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Article

Development and design of artificial intelligence robot-assisted Chinese language education modules for young children: a study based on the DDR model

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Abstract: With the development of artificial intelligence technology, educational robots have been gradually introduced into the field of preschool education, particularly showing unique advantages in language education. However, the current application of AI robots in kindergarten language teaching still presents problems, including a lack of systematic teaching design, unnatural interaction, and a low match with course objectives. To solve the above problems, this study adopts the DDR model research method to develop and design a preschool language education module assisted by artificial intelligence robots.

The study follows the three stages of the DDR model. Each stage uses different methods to achieve its goals. The first stage is the analysis stage, followed by the design and development stage, and finally the implementation and evaluation stage. Through practice in a real teaching situation in a kindergarten in Zhengzhou, China, an AI-assisted language teaching module with complete structure, rich content, and high matching with the language development stage of young children is gradually formed. The study uses classroom observation, teacher interviews, etc. to collect qualitative data for analysis.

This study verifies the application value of AI robots in early childhood language education and

proposes a set of scalable AI education module design processes. The research results have positive significance for artificial intelligence to empower preschool education and promote the deep integration of teaching tools and teaching goals.

Keywords: Artificial intelligence robots, early childhood language education, design research, module development, interactive learning

1. Introduction

The research aims to build a multifunctional education platform that integrates advanced artificial intelligence technology to promote the systematic improvement and personalized development of children's language ability. By integrating multimodal data analysis and intelligent interaction mechanisms, the platform will achieve accurate monitoring of children's learning behaviors and dynamic adjustment of individualized teaching strategies, thereby effectively improving the scientific nature and adaptability of education. In addition, the platform will also rely on big data analysis and machine learning algorithms to optimize teaching content and methods to meet the differentiated education needs of older children, thereby promoting the comprehensive and balanced development of children's language development.

In the context of rapid advancements in artificial intelligence, the integration of intelligent technologies into early childhood language education has emerged as a key direction for educational innovation. Language ability forms the core foundation of children's cognitive development and social interaction, and the quality of early language learning directly affects their future learning capabilities and social adaptability. However, traditional approaches to early language education often face limitations in areas such as personalized support, sustained interaction, and engagement.

AI robots, as emerging intelligent educational tools, possess functions such as speech recognition, real-time feedback, and contextual dialogue, making it possible to create immersive and highly interactive language learning environments. This study aims to develop an AI robot-assisted language education module suitable for practical

use in kindergarten settings, and to enhance children's language proficiency through implementation in real-life educational contexts.

To ensure the module's relevance and effectiveness, the study incorporates the DDR model. By integrating AI technology with the DDR model, the research not only addresses the urgent need to improve the quality of early childhood language development but also provides theoretical support and a design framework for the practical application of AI-assisted language education.

A high-quality early education environment plays a crucial role in the development of children's language abilities. Berger et al. (2021) highlighted that language-rich, center-based child care significantly supports the language development of disadvantaged children, underscoring the pivotal role of educational settings in fostering language skills. Similarly, Finders et al. (2023) emphasized that evaluating the language environment is essential for improving the quality of early childhood education, as language competence underpins multiple domains of development, including cognitive, socio-emotional, and academic areas.

The importance of language education has become even more evident in the face of global challenges. For instance, Davies et al. (2021), in their study during the COVID-19 pandemic, found that children's participation in early childhood education and care (ECEC) was closely associated with the development of both language skills and executive functions. Their findings suggest that early educational experiences, even amid disruptive contexts, can effectively support children's language growth.

At the same time, the interactivity of teaching methods is also considered an important factor affecting language acquisition. Boerma et al. (2021) found that interactive book reading, especially when combined with focused attention guidance and graphic strategies, can significantly improve children's language ability. These studies jointly emphasize a core point: language development depends not only on the teaching content itself, but also highly on the quality of the environment and the way of teaching interaction.

In the context of the rapid development of educational technology, more and more research focus on the application of technology in language teaching. Iqbal et al. (2021) pointed out that although the introduction of technology into the classroom can help improve language skills, the current technology integration is still not deep enough and has not fully realized its potential. Dai et al. (2022) further pointed out that the existing online foreign language course design still faces the problem of

insufficient systematization and called for the establishment of a more scientific and systematic teaching design framework.

LMs can be evaluated through a three-stage framework, mirroring human language acquisition from basic word understanding to complex grammar (Yang et al., 2024).

Studies show that LMs, like children, learn linguistic skills systematically, with certain tasks learned in a parallel manner (Evanson et al., 2023). Mathematical models of language acquisition provide insights into how learners integrate linguistic experience with prior knowledge, applicable to both child and adult language acquisition (Yang, 2018).

While LMs exhibit some similarities to human language acquisition, their learning processes and outcomes reveal notable differences, particularly in the complexity and adaptability of their linguistic capabilities.

In summary, although researchers generally agree on the important value of early language environment, interactive teaching and technology integration for children's language development, existing research is still insufficient in the field of "how to effectively embed artificial intelligence technology, especially robot interactive systems, into early language teaching". Therefore, this study aims to develop and optimize an artificial intelligence robot-assisted early childhood language education module based on the DDR method to explore its role in promoting children's language learning in a real teaching environment and fill the gap between technology design and teaching practice.

2. Methodology

This study adopts a simplified design-based research (DDR) framework, which mainly includes three stages: needs analysis, preliminary design and development, implementation, and evaluation, aiming to develop a set of AI robot-assisted modules that can be used for language teaching in kindergartens.

The main concern is to improve the design of pedagogical interventions and discover how they affect learners. The DDR research design attempts to "combine the intentional design of learning environments with the empirical exploration of our understanding of those environments and how they interact with individuals" (Hoadley 2004, p.205). In addition, McKenney and Reeves (2012) pointed out the

contribution of design research is in the intervention that was developed as a solution to the existing problem. In a DDR methodology, a progressive refinement approach is undertaken by the researcher whereby a design is placed in a real-world context in order to gauge how it functions and is revised in order to improve the design (Collins et al. 2004).

2.1. Demand Analysis

Through interviews and classroom observations with teachers at a kindergarten in Zhengzhou, it was found that traditional language teaching lacks interest and interactivity, making it difficult to effectively stimulate children's enthusiasm for language expression. At the same time, the technical characteristics of existing AI educational robots were analyzed to confirm that they have functions such as voice recognition, voice output, and simple dialogue management, and are feasible for conducting auxiliary teaching.

2.2. Preliminary design

The teaching goal is to improve children's vocabulary, expression ability and willingness to actively communicate. The module is based on life-like theme scenes (such as "My Home", "Going to the Supermarket", etc.), designing interactive processes and language points, and preliminarily writing robot interaction scripts to form a module prototype structure.

2.3. Module development

Based on the preliminary design content, use the existing AI robot platform to build a teaching interaction module, integrate the voice recognition engine and content script, and complete a version that can be used for kindergarten classroom trials.

2.4. Implementation and evaluation

A teaching practice was carried out in the target kindergarten, and a middle-class class was selected for trial. The study collected data through classroom observation and teacher interviews. Preliminary results showed that the module can effectively

stimulate children's interest in participation, and some children have improved in vocabulary use and active expression, but the language output is still relatively simple, and the content richness needs to be further optimized.

3. Results

In the actual teaching carried out in the middle class of a kindergarten in Zhengzhou, the AI-robot-assisted language teaching module implemented a total of 3 theme teaching activities, including "Going to the Supermarket", "My Home" and "Animal Friends". Classroom observations showed that children showed great interest in the interaction with AI robots, actively participated in questions and dialogues, and the average number of times they raised their hands to speak and the frequency of active responses increased significantly. Teachers' interview feedback believed that AI robots can effectively attract attention, maintain classroom order, and increase children's motivation for language participation. Analysis of children's language behavior records showed that most children used target vocabulary in the activities, and some children tried to imitate robot sentences in free expression, but the language output was still mainly phrases and keywords, and the sentence structure was not complete.

4. Discussion

The research results show that AI robots have the potential to play a positive auxiliary role in children's language learning, especially in stimulating interest and improving language participation. Compared with traditional teaching, the instant response and anthropomorphic voice output provided by robots enhance the interactivity and immersion of learning, which is in line with the characteristics of children's language learning mainly through games and dialogues.

However, this study also found that although children were enthusiastic about participating, their language output was still relatively brief and lacked naturalness and extensibility, which may be related to the following factors: First, the current robot script content is relatively structured and lacks personalized response strategies; second, children are still in the early stages of language development and have limited

language organization ability; third, robot speech recognition has the risk of misjudgment in a noisy classroom environment. In response to these problems, subsequent research should continue to optimize the module content and technical interface to improve the naturalness and depth of language output.

5. Conclusion

This study developed and tested a set of AI robot-assisted early childhood language teaching modules. The results showed that the module had a significant effect in improving early childhood learning interest and language participation, and preliminarily verified the application value of AI technology in early childhood language education. This study provides a practical basis for the introduction of artificial intelligence teaching tools in preschool education scenarios in the future.

Future research recommends expanding the sample size, combining multiple rounds of teaching optimization with long-term tracking evaluation, and further verifying the continued impact of AI robots on language ability development. At the same time, it is recommended to introduce a richer corpus and multimodal interaction mechanism in robot design to improve teaching adaptability and language output quality, laying the foundation for building an intelligent early childhood language education system.

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