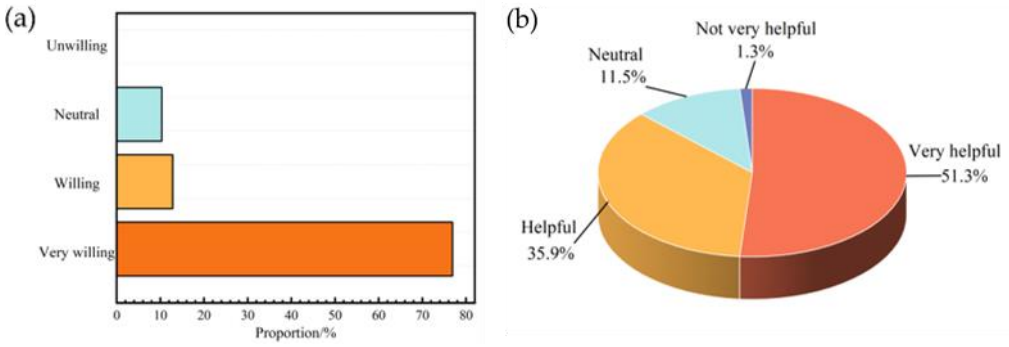

Figure 2. Survey Feedback Results: (A) Willingness to Continue the Current Teaching Model; (B) Whether the Teaching Model Helps Enhance Learning Motivation

Interview feedback further reinforced these findings: one student noted, "I used to be most afraid of being asked questions in English. Now, following the BOPPPS steps and having prepared key terminology beforehand, I feel more confident speaking in class." A classroom observer remarked, "The lesson structure is well-organized, student attention remains consistently high, and digital tools are integrated purposefully—not merely for demonstration." Such qualitative insights corroborate the quantitative outcomes and provide complementary, multi-dimensional validation of the model's pedagogical effectiveness [16].

3.4. Problems Identified in Teaching and Directions for Improvement

During practical implementation, several challenges emerged that require ongoing refinement in subsequent teaching iterations.

First, achieving an optimal balance in bilingual instruction remains challenging. Some students with limited English proficiency reported difficulty comprehending and expressing ideas during fully English participatory activities; however, excessive code-switching between Chinese and English may undermine the development of a consistent bilingual learning environment. To address this, a clear language-switching protocol will be introduced, and real-time bilingual subtitles or keyword-based on-screen annotations will be integrated into the Chaoxing platform to reduce linguistic cognitive load and support learners across diverse English proficiency levels.

Second, alignment between online preparatory tasks and face-to-face class time requires further optimization. Initially, some pre-class video assignments were overly

lengthy and competed with students' time commitments for other courses. Going forward, micro-lecture videos will be strictly limited to 10–15 minutes, and associated tasks will be differentiated into "core" and "supplementary" categories to better accommodate varied learning paces.

Third, role allocation in bilingual group collaboration exhibited uneven distribution. Moving forward, roles within collaborative tasks will be explicitly assigned—such as "terminology documentation specialist," "English-language presenter," and "visual diagram coordinator"—with systematic rotation implemented. Additionally, the peer evaluation feature embedded in Chaoxing's group task module will be leveraged to mitigate unbalanced participation and strengthen both fairness and pedagogical effectiveness [17].

Fourth, utilization of digital platform capabilities remains underdeveloped [12]. Intelligent tools—including AI-assisted oral assessment and virtual simulation training for construction organization planning—have not yet been incorporated, indicating opportunities to enrich instructional design. Future work will progressively investigate integration pathways for these tools to advance teaching intelligence and personalization.

4. Conclusions and Outlook

This study integrated the BOPPPS teaching model with the Chaoxing Learning Platform to develop and implement an online–offline blended teaching approach for the bilingual course Civil Engineering Construction Technology and Organization. Results indicate that structured instructional design transformed a previously fragmented bilingual classroom into a cohesive learning environment where objectives, activities, and assessment are closely aligned—leading to measurable improvements in academic performance and course engagement. The blended teaching group achieved a mean overall grade of 79.8 points, significantly higher than the 71.6 points attained by the traditional teaching group; all formative assessment components showed statistically significant differences ($p < 0.01$). Through the platform's data tracking and real-time feedback capabilities, a formative assessment mechanism was established wherein learning progress is transparent and evaluation is grounded in empirical evidence; the blended group recorded a task completion rate of 95.1% and a pre-assessment participation rate of 98%, supporting data-informed instructional decisions. The integration of online and offline modalities extended the temporal and spatial scope of bilingual input and output, helping mitigate the tension between limited class time and high cognitive demand. Survey data indicated that 87.2% of students perceived enhanced learning motivation, and their confidence in using professional English improved demonstrably. Challenges identified include optimizing the balance between Chinese and English language use, aligning online task load with face-to-face session duration, clarifying collaborative roles in group work, and fully utilizing platform features. Future work will broaden implementation across additional courses and cohorts to strengthen generalizability; incorporate AI-powered oral assessment and virtual simulation training to enhance interactivity and realism; and build an adaptive pre-assessment item bank to generate personalized learning pathway recommendations—advancing the synergistic integration of educational technology and bilingual engineering instruction.

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