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Design and Practice of "AI+" Higher Vocational English Courses Based on Cognitive Load Theory

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Abstract: The development and integration of "AI+" English courses within higher vocational education represent a critical direction for advancing vocational education frameworks and enhancing pedagogical efficacy. While artificial intelligence provides vast digital resources, interactive tools, and immersive virtual environments for language learning, the inappropriate selection of these resources or a lack of structured summarization and knowledge internalization can easily lead to severe cognitive overload for students. To address this challenge, this study introduces cognitive load theory—specifically categorizing cognitive load into internal, external, and germane cognitive loads—as a comprehensive analytical framework. This framework is utilized to systematically explore how to optimally balance these three distinct types of cognitive load through meticulous and innovative course design. Through the implementation of three sets of rigorously controlled experiments, the research empirically demonstrates that "AI+" higher vocational English courses, which strategically combine traditional classroom teaching methodologies with advanced AI-assisted technologies, yield significant educational benefits. Specifically, this blended approach can effectively reduce extraneous external load, minimize unnecessary internal load, and substantially enhance the germane cognitive load, thereby facilitating deeper learning. The detailed instructional course design principles and the practical case studies of "AI+" higher vocational English courses presented in this paper offer valuable insights. Ultimately, these findings can serve as a robust foundational reference and practical guide for the future development and optimization of the broader "AI+" series of higher vocational educational programs.

Keywords: cognitive load theory; artificial intelligence; vocational English; course design; teaching practice

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1. Introduction

In response to the national strategy to integrate artificial intelligence into various sectors and in alignment with educational digitalisation guidelines, higher education institutions are actively advancing the development of courses that incorporate artificial intelligence [1]. The integration of artificial intelligence and education has been identified as a key area of focus. As an essential component in the training of technical and skilled professionals, it is crucial for higher vocational education to develop high-quality AI-assisted English courses.

Recent research has explored the use of artificial intelligence tools in foreign language teaching. Studies have shown that such tools provide extensive language communication resources and create authentic environments for learners, significantly enhancing independent learning. However, concerns have been raised that reliance on these tools may reduce real-world human interactions, potentially hindering the development of critical thinking skills. In the context of university English teaching, methods have been identified for developing intelligent teaching resource repositories, creating multimodal intelligent teaching environments, constructing tiered teaching systems, and establishing intelligent assessment and feedback mechanisms. Despite these advancements, experts emphasize that the mutual exchange of ideas and the formation of students' worldviews, outlooks on life, and values still require face-to-face classroom interaction and discussion [1].

Existing research has primarily focused on the facilitation of foreign language teaching through artificial intelligence, but investigations seldom address the perspective of cognitive load theory in designing highly effective AI-integrated vocational English courses. The vast resources and instant feedback provided by artificial intelligence may occupy learners' limited working memory capacity. Vocational students, who generally have lower levels of metacognition, often experience cognitive overload when faced with large amounts of information delivered by artificial intelligence. This study introduces cognitive load theory as an analytical framework, focusing on maximizing learning efficiency within the constraints of working memory capacity. It systematically explores the design of efficient AI-integrated vocational English courses. Based on national educational plans, vocational English course standards, and cognitive load theory principles, the study first surveys students' learning situations to construct English learning profiles [1]. It then designs course objectives, content, teaching activities, and an assessment system, followed by a preliminary demonstration through case studies. The aim is to provide a theoretical foundation and practical approaches for improving higher vocational English courses, thereby minimizing unnecessary cognitive load caused by poor course design.

Cognitive load theory posits that the learning process involves internal cognitive load, external cognitive load, and germane cognitive load. Internal cognitive load arises from the inherent difficulty of the knowledge content, while external cognitive load results from inappropriate presentation or delivery methods, often due to poor instructional design. Both internal and external cognitive loads consume working memory capacity and, if excessive, can negatively impact learning outcomes. germane cognitive load refers to the cognitive resources allocated to schema construction, storage, monitoring of learning activities, and attention to learning strategies, playing a positive role in learning. Given the limited processing capacity of working memory, course design must aim to reduce internal and external cognitive loads while increasing germane cognitive load [2]. By maintaining the total cognitive load within the limits of working memory, learning efficiency can be enhanced.

Re-examining the learning challenges faced by vocational college students through the lens of cognitive load theory reveals an imbalance across the three types of load. Firstly, excessive internal load is evident, as vocational college students often have a weak foundation in English, with textbooks presenting new vocabulary and complex sentences that exceed their working memory capacity. Secondly, excessive external load occurs in traditional classrooms, where simultaneous audio playback, PowerPoint presentations, and oral explanations overwhelm students' working memory capacity needed for language processing [3]. Thirdly, vocational college students exhibit insufficient germane cognitive load, as they generally lack self-monitoring and strategic reflection during their studies.

The core objective of this study is to employ AI-integrated course design to manage lower-order cognitive processing, thereby freeing up working memory capacity for higher-order cognitive processing during face-to-face classroom interactions [4]. This approach aims to achieve the goal of reducing internal and external cognitive loads while enhancing germane cognitive load.

2. Instructional Design

2.1. Analysis of Student Profiles

The target students of this study are 12 classes of automotive-related majors in the 2025 intake at our institution. The teaching team utilized questionnaires and assessment tests to gather data on students' basic information, learning objectives, English proficiency levels, learning interests, and habits, thereby constructing a comprehensive student profile database (as shown in Figure 1). The percentages in the figure represent the proportion of students in each category [5].

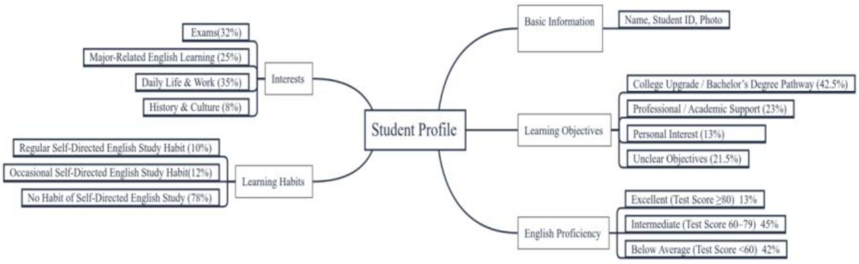

Figure 1. Student Profiles

From the perspective of cognitive load theory, the analysis indicates that 42.5% of students prioritize exam performance, suggesting their cognitive resources are primarily directed towards "passing exams" rather than "language use." Additionally, only 10% of students exhibit independent learning habits, highlighting a general lack of ability to effectively manage cognitive resources through metacognitive monitoring.

2.2. Development of an Intelligent Resource Repository

Firstly, in alignment with national and local policy requirements for higher vocational English courses, and considering the students' learning context, a question map was developed to address key queries such as "What to learn?", "How to learn?", and "What is the purpose?". This approach aims to resolve students' uncertainties about higher vocational English learning and assist them in setting clear and appropriate learning objectives. Secondly, the national vocational education textbook for the 14th Five-Year Plan, Practical English for the New Era, was selected to construct a knowledge map. Each unit of this textbook includes five sections: dialogues, reading, Chinese and foreign cultures, workplace English, and practical writing. The lesson types covered, in sequential order, are listening and speaking, intensive reading, cultural literacy, workplace English, and practical writing. Based on the tripartite teaching objectives of "value shaping," "knowledge transmission," and "skill development," this textbook provides robust theoretical and practical guidance. Thirdly, resource repositories were created for examination questions, automotive English, daily life and production, and historical and cultural English, tailored to students' learning objectives and interests [6]. This enables precise content delivery based on individual needs. Specifically, in accordance with national policy requirements for integrating vocational education with regional economic development, specialized resources—including English-language texts and videos—were developed to introduce the historical and cultural heritage, distinctive industries, and local customs of the region where the school is located. The teaching objectives of this course are formulated based on the "Standards for English Courses in Higher Vocational Education (Specialist Level) (2021 Edition)," encompassing four dimensions: workplace communication, cultural exchange, critical thinking, and independent learning.

2.3. Design of the Teaching Process

To evaluate the learning effectiveness of the "AI+" higher vocational English teaching model, which integrates traditional methods with artificial intelligence, against that of a purely traditional classroom teaching model and a purely AI-led teaching model, this study randomly divided students of automotive-related majors (12 classes) into three groups [7]. All groups received the same teaching content of higher vocational English. The traditional model group (4 classes) received only traditional face-to-face classroom instruction; the AI-only group (4 classes) received AI-only instruction; and the "AI+" model group combined traditional and AI approaches (the instructional process designs for the three groups are shown in Figures 2, 3, and 4, respectively) (As shown in Figure 2, 3, 4).

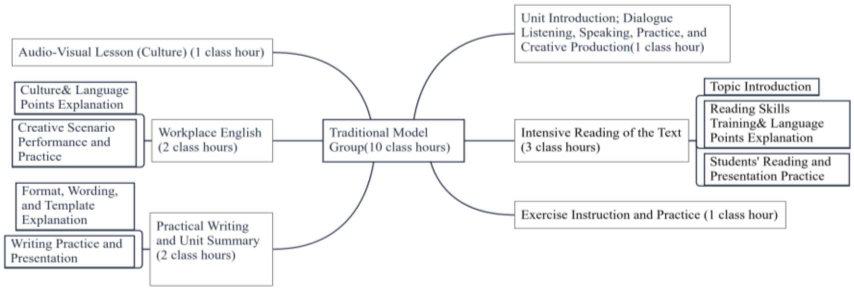

Figure 2. Design of the Traditional Face-to-face Teaching Model

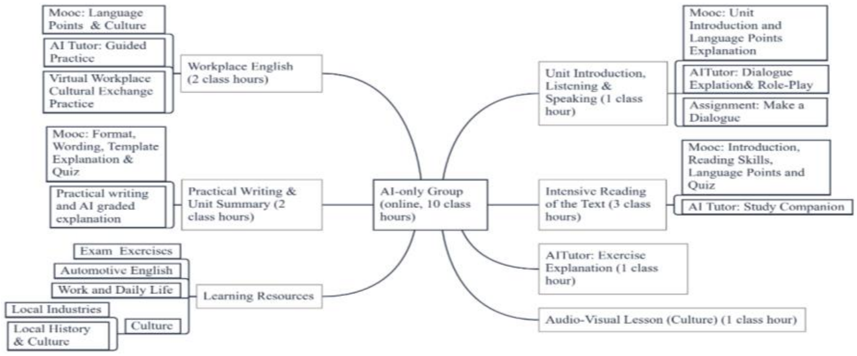

Figure 3. Design of the AI-only Teaching Model

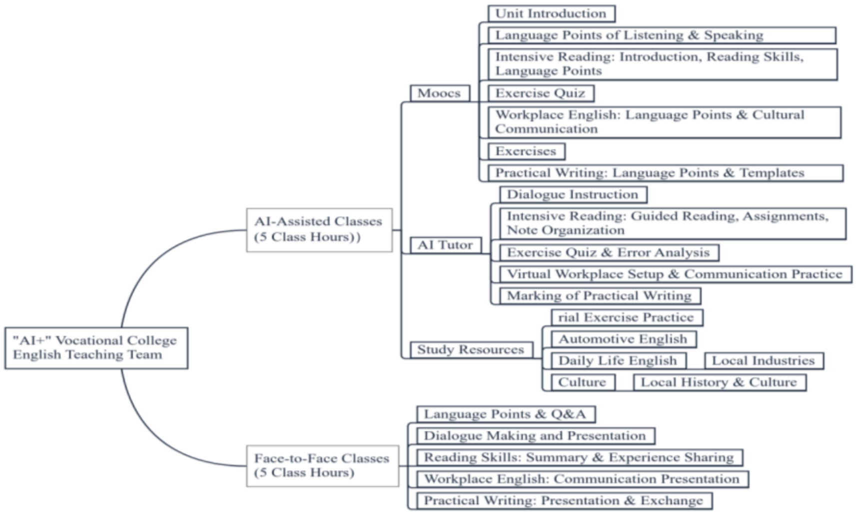

Figure 4. Design of the "AI+" Teaching Model

The "AI+" higher vocational English course designed in this study alternates between AI-assisted lessons and face-to-face classroom sessions. For each unit of the AI-assisted lessons, students must complete a knowledge graph MOOC, guided reading and listening with an AI teaching assistant, virtual workplace scenario-based communication, assessment of practical writing, and exercise tests, amounting to five teaching hours of learning tasks. The MOOC content includes an introduction to the unit theme, listening and speaking dialogues, reading techniques and close reading of texts, workplace English, and explanations of key linguistic points for practical writing. Each video is limited to 15 minutes and is accompanied by corresponding exercises to assess and consolidate students' learning outcomes. The face-to-face classroom sessions, also lasting five teaching hours per unit, consist of listening and speaking dialogue practice, Q&A sessions on linguistic points and the application of reading techniques, workplace English presentations, the presentation and critique of practical writing pieces, and a unit summary discussion. These face-to-face classes primarily focus on teacher-student interaction and the summarization of learning outcomes.

Researchers examined the three instructional designs from the perspective of cognitive load theory. In traditional classes, multiple information channels are presented simultaneously, which can result in excessive external load; a uniform pace for the entire class may lead to internal overload for students with weaker foundations; and a lack of metacognitive guidance can result in insufficient germane cognitive load. In AI-only classes (fully online), students can control their own pace, keeping internal load manageable; AI-powered real-time Q&A and automatic marking reduce external load. However, the absence of teacher guidance and peer interaction may lead students to adopt a "task-oriented" learning approach, resulting in insufficient activation of germane load, which is associated with the "learn and forget" phenomenon observed in interviews [8]. In "AI+" integrated learning classes (combining traditional and AI-assisted teaching), AI handles lower-level cognitive tasks such as explanations of words and phrases, freeing students' working memory capacity. Face-to-face classroom activities, such as teacher-student Q&A sessions and project presentations, shift attention toward strategic reflection and schema construction, thereby enhancing germane cognitive load and achieving a dynamic balance among these three types of load.

After all three groups of students completed the study of a unit, they took a learning effectiveness test based on the unit's content. The results indicated that students in the traditional classroom group performed better than those in the AI-only group, while students in the "AI+" group, which integrated traditional and AI approaches, performed significantly better than the other two groups [9].

2.4. Assessment Methods

Assessment integrates intelligent evaluation with teacher and student evaluation. Students' final scores are determined through a combination of formative and summative assessments [5]. Academic performance is primarily evaluated based on participation in MOOCs, completion of online assignments, classroom engagement, in-class activities, and end-of-term examinations. The intelligent assessment system collects data from students' online learning activities, including progress in knowledge graph content, accuracy in assignments and tests, frequency of practice in virtual environments, and participation in forum discussions. This data is used to conduct a multi-dimensional evaluation, generating assessment reports that visually present students' online learning progress and provide specific recommendations for teaching improvements. Traditional assessment methods employ a three-pronged evaluation mechanism involving self-assessment, peer assessment, and teacher assessment, with a focus on evaluating classroom engagement and in-class activities. Classroom engagement assesses students' understanding of the subject matter through interactive question-and-answer sessions between teachers and students. In-class activities are designed to reflect learning outcomes and are conducted alongside smart course and classroom teaching modules, emphasizing the application of new knowledge, critical thinking, and learning capabilities. These activities provide valuable opportunities for teachers to evaluate students' progress and for students to engage in collaborative learning. To ensure fairness and impartiality, teachers and students collaboratively develop marking criteria for classroom presentations, which include teacher and peer assessment forms.

The integration of intelligent assessment with traditional teacher-student evaluation offers a more accurate and equitable reflection of students' learning progress [10]. Additionally, it helps prevent an excessive focus on human-computer interaction, ensuring that human-to-human interaction remains a vital component of the learning process.

3. Teaching Implementation Case Study

Using Unit 1 Enjoy a New Journey from the Practical English for the New Era textbook as an example, this study illustrates the "AI+" teaching model designed for higher vocational English courses. The unit focuses on the theme of freshmen beginning university and starting a new chapter in their lives.

3.1. Unit Introduction (AI MOOC)

At the start of this "New Journey," students are guided by the teacher to film the college's landmark buildings and main teaching and activity venues on-site, learning the English terms for key facilities and various activities. This video-making activity integrates the practical application of English with campus culture, enabling students to immerse themselves in the university's cultural atmosphere while creating and viewing the videos. Simultaneously, it motivates students to establish new objectives for their academic journey. The online assignment involves a matching exercise that pairs the Chinese and English names of the campus's primary functional buildings [11]. This unit introduction merges English language learning with campus culture, encouraging students to apply English in practical, everyday contexts.

The use of short videos lasting 15 minutes or less, combined with immediate testing, aligns with the "segmentation principle" of cognitive load theory, which involves breaking new knowledge into smaller units to prevent overloading working memory. Additionally, filming on campus connects abstract vocabulary to real-world scenarios, thereby reducing the complexity of interactions among elements and minimizing cognitive load [12].

3.2. Listening and Speaking Lessons (AI + Offline)

Online MOOCs explain the vocabulary, phrases and common expressions used in dialogues, supplementing students' foundational knowledge. For words or phrases not covered by the teacher, students can click on the item in question; the AI teaching assistant will then search for authoritative definitions from major English-Chinese dictionaries and promptly provide them to the student. If students have queries regarding a particular topic, they may post questions on the discussion platform and contact the teacher for clarification. If the teacher is unable to provide an immediate answer, the AI teaching assistant will search for answers using advanced models and provide a preliminary response. If students find the AI's response unsatisfactory, the question will remain on the discussion platform pending the teacher's reply. After completing the MOOC module, students can practise dialogue with the AI teaching assistant, followed by a learning task in which they co-create a dialogue with a partner, record it and submit the recording.

In-person class: 1. Classroom questioning: The teacher asks a question in Chinese, and students provide the corresponding English expression; 2. Classroom role-play: Students work in pairs to act out scenarios of greetings and interactions on campus; the teacher and students assess and record the role-plays based on criteria such as linguistic accuracy, richness, fluency and authenticity of the scenario; 3. Classroom summary: Correct obvious errors in students' spoken expressions, select and commend students who have performed exceptionally well, and summarise commonly used relevant language expressions.

From "AI teaching assistant word lookup" to "creating dialogues with peers", and on to "classroom presentation and assessment", a "staged release" pathway for cognitive load is formed: the AI handles low-level processing (vocabulary definitions), freeing up working memory capacity for mid-level processing (dialogue creation), which ultimately flows into high-level processing (live presentation and metacognitive reflection) - with the germane cognitive load gradually increasing throughout this process [1].

3.3. Intensive Reading Lesson (AI + Face-to-Face)

The MOOC video introduces the text titled A Day for a College Student as a foundation to encourage students to describe their own daily routines, while explaining the chronological method, skimming techniques, and essential language points. Online assignments are designed to reinforce and apply the reading techniques covered in this lesson through exercises focused on reading comprehension, translation of key sentence patterns, and vocabulary application. While students explore the knowledge map for this lesson in the smart classroom, the system tracks each student's study duration for each section and the frequency of word lookups, adding the looked-up words and language points to the student's revision knowledge base. Upon completing the online exercises, students can review their results and understand the reasoning behind any errors with the assistance of the AI teaching tool [8].

During the face-to-face session, the teacher conducts a Q&A on key concepts to evaluate students' understanding of the language points and emphasizes the importance of valuing time and making the most of one's youth, aligning with the theme of the text. The classroom activity for this lesson involves students describing the most meaningful day of their university life in English and sharing their experiences with classmates.

AI is responsible for basic tasks such as explaining skimming techniques, presenting language points, and marking exercises, while the teacher in the classroom focuses on interactive activities, including Q&A on key concepts, guiding students, encouraging reflection, and facilitating the sharing of personal experiences [8]. This "human-machine division of labor" strategy reduces external cognitive load and, through face-to-face interaction, directs students' attention toward schema construction by linking reading skills to their own experiences, thereby enhancing germane cognitive load.

3.4. Business English (AI + In-Person)

MOOC videos provide explanations on titles and forms of address, greetings, self-introductions, and common expressions in both formal and informal contexts. Artificial intelligence is utilized to create virtual workplace scenarios, allowing students to immerse themselves in observing and practicing expressions for greetings and self-introductions during initial meetings in various settings.

In-person group activities involve dividing the class into groups of four. The teacher randomly distributes scenario cards to each group, featuring settings such as school campuses, job interviews, trade fairs, and companies [2, 5]. Students are tasked with performing classroom skits using the knowledge acquired in the lesson. They must create dialogue content based on the scenario, incorporating forms of address, greetings, and self-introductions. Students may recreate scenarios from the MOOC or use their creativity, thereby gaining experience in multicultural communication.

AI-generated virtual workplace scenarios make abstract rules regarding forms of address and greeting etiquette more tangible, thereby reducing cognitive load by minimizing interactivity between elements. The random distribution of scenario cards during in-person group activities enables students to transfer and apply their learning across different contexts. This varied practice is essential for promoting schema automation and serves as an effective strategy for enhancing cognitive load relevant to the task.

3.5. Practical Writing (AI + Offline)

The MOOC provides an overview of the purpose, structure, common phrases, and templates for CV writing. The online assignment involves matching common CV phrases in Chinese and English [12]. Offline, students are tasked with preparing Chinese and English CVs tailored to job requirements and their own qualifications for on-campus work-study positions, off-campus part-time roles, and real-world vacancies found online. During class, the teacher evaluates students' understanding of common CV phrases and key vocabulary by asking questions, while students present their CVs. Performance is assessed based on the accuracy and completeness of basic information, the effective use of key vocabulary to highlight strengths, and the creativity demonstrated in CV design.

To address the challenge of unclear learning objectives, students can be encouraged to reflect deeply on their future career plans by researching the competency requirements for various jobs and evaluating their own qualifications and abilities while drafting their CVs. This process enables them to define their academic goals more clearly and develop skills more effectively to meet future career demands.

AI offers structural templates, a library of common phrases, and exemplary models for CV writing, which collectively provide a cognitive framework for the task. By breaking down complex writing tasks into manageable sub-tasks, AI helps to control cognitive load effectively. When students search for real job vacancies and assess their own qualifications, they engage in metacognitive monitoring, establishing connections between the knowledge they have acquired and their personal career plans. This facilitates a transition from "learning English" to "using English" in practical contexts.

4. Survey on Teaching Outcomes

4.1. Course Satisfaction Questionnaire

A questionnaire was designed to survey students in the "AI+" vocational English teaching group regarding the "AI+" teaching model, learning outcomes, and conceptual development. The survey results, presented in Tables 1, 2, and 3, indicate that over 60 percent of the students believed the "AI+" vocational English teaching model supported independent learning, interactive communication, and the acquisition of additional English language knowledge. The creation of a virtual environment was found to increase students' willingness to express themselves and provide more opportunities for communication, leading to improved communication skills and heightened interest in learning. Overall, the majority of students expressed satisfaction with this teaching model (As shown in Table 1, 2).

Table 1. Survey Results on Learning Effectiveness of the "AI+" English Teaching Model in Higher Vocational Education (N=246)

Option	Subtotal	Percentage
Facilitates independent learning	155	63.01%
facilitate communication and interaction	180	73.17%
Facilitate the acquisition of English language knowledge	172	69.92%
Not conducive to learning	5	2.03%
No special feeling	34	13.82%

Table 2. Results of the Self-Assessment Survey on Learning Outcomes of the "AI+" Vocational English Teaching Model (N=246)

Option	Subtotal	Percentage
A more solid grasp of the fundamentals of the language	196	79.67%
Improved language communication skills	168	68.29%
Enhanced logical thinking skills in the language	137	55.69%
No noticeable improvement	23	9.35%

Interpreting the survey data through the lens of cognitive load theory: the high proportions of "facilitates independent learning" (63.01%) and "facilitates knowledge acquisition" (69.92%) in Table 1 suggest that AI effectively reduces external load by minimizing the cognitive effort required for information filtering. The highest proportion in Table 2 for "more solid understanding of basic language knowledge" (79.67%) indicates that internal load has been managed, as AI simplifies complex content into comprehensible units. Additionally, the figures in Table 2 for "improved communication skills" (68.29%) and "enhanced logical thinking" (55.69%), along with the figure in Table 3 for "increased interest in learning" (74.8%), demonstrate that germane cognitive loads have increased, as classroom interaction fosters schema construction. However, the fact that 46.75% of students "still do not enjoy learning," combined with feedback from interviews about "reliance on AI for answers," highlights the risk of dependency on cognitive offloading, which must be addressed in future instructional designs.

Table 3. The Impact of the "AI+" Vocational English Teaching Model on Students' Learning Attitudes (N=246)

Option	Subtotal	Percentage
Increased interest in learning	184	74.8%

Understands the importance of learning, but still does not enjoy it	115	46.75%
Helps to complete learning tasks	138	56.1%
No effect	27	10.98%

4.2. In-Depth Interviews

The interviews provided a comprehensive understanding of the teaching effectiveness of the "AI+" vocational English course. A group of 20 students participated in a round table discussion to express their reasons for satisfaction and dissatisfaction with the "AI+" vocational English teaching approach. The reasons for satisfaction included the flexibility of learning methods in AI-assisted classes, the ability of the AI teaching assistant to promptly address new and challenging vocabulary during study sessions, which significantly reduces cognitive load, and the smart teaching system's capability to provide immediate feedback on exercises while identifying and recording areas where students face difficulties [4]. Additionally, immersive virtual scenario exercises encouraged students to practice spoken English, greatly enhancing their motivation, and the inclusion of project-specific learning tasks facilitated more effective acquisition of course material. However, dissatisfaction stemmed from reduced teacher supervision due to increased immersion in AI-based classes, which led to a diminished sense of engagement. Furthermore, students developed a dependency on the system, often relying on the computer to think and solve problems for them.

5. Conclusion

The central finding of this study is that the high effectiveness of "AI+" vocational English courses depends on systematic instructional design grounded in cognitive load theory: minimizing intrinsic cognitive load through segmented AI MOOC delivery and real-time vocabulary support, reducing extraneous cognitive load by assigning lower-order processing to AI, and strengthening germane cognitive load through reflection and schema construction in face-to-face classes. The three controlled experiments confirmed this design logic. The AI-only group showed weaker performance because germane cognitive load was insufficient, whereas the traditional group was limited by excessive extraneous cognitive load. Only the blended group achieved a dynamic balance among the three types of cognitive load and produced the strongest academic outcomes. This finding also answers the question raised in the introduction regarding whether AI occupies limited working-memory capacity. The answer depends on instructional design: when AI supports lower-order cognitive processing, it releases working-memory resources; when it replaces students' own thinking, it can lead to dependence on cognitive offloading.

This study has several limitations, including the short experimental duration, the limited sample size, and the reliance on subjective rating scales. Future research may examine the integration of a "cognitive load threshold alert" function and further investigate how generative AI can be used to regulate intrinsic, extraneous, and germane cognitive load more effectively.

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