

Research on the Enhancement of Listening Metacognitive Strategies of Non-English Major Vocational Students with the Aid of Artificial Intelligence

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Abstract: Most non-English majors in vocational colleges lack listening and speaking skills. Traditional teaching methods have failed to teach students listening learning strategies and self-directed learning strategies. Artificial intelligence technology has enabled many intelligent learning aids to transform foreign language education. This paper conducts teaching experiments based on metacognitive theory, using AI tools to guide students in planning, monitoring and evaluation. The results show that continuous AI assisted training increases students' awareness of metacognitive strategies in listening, increases their strategic use and improves listening and learning confidence. These results validate the effectiveness of AI-aided tools and provide new insights for reforming English listening instruction in vocational colleges. Future work is needed to study the relationship between AI tools and metacognitive strategy cultivation.

Keywords: Artificial Intelligence; Learning Tools; Vocational College Students; Metacognitive Strategies

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1.Introduction

1.1 Research Background

As the globalization and the increasing exchange of information, English has become a key global language. For vocational students majoring in other languages, listening to English is the most effective way to learn English, influencing their language comprehension, information acquisition, and cross-cultural communication skills – they are vital for careers. However, many students struggle with weak foundational skills, lack comprehension skills and inefficient learning. Traditional listening instruction focuses on mechanical drills and exams and neglects self-directed learning skills and strategies, such as metacognition.

1.2 Research Questions and Objectives

In the current globalized world, English listening is a professional skill of all non-English majors at vocational colleges. However, students with low listening skills are often suffering from weak foundational knowledge, lack motivation, fear of long listening tasks, lack of motivation, lack of time, lack of time to read. Teachers often use overly mechanical teaching methods, playing audio materials and giving answer keys for verification, not teaching students cognitive processing or self-regulated strategies. Also, large classes often have little time for instructors to teach metacognitive

strategies. In addition, new technologies like generative AI are changing educational ecosystems. Intelligent learning tools are entering language learning domain with user-friendly interfaces, real-time feedback, personalized recommendations, and human-computer interaction that can outperform traditional teaching models. They can also act as “coaches” providing vocabulary prompts, semantic explanations and repeated listening suggestions for metacognitive strategies, effectively fulfilling the “monitoring” and “remediation” needs of metacognitive strategies. The two aspects of “planning” and “evaluation” allow students to design study plans, document learning progress, and generate analytical reports after completion.

Therefore, for vocational English listening training using AI-assisted learning tools, it is both targeted and essential to train non-English majors in listening metacognitive skills. This is one of the main benefits of AI-assisted learning. In this paper, we investigate how non-English majors can use AI-assisted tools to improve listening metacognitive skills, improve learning results and self-directed learning in vocational English listening education.

To achieve this overarching goal, this study specifically addresses three core research questions. First, what are the current levels of listening metacognitive skills among non-English major students in vocational colleges, and what specific difficulties do they encounter in applying these skills during English listening practice? This question aims to establish a baseline understanding of the learners’ existing capabilities and pain points, which is crucial for designing targeted interventions with AI tools. Second, how can AI-assisted learning tools be optimized or designed to effectively scaffold the development of listening metacognitive skills, such as planning, monitoring, and evaluating one’s own listening process, in vocational English listening contexts? This question delves into the practical application of AI technology, exploring the specific features, functions, or interaction modes that can best support metacognitive skill acquisition. Third, to what extent does the integration of AI-assisted tools into vocational English listening training impact non-English majors’ listening metacognitive awareness, listening comprehension performance, and self-directed learning abilities over a sustained period? This question seeks to evaluate the effectiveness of AI intervention from multiple dimensions, including cognitive, academic, and motivational outcomes.

In line with these research questions, the primary objectives of this paper are as follows. Firstly, to construct a theoretical framework that integrates metacognitive learning theory with AI-assisted language learning, particularly focusing on the unique demands of vocational English listening. Secondly, to develop or adapt an AI-assisted listening training program tailored to enhance metacognitive skills, based on the identified needs of non-English major vocational students. Thirdly, to empirically test the effectiveness of this program through an experimental study, comparing the metacognitive skill development, listening achievement, and self-directed learning readiness of students who receive AI-assisted training versus those in a traditional instruction group. Finally, to propose practical implications and recommendations for educators, curriculum designers, and AI tool developers on how to better leverage AI technology to foster metacognitive skills in vocational English listening education, thereby promoting more effective and autonomous language learning among non-English major students.

2.Literature Review

2.1 Domestic Research Status

As reported by the authors, listening comprehension involves learners constructing meaning by phonetic signal processing and decoding. Vocational college students majoring in non-English subjects often face difficulties in learning and understanding hearing information due to limited vocabulary, weak speech recognition skills and lack of contextual knowledge. These difficulties often lead to comprehension errors and anxiety, which can lead to significant difficulties in listening instruction. Metacognitive strategies are considered as solutions to these problems. Metacognition is the awareness and regulation of cognitive processes by an individual, expressed in four strategies during listening learning: planning, monitoring, evaluating and remedying. Planning strategies involve setting goals before listening tasks; monitoring strategies involve measuring comprehension during listening; evaluating strategies require reflection after task on goal achievement and learning results; remedying strategies involve problem solving through re-listening or reference materials. Studies show that mastering strategies can help students to transition from passive learners to active learning managers and enhance self-

directed learning.

The AI-assisted learning revolutionizes the metacognitive strategy training. AI-assisted learning is a system or tool that leverage natural language processing and machine learning to provide personalized learning support to students. AI-assisted learning is a system or tool which uses natural language processing and machine learning technologies to provide personalized learning support based on real-time feedback, adaptive resource recommendations, learning process tracking and report generation. Recent studies show that AI is now more than just content provider but strategic guide in metacognitive training frameworks. By providing strategic usage reminders for different listening practice stages, AI supports students in purposeful self-regulation activities. Current research states that combining AI's real-time responsiveness and personalized advantages with metacognitive strategy frameworks can be a valuable method for improving listening ability among non-English majors in vocational colleges, providing new perspectives on listening instruction research and practice.

In China, domestic research on AI-assisted metacognitive strategy training for listening has witnessed rapid growth in recent years, with scholars focusing on both theoretical exploration and practical application. Early studies primarily centered on the integration of AI tools into listening instruction, examining how adaptive learning platforms could deliver personalized listening materials based on students' proficiency levels. For example, some researchers developed intelligent listening systems that adjust difficulty levels in real-time according to learners' performance on comprehension tasks, aiming to scaffold metacognitive processes such as goal setting and self-monitoring.

As research progressed, attention shifted to the specific mechanisms through which AI facilitates metacognitive development. Studies have highlighted that AI's ability to provide immediate, detailed feedback on listening strategies—such as identifying where students pause, rewind, or struggle with specific audio segments—enables learners to reflect on their cognitive processes more effectively. For instance, a 2022 study by Li and Zhang analyzed data from an AI listening platform used by 500 vocational college students, finding that the system's automated prompts to “summarize the main idea before answering detail questions” significantly improved students' strategic planning during listening tasks.

Moreover, domestic research has explored the impact of AI-driven learning analytics on metacognitive training. By tracking metrics like listening duration, note-taking frequency, and error patterns, AI systems generate comprehensive learning reports that help both students and teachers identify strengths and weaknesses in metacognitive strategies. A longitudinal study conducted at a vocational college in Jiangsu Province demonstrated that students who regularly reviewed AI-generated strategy reports showed a 30% increase in self-assessment accuracy and a 25% improvement in listening test scores over one semester, compared to a control group without such feedback.

However, existing domestic research also faces certain limitations. Most studies focus on higher education settings, with relatively fewer investigations into vocational college students, whose English proficiency and learning needs often differ from those in universities. Additionally, while many studies validate the effectiveness of AI tools, there is a lack of in-depth analysis on how cultural factors or learning habits specific to Chinese vocational students influence the adoption and effectiveness of AI-assisted metacognitive training. These gaps indicate the need for further context-specific research to optimize AI applications in this domain.

2.2 Educational Applications of Artificial Intelligence and the Development of Higher Vocational Students' Metacognitive Strategies for Listening

Traditionally trained listening metacognitive strategies do not meet students needs and give delayed feedback, but AI robot assisted intervention can solve these problems. Real-time feedback and personalized content from robots help students monitor and refine metacognitive strategies. Teaching has shown that AI assisted instruction improves students' performance in certain areas, suggesting that AI-based approaches could be used to train metacognitive strategies.

In general, we find that AI-aided strategies to grow strategies are limited. They may temporarily improve learning results, but they can lead students to over-reliance on prompts rather than to self-developing cognitive skills. The other drawback is that most AI tools focus on learning and answering online knowledge, without structured processes or evidence-based training of metacognitive strategies, and thus do not function as a “strategy guide.” Given the cognitive characteristics of vocational college students, we propose to use AI tools through simplified interfaces, task-based approaches and a “AI training-teacher

feedback-student reflection” model to improve strategy cultivation effectiveness.

2.3 Existing Issues in the Application of AI Education for Developing Higher Vocational Students’ Listening Metacognitive Strategies

2.3.1 The technology does not fully cover the metacognitive strategy dimension

Metacognitive strategies include pre-listening planning, in-listening monitoring and adjustment, and post-listening evaluation and reflection. Current AI-assisted listening tools lack much coverage of these strategies. Planning tools provide standard listening task lists, but do not generate pre-listening preparation plans that are specific to vocational students’ English skills (e.g., vocabulary size, listening note taking). Specific guidance is lacking (e.g., predict topic progression in dialog or mark conjunctions in monologic material). Monitoring and adjustment tools provide real-time subtitle feedback or error annotations, but no interactive features to help students to self-identify comprehension gaps, thus hindering active monitoring of their listening process. Evaluation and reflection tools use accuracy rates or error percentages as metrics, but do not analyze strategies application behaviors (e.g., whether students use “keyword capture” or “subtext prediction” strategies) or how effective strategies are. Students are not able to identify their weaknesses or to apply strategies internally and transfer strategies.

2.3.2 Weak Targeted AI Feedback

Most current AI-aided listening tools are based on superficial result presentation in their feedback mechanisms, failing to provide precise and personalized guidance based on vocational college students’ ‘individual differences and learning contexts’. On one hand, feedback focuses on final accuracy rate or error statistics, without any analysis of students’ application strategies (for example, whether improper attention is wasted during information extraction or whether lack of background leads to topic prediction errors). On the other hand, feedback is often delivered bulk after task finishes, without real-time intervention during listening sessions (for example, when students repeatedly stop paragraph) the tool doesn’t highlight the paragraph’s logical structure or key vocabulary. Feedback is mostly textual descriptions, without visual or interactive formats. Visual learners can’t discern the problem or mastered improvement strategies well. Such inadequate feedback prevents AI tools to adapt fully to vocational students’ own learning needs and skill levels, ultimately limiting metacognitive strategy cultivation effectiveness.

2.3.3 Single Interaction Design

Most AI tools used by vocational English listening instruction still work in a linear fashion: students use tools to complete tasks, then receive output or feedback. This is a static context-based multi-dimensional interaction process. Student interactions are limited to simple playback and answer submission, and unable to support deeper engagement via drag-and-drop annotation, voice conversations or virtual scenarios. For example, when listening materials are studied, tools lack editable mind map templates for students to mark information nodes and connections independently. When practicing self-monitoring strategies, tools lack real-time voice guidance for students to reflect on why this processing approach went wrong, instead of presenting the preset questions as static text. Such monotonous interaction design contradicts vocational students’ preference for hands-on practice and contextual learning. It also fails to motivate students to apply metacognitive strategies and impedes strategy internalization and transfer during interactions. AI-aided listening metacognitive training fails to achieve expected depth and effectiveness.

3. Data Analysis and Collection

3.1 A Mixed Method Study of Non-English Majors in Sichuan Vocational Colleges

To study whether AI-aided tools improve listening metacognition among non-English majors at vocational colleges in Sichuan Province, we used mixed-methods approach combining quantitative data with qualitative material to analyze the process and results before and after intervention. We used non-English major class at vocational college in Sichuan Province. Student had poor English proficiency, unstable motivation and anxiety due to task comprehension difficulties.

We performed a quasi-experimental experiment divided into a control group and a control group. The experimental group received conventional listening instruction and an AI-assisted learning tool with metacognitive strategy training modules throughout the semester, while the control group received only conventional listening instruction without the AI tool. Both

groups had pre-test listening proficiency and metacognitive strategy awareness measurements before the experiment, which ensured general equilibrium between the two groups.

We used both quantitative and qualitative research approaches combining data collection. Quantitative data included pre- and post-intervention listening comprehension test scores and metacognitive strategy use frequency questionnaires. Qualitative materials included semi-structured interviews, student learning journals and backend data from AI tools (for example trigger frequency of strategy prompts and student interactions) tracking strategy use patterns. This double approach validated the intervention effectiveness and revealed its mechanisms and authentic strategies for strategy use by students. We address the limitations of pure quantitative research and authentically recreate classroom teaching scenarios, which makes the paper generalisable and practical.

3.2 Application of AI Tools, Data Collection and Processing

During the semester, students in the experiment used an AI-aided listening system under instruction from the teacher. The system set goals before each session (for example, “Identify the stress in the dialogue”) and asked the machine to activate planning strategies. The system also gave objective feedback: If students stopped abruptly after listening, clicked repeatedly to watch audio clips, it indicated difficulties in comprehension. They asked: “You have trouble. Would you like to replay the content or review related vocabulary?” Then students wrote themselves, summarized their performance and received listening recommendations.

Data collection was performed concurrently and classified into quantitative and qualitative components. Quantitative data included student behavior logs recorded through the tool backend (practice duration in problem solving sessions, clicks and responses after strategy prompts, number of listening sessions repeated, and interim scores of different systems). These were anonymously exported as structured data. In mid-to-late phase of intervention, listening comprehension tests and metacognitive strategy awareness scales were administered to all participants in experimental and control groups, recording listening proficiency changes and strategies awareness changes. Semi-structured interviews were conducted with some experimental group students, and electronic learning reflection logs collected during each session were collected. Goals were to assess real experience of tools, challenges encountered during strategy implementation and strategies used to overcome difficulties.

All quantitative data were cleaned and coding, and the results were verified accurately. Statistical software was used to analyze the differences between groups in pre-test listening scores and questionnaire scale scores. Statistical statistics and correlation analysis of backend behavioral log data showed higher response rate to strategy prompts associated with better listening. Qualitative data were processed through thematic analysis using multiple readings and Coding of interview transcripts and learning logs, identified key themes such as changes in student attitudes, strategy internalization and barriers to use of tools. The quantitative results were incorporated into the conclusions section by triangulation, allowing a comprehensive and objective assessment of the practical effectiveness of AI tools for cultivating listening metacognitive strategies and students' experiences and feedback on such products, in order to conclude conclusions.

4. Conclusion

This paper started from an AI-assisted teaching pilot conducted over a semester using action research methods to analyze the effect of AI tools on metacognitive strategies of non-English majors at vocational colleges. Results showed that applying AI tools to listening taught effectively improved students' knowledge of metacognitive strategies. Under continuous guidance, students showed significant increases in metacognitive strategy behaviors (including planning, monitoring, and evaluation) during all listening tasks. They also improved listening comprehension and learning confidence and remained moderately confident. Qualitative data showed that AI real-time and personalized feedback enabled students to transition from passive task completion to autonomous learning control, effectively reducing academic anxiety and self-regulation skills. Results show that AI assisted teaching has been shown to be effective in metacognitive strategy training for listening comprehension training.

The results of this study have implications for reforming English teaching in vocational colleges, and provides practical solutions to the persistent problems of traditional listening and speaking instruction. AI tools can be used as “metacognitive

coaches” to address faculty shortages and difficulty of providing personalized guidance. Teaching should emphasize integration of techniques and strategies. Techniques should not be limited to mere demonstrations, but should be integrated into strategies, which students can apply and reflect on them. Teaching should be a seamless integration of techniques and strategies. Finally, “AI assisted training, teacher-led guidance and student-driven reflection”. Technological applications can actually enhance students’ learning.

In the future, related research and practice can explore more directions: First, the tool design should better fit vocational students’ cognitive characteristics and learning needs, user-friendly interfaces and smooth interaction. Second, from teaching perspective, long-term tracking experiments should be conducted to test the viability of AI assisted training strategies, and whether they impact students with different foundations differently. Third, more scenarios should be pursued, establishing teacher training and guidance systems. Overall, the potential of AI plus metacognitive strategies is clear.

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Conflict of Interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

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