

# Research on Interactive Teaching System and Method Based on Augmented Reality

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**Abstract:** This study provides an interactive teaching system and method based on augmented reality, belonging to the field of educational technology. The interactive teaching system and method based on augmented reality feature an interactive teaching system that includes a core processing module, a content creation and management module, a user interaction module, a data analysis and evaluation module, and a technical support and maintenance module. The learning behavior analysis unit tracks learning paths and interactive data, the effectiveness evaluation unit uses big data analysis to evaluate learning outcomes and the effectiveness of teaching strategies, the personalized recommendation unit recommends resources or adjusts paths based on student performance, utilizes deep learning prediction models for multidimensional learning effectiveness evaluation, provides real-time feedback, guides adjustments to teaching strategies, offers remote diagnostics, automatic updates, and fault prevention, adopts predictive maintenance strategies to reduce downtime, operates a 24/7 customer service system to instantly resolve technical issues, ensuring teaching activities are not disrupted.

**Keywords:** Augmented Reality, Core Processing Module, Tracking Paths

## 1. Research Background

The research on interactive teaching systems and methods based on augmented reality (AR) represents an innovative achievement in the field of educational technology. It aims to address issues such as insufficient interactivity, limited personalized learning resources, and a lack of diverse teaching evaluation methods in traditional teaching models. Despite the widespread use of multimedia and network technologies in traditional teaching, they often fail to fully leverage the potential of modern technologies, especially the unique advantages of augmented reality technology in creating immersive learning experiences.

Existing teaching methods often lack sufficient interactivity and immersion, failing to fully engage students' attention. Through AR-based technologies, students can seamlessly interact between virtual content and the real environment, enhancing the fun and engagement of learning. By recognizing various input methods such as touch, gestures, and voice, combined with visual and auditory feedback, further interactivity is enhanced. Adaptive interfaces ensure compatibility with different devices and user needs.

Therefore, the aforementioned technological challenges necessitate the design of interactive teaching systems and methods based on augmented reality.

## 2. Research Content

The purpose of this study is to provide an interactive teaching system and method based on augmented reality (AR) to address the lack of interactivity and immersion in current teaching methods. These methods often fail to sufficiently engage students' attention. Through AR technology, students can seamlessly interact between virtual content and the real environment, enhancing the interest and engagement in learning.

To achieve this goal, the study proposes the following technical solutions: An interactive teaching system and method based on augmented reality, including **core processing module, content creation**



**and management module, user interaction module, data analysis and evaluation module, and technical support and maintenance module.**

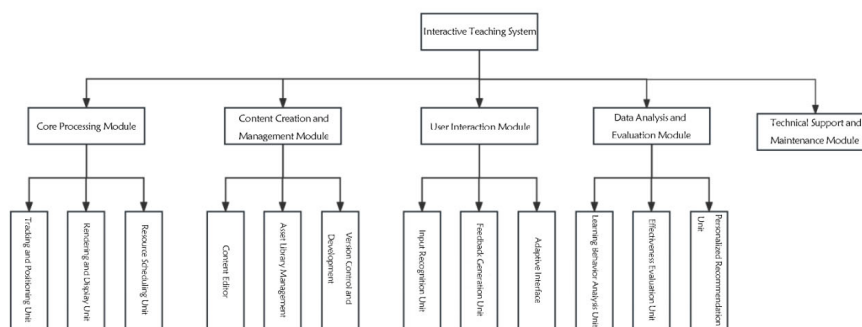
As a preferred solution in this study, the core processing module is responsible for data processing, logical operations, and resource scheduling of the entire teaching module, serving as the central hub connecting various modules. The content creation and management module support teachers or content developers in designing, editing, uploading, and managing AR teaching content. The user interaction module includes user interface design and interaction logic to ensure smooth interaction between students and teachers with virtual content. The data analysis and evaluation module collect learning data, conduct performance analysis, and provide the basis for evaluating teaching effectiveness and personalized learning. The technical support and maintenance module ensure the normal operation of software and hardware, including updates, troubleshooting, and technical support.

**The core processing module** includes the tracking and positioning unit, which achieves precise AR content positioning through technologies like SLAM and image recognition. The rendering and display unit is responsible for the three-dimensional modeling of virtual content, texture mapping, and the integration display with the real environment. The resource scheduling unit optimizes system resource allocation to ensure a smooth user experience.

**The content creation and management module** consist of a content editor with a user-friendly interface for designing AR teaching materials. It also includes a material library for storing and categorizing 3D models, images, audio, video, and other resources needed for teaching. The version control and publishing management allow for content versioning and support one-click publishing to the teaching platform.

**The user interaction module** comprises an input recognition unit that identifies user inputs such as touch, gestures, and voice. The feedback generation unit provides visual and auditory feedback based on user operations to enhance interactivity. The adaptive interface automatically adjusts the interface layout and content to adapt to different devices and user needs.

**The data analysis and evaluation module** include a learning behavior analysis unit that tracks learning paths, time spent, interaction frequency, and other data. The effectiveness evaluation unit assesses learning outcomes and the effectiveness of teaching strategies based on data analysis. The personalized recommendation unit recommends suitable learning resources or adjusts learning paths based on student performance. As shown in Figure 1.



**Figure 1.** Interactive Teaching System and Method Based on Augmented Reality

In this implementation, the core processing module deepens the core process of the module, which is not limited to basic data processing and resource scheduling. It also involves advanced algorithm optimization and intelligent decision-making. It adopts a distributed computing architecture to ensure high concurrency processing capabilities. Even in scenarios where a large number of users are online simultaneously, the system can maintain stable operation. The core processing module embeds a sophisticated event-driven system that can respond in real-time to requests from other modules. For

example, it can quickly process new educational resources uploaded by the content creation module or dynamically adjust teaching content delivery strategies based on feedback from the data analysis module. Additionally, the module implements strict permission management and security mechanisms to protect sensitive data, prevent unauthorized access, and operations. The content creation and management module enhances flexibility and efficiency by utilizing advanced cloud-native technologies. This allows content creators to log in and continue working on any device, enabling seamless content editing and version control. The module integrates an intelligent recommendation engine to suggest suitable 3D models, animation materials, or interactive templates to teachers based on teaching objectives, student age groups, and learning progress. It also introduces AI-assisted design functions such as automatic scene layout optimization and object collision detection to reduce manual adjustments and enhance the quality and realism of content production. The user interaction module not only focuses on basic UI/UX design but also delves into ergonomic and cognitive psychology principles to design interfaces that align with natural human interaction habits. It leverages machine learning techniques to learn from user interaction behavior, gradually optimizing feedback prompts and operational logic to achieve personalized interaction.

For instance, the system can anticipate a student's next likely actions based on their historical interactions, preload relevant resources, and reduce waiting times. Additionally, it includes accessibility features to ensure that students with disabilities can equally benefit from AR teaching advantages. The data analysis and evaluation module employs deep learning algorithms to analyze unstructured data during the learning process, such as changes in student expressions and speech tones. It combines traditional learning performance metrics to generate multidimensional learning effectiveness assessment reports. The module incorporates predictive models to forecast students' future learning performance based on their learning trajectories, providing intervention suggestions to teachers. It also supports real-time data analysis, allowing teachers to instantly access student learning feedback in class, adjust teaching strategies flexibly, and achieve efficient teaching cycles of "teaching while evaluating and improving." The technical support and maintenance module emphasizes proactive maintenance and intelligent services. It utilizes IoT technology and remote monitoring systems to continuously monitor hardware status in the educational environment. Upon detecting anomalies, it triggers immediate alerts and maintenance arrangements to prevent faults from affecting the teaching process. The maintenance team can use AR remote assistance technology to guide on-site personnel in equipment repairs, significantly reducing fault response times. On the software side, automated testing and continuous integration/continuous deployment (CI/CD) processes are implemented to ensure smooth transitions with each update without impacting user experience. Furthermore, a user feedback mechanism is established to continuously gather user opinions as a crucial basis for product iteration and optimization.

### **3. The beneficial effects of this research compared to existing technologies are multifaceted.**

(1) In this study, teachers or content developers can design AR teaching materials using a content editor with drag-and-drop operations and visual programming tools, enabling the creation of interactive course content without the need for deep programming knowledge. The material library management module categorizes and stores various teaching resources, supporting AI-assisted automatic tagging for quick retrieval and reuse. After editing, content iterations are managed through a version control system and can be easily published to the teaching platform. Copyright management and audit mechanisms ensure the legality of the content. The system utilizes cloud computing and edge computing to process real-time data from sensors. It employs SLAM and VIO technologies for precise AR content positioning, while deep learning enhances image recognition to ensure accurate integration of content with the environment. Rendering and display units use PBR technology to simulate realistic lighting effects, achieving a natural blend of virtual and real elements. Parallax correction algorithms optimize the visual experience, and resource scheduling units dynamically adjust resources using machine learning algorithms to ensure a smooth experience. The input recognition unit captures user inputs such as touch, gestures, and voice, while the feedback generation

unit provides rich audiovisual feedback based on interactions to enhance the interactive experience. The adaptive interface automatically adjusts to different devices and user needs, including accessibility design to ensure educational equity. Emotion recognition technology adjusts teaching pace based on student emotions to enhance emotional resonance. The learning behavior analysis unit tracks learning paths and interaction data, while the effectiveness evaluation unit uses big data analysis to assess learning outcomes and teaching strategy effectiveness. The personalized recommendation unit recommends resources or adjusts pathways based on student performance, utilizing deep learning predictive models for multidimensional learning effectiveness assessment, providing real-time feedback to guide teaching strategy adjustments. The system offers remote diagnostics, automatic updates, and fault prevention, reducing downtime through predictive maintenance strategies. An all-day customer service system promptly resolves technical issues to ensure uninterrupted teaching activities.

**(2)** The system achieves user-friendly interaction by utilizing a high-precision input recognition unit that recognizes user touch, complex gestures, and natural language commands. This capability allows students to smoothly interact with virtual content in augmented reality environments. The feedback generation unit enhances the learning process's fun and engagement through visual and auditory feedback. The adaptive interface ensures the best user experience across different devices and environments, further enhancing the immersion and interactivity of the learning process. For example, celebratory animations and encouraging feedback provided after completing tasks not only boost students' sense of achievement but also encourage them to participate more actively in learning.

**(3)** The data analysis and evaluation module deeply analyzes each student's learning behavior using big data technology and machine learning models. It tracks not only learning time and interaction frequency but also delves into learning patterns and emotional changes. For example, it identifies peak learning periods, overcoming difficult points, and student emotional responses. These analysis results are used to provide personalized learning resource recommendations and pathway adjustments, ensuring that the learning content matches the student's current ability level, interests, and needs. Furthermore, utilizing item response theory and learning progress models, the module accurately assesses learning effectiveness, providing scientific feedback to teachers and students. This fosters personalized adjustments in teaching strategies and enhances learning efficiency.

In a specific implementation, the core processing module utilizes advanced cloud computing and edge computing technologies to establish an efficient data processing center. It is responsible for processing real-time data from various sensors such as cameras and location sensors. By applying machine learning algorithms to analyze this data rapidly, the module achieves precise scene understanding and content positioning. Additionally, the core processing module includes an intelligent scheduling subsystem that dynamically allocates computing resources based on current teaching tasks and system loads to ensure smoothness and stability in the AR experience. The content creation and management module in this implementation adopts visual programming and drag-and-drop editing tools, lowering the technical barriers for content creators. Teachers or curriculum designers can easily import multimedia resources like 3D models, videos, and audio, and design interactive logic and learning paths through an intuitive interface. The content management system features version control functionality, supports multi-user collaboration, ensures continuous iteration of content, and maintains quality control. The built-in copyright management and audit mechanisms safeguard the legality and compliance of educational content. The user interaction module integrates advanced technologies such as natural language processing (NLP), gesture recognition, and eye-tracking. It can identify and respond to various student interaction commands, including voice queries, gestures, or gaze focus, triggering corresponding teaching feedback. Through adaptive UI design, the system can automatically adjust interface layout and brightness based on students' behavioral habits and ambient lighting, ensuring optimal visual comfort and learning experience.

Additionally, the system incorporates emotion recognition technology to adjust teaching pace and content presentation based on students' emotional states, enhancing emotional resonance. In the data analysis and evaluation module, big data analysis and artificial intelligence algorithms are utilized to

deeply explore massive data generated during the learning process. Apart from conventional learning effectiveness assessments like knowledge mastery and test scores, the module conducts advanced analyses such as emotion analysis and attention tracking to evaluate students' learning interests, engagement, and cognitive load. Based on these analysis results, the system can generate personalized learning reports, provide customized learning recommendations to students, and offer bases for teachers to adjust teaching strategies. The technical support and maintenance module integrates remote diagnostics, automatic updates, and fault prevention technologies. By continuously monitoring system operation status, potential issues are identified and resolved promptly to reduce downtime. For hardware devices, predictive maintenance strategies are employed to predict faults based on equipment usage and historical data, enabling proactive repairs or replacements. Additionally, establishing a round-the-clock online customer service system ensures immediate technical support and guidance for users, ensuring that teaching activities are not disrupted by technical issues.

#### **4. Conclusion**

the interactive teaching system based on augmented reality, with its intricate processes and highly integrated module design, not only provides students with an immersive and personalized learning environment but also offers educators efficient teaching management and evaluation tools. Together, they drive the forefront development of educational technology.

#### **References**

- [1] Musamih A ,Salah K ,Jayaraman R , et al. Enhancing claustrophobia exposure therapy: A blockchain and NFT-enabled metaverse approach[J]. *Computers in Human Behavior*,2024,160.
- [2] Canlong L ,A. V G ,Gaang L , et al. Understanding Social Interaction and Physiological Patterns in Nonlean and Last Planner System–Based Project Teams: A Comparative Study Using Immersive Virtual Reality[J]. *Journal of Construction Engineering and Management*,2024,150(10).
- [3] Bazargani S J ,Rahim N ,Niaraki S A , et al. Alzheimer's disease diagnosis in the metaverse[J]. *Computer Methods and Programs in Biomedicine*,2024,255.
- [4] Gunawan H ,Gunawan I ,Hambarasari Y , et al. Virtual reality intervention for improving cognitive function in post-stroke patient: A systematic review and meta-analysis[J]. *Brain Disorders*,2024,15.
- [5] Lu M ,Song Y ,Niu Y , et al. Effectiveness of Virtual Reality in the Management of Anxiety and Pain Peri-Treatment for Breast Cancer: A Systematic Review and Meta-Analysis.[J]. *The journal of nursing research : JNR*,2024,32(4).
- [6] Chan M H C ,Ma I K M ,Chan K T , et al. Current applications of virtual reality in basketball training: a systematic review[J]. *Sports Engineering*,2024,27(2).