Research on a Metaverse-Based English Teaching Model for Rail Transit Majors

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Abstract. With the internationalization of China's rail transit industry, there is an urgent demand for professionals who possess both solid technical expertise and specialized English communication competence. This study proposes a metaverse-based English teaching model for rail transit majors guided by Outcome-Based Education (OBE). By integrating artificial intelligence (AI), extended reality (XR) technologies, and authentic industry tasks, the model reconstructs the curriculum system, instructional procedures, and evaluation framework. A competency-oriented structure and an intelligent, multi-dimensional assessment mechanism are established to enhance learners' practical communication ability and cross-cultural competence. The proposed model offers a scalable and replicable approach for cultivating interdisciplinary rail transit talents with international competitiveness.

Keywords: Metaverse; English for Specific Purposes; Teaching Model; Rail Transit English

1 Introduction

In the context of China's ambitious goal to build a "Strong Transport Nation," the rail transit industry is rapidly advancing toward internationalization. Rail transit equipment exports, overseas project contracting, and international collaborative research have shown steady growth in recent years. However, during the implementation of international projects, the industry continues to face prominent challenges, particularly insufficient foreign language communication skills, limited international cooperation capacity, and weak cross-cultural communication competence. These problems are especially evident in key scenarios such as technical briefings, safety instructions, project coordination, and cross-cultural negotiations. The shortage of interdisciplinary professionals who are proficient in both rail transit technologies and foreign languages has become a major constraint on the sustainable development of the industry.

Therefore, establishing an "intelligent + specialized" foreign language talent cultivation model for rail transit is essential for addressing this gap and providing high-quality human resources to support the national transport strategy. This initiative carries significant strategic value and practical relevance.

C. F. Peng et al. (eds.), *Proceedings of the 2026 5th International Conference on Humanities, Wisdom Education and Service Management (HWESM 2026)*, Advances in Social Science, Education and Humanities Research 1024,
https://doi.org/10.2991/978-2-38476-593-5_11

The College English Teaching Guidelines (2020 Edition) [1] advocate the construction of an integrated curriculum framework encompassing "EGP–ESP–Cross-Cultural Communication Competence," highlighting the importance of English for Specific Purposes (ESP). Focusing on rail transit professional English, this study incorporates authentic industry cases and international engineering contexts. Through intelligent technologies, the curriculum content, teaching methods, and evaluation systems are systematically redesigned to form an interdisciplinary and integrated talent cultivation model.

2 Literature Review

2.1 Concept of the Metaverse

In recent years, China has attached increasing importance to educational digitalization and smart teaching. The Action Plan for Education Informatization 2.0 (2018) [2] emphasizes deep integration of artificial intelligence, virtual reality, and big data with education, while the Digital Education Strategic Action (2022) [3] calls for the construction of intelligent learning environments and the sharing of digital resources. Although research on metaverse-enabled professional foreign language teaching has progressed both domestically and internationally, notable limitations remain.

Internationally, Stanford University's International Engineering Negotiation VR Training System and the EU's Erasmus+ Virtual Exchange project have demonstrated that XR technologies significantly enhance cross-cultural communication efficiency and sensitivity. In contrast, practices in Germany and Japan have mainly focused on AI-assisted terminology learning or single-skill VR training, often lacking systematic curriculum integration. In China, initiatives such as the High-Speed Rail Cockpit English AR System have achieved positive outcomes, yet challenges related to immersion depth and curricular alignment persist.

2.2 English for Specific Purposes (ESP)

ESP research originated in the early 1980s and has developed for over four decades. ESP refers to English designed for specific professional or disciplinary contexts and is commonly categorized into English for Occupational Purposes (EOP) and English for Academic Purposes (EAP). Distinct from General English, ESP integrates language learning with professional knowledge acquisition. Strevens [4] identified four absolute characteristics—needs orientation, disciplinary relevance, focus on language use, and contrast with General English—and two variable characteristics concerning skill focus and teaching methods. These principles underscore that ESP instruction should be learner-centered, needs-driven, and context-specific.

2.3 Outcome-Based Education (OBE)

Outcome-Based Education (OBE) is an educational approach driven by clearly defined learning outcomes. It emphasizes competence development, respects individual differences, and relies on continuous feedback to improve instructional design. Blended teaching models based on OBE encourage learner motivation, personalized learning, and skill cultivation. Interactive strategies such as problem-based learning further promote critical thinking and deep learning.

The Outcome-Based Education (OBE) philosophy emphasizes determining teaching objectives and instructional methods based on students' learning outcomes [5]. In the reform of ESP teaching in application-oriented undergraduate institutions, accurately aligning talent cultivation objectives with the OBE philosophy is of critical importance for improving the quality of ESP instruction and meeting social and industrial demands. Under the OBE framework, curriculum design follows a backward design approach, in which instructional planning starts from the ultimate learning outcomes and proceeds downward [6].

When formulating ESP teaching objectives, it is first necessary to decompose the overall talent cultivation objectives, namely graduation requirements, into specific outcome indicators that define the competencies and qualities students are expected to achieve upon graduation. Second, the alignment between ESP courses and these graduation requirement indicators should be systematically clarified. Finally, these indicators should be transformed into concrete teaching objectives that are specific, measurable, achievable, relevant, and time-bound (SMART) [7].

Throughout this process, continuous evaluation and adjustment are essential to ensure that teaching objectives precisely correspond to talent cultivation goals. By identifying problems and shortcomings in the teaching process in a timely manner, instructional objectives can be refined and optimized, thereby enhancing teaching effectiveness and talent development outcomes. In summary, determining teaching objectives based on the OBE philosophy is a key pathway for achieving precise alignment between ESP courses and talent cultivation goals. Guided by OBE, learning outcomes serve as the central thread throughout the entire ESP teaching process, ensuring that instructional activities consistently focus on the development of students' competencies and thus maximize educational effectiveness.

3 Construction of a Smart Teaching Model for Rail Transit English

3.1 Teaching Design

Smart teaching leverages next-generation artificial intelligence technologies to optimize instructional pathways and provide personalized learning support. The AI-assisted dual-instructor model enables collaboration among teachers, students, and intelligent systems to facilitate precise and efficient learning.

This model comprises three interconnected stages: intelligent learning diagnosis, human–machine assisted learning, and precision-based assessment. These stages collectively form a closed-loop teaching process spanning pre-class, in-class, and post-class learning, allowing for continuous instructional refinement. Human–machine collaboration serves as the foundation of smart teaching, ensuring intelligent, scientific, and personalized instruction.

3.2 Teaching Procedures

Stage One: Intelligent Learning Diagnosis.
AI-driven platforms generate learning analytics reports to support personalized diagnostic feedback. Teachers design flexible teaching plans accordingly.

Topic Activation: Students engage in virtual learning scenarios to activate prior knowledge.

Self-Directed Assessment: AI provides adaptive pre-learning tools with instant feedback.

Output-Driven Learning: Students produce oral and written outputs based on professional rail transit contexts.

Stage Two: Human–Machine Assisted Learning.
Based on the learning diagnostics, teachers collaborate with AI systems to design classroom tasks of varying difficulty levels for students at different proficiency levels, forming a progressive task chain. Within the same instructional time frame, students of different levels engage in parallel, multi-threaded learning under the same thematic framework.

Virtual Scenario Introduction.
Students enter immersive learning environments through virtual laboratories on smart platforms or wearable intelligent devices, enabling immediate situational immersion and fostering an engaging and authentic learning atmosphere.

Multi-Level Task Demonstration.
Based on AI-generated learning reports from pre-class preparation, task demonstrations at multiple difficulty levels are provided. In multi-threaded parallel learning scenarios, learners encounter diverse challenges, and ESP teachers collaborate with AI systems to deliver targeted guidance.

Multi-Threaded Task Expression.
AI provides learning analytics reports based on students' pre-class preparation and output-driven tasks. ESP teachers conduct flexible grouping according to the principle of inter-group heterogeneity and intra-group homogeneity, assigning differentiated task scenarios and difficulty levels under the same topic to different groups.

Targeted Summary and Feedback.

ESP teachers utilize visualized data on task completion rates and accuracy generated by AI to reinforce key and difficult learning points through focused explanation and feedback.

Stage Three: Precision-Based Assessment.

The precision-based assessment stage aims to construct learner profiles using big data technologies and deliver data-driven evaluation and feedback. AI records learners' full learning trajectories and performs edge computing on assignments and tests to enable real-time data analysis and feedback.

Personalized Assignment Delivery.

Objective items receive instant automated feedback and reference answers from AI systems, while subjective tasks require personalized guidance and feedback from ESP teachers.

Multi-Dimensional Comprehensive Evaluation.

By leveraging 5G, virtual reality, and big data technologies, more objective and diversified evaluations are achieved, including teacher evaluation, self-evaluation, and peer evaluation. Unlike traditional score-based assessment, the smart platform supports multiple evaluation formats such as text and voice-based ratings. Students complete self-assessment and peer assessment using four-dimensional rubrics covering pre-class preparation, teacher–student interaction, peer interaction, and task performance.

4 Conclusion

This study proposes a metaverse-based smart teaching model for Rail Transit English guided by Outcome-Based Education (OBE). By integrating artificial intelligence, extended reality technologies, and ESP pedagogy, the model reconstructs instructional design, teaching procedures, and assessment mechanisms around clearly defined learning outcomes and industry-oriented competencies. Through a three-stage closed-loop process of intelligent diagnosis, human–machine collaborative learning, and data-driven evaluation, the model effectively links pre-class preparation, in-class practice, and post-class reflection.

By emphasizing authentic professional tasks and immersive learning scenarios, the model enhances students' ability to apply English in real rail transit contexts, including technical communication, safety briefings, and cross-cultural collaboration. Moreover, the intelligent and multi-dimensional assessment system ensures the observability, measurability, and traceability of learning outcomes, supporting continuous course improvement.

Overall, this teaching model promotes deep integration between industry and education, strengthens students' autonomous learning, practical communication, and critical thinking abilities, and provides a scalable and replicable pathway for cultivating interdisciplinary rail transit professionals with strong international competitiveness.

Acknowledgments

This study was supported by the Ministry of Education Industry–University Cooperative Education Project, titled "Exploration of Intelligent Teaching Practices for Rail Transit Foreign Languages Based on Artificial Intelligence" (Grant No. 250702690182202).

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