

The Application and Challenges of Intelligent Voice Classroom Technology in Interactive Teaching: A Qualitative Study Based on Educational Experts

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To Link this Article: <http://dx.doi.org/10.6007/IJARBS/v14-i7/22336>

DOI:10.6007/IJARBS/v14-i7/22336

Published Date: 29 July 2024

Abstract

With the continuous advancement of digital education, intelligent voice classroom technology has shown great potential in enhancing the quality and efficiency of interactive teaching. This study employs qualitative methods based on in-depth interviews with three experts in the field (coded as Expert A, Expert B, and Expert C) to explore the current application status, challenges, and optimisation strategies of intelligent voice classroom technology in interactive teaching at a higher normal university P in Henan Province, China. The findings reveal that intelligent voice classroom technology significantly enhances student interaction and engagement and supports personalised learning paths. However, technological limitations, uneven distribution of educational resources, and acceptance issues remain key factors restricting its widespread application and effectiveness. Based on these findings, the paper proposes a series of recommendations to optimise the application of intelligent voice classroom technology in the educational field. These include strengthening teacher training, improving technological accessibility, and ensuring equity. These recommendations are intended to promote the effective application of intelligent voice classroom technology in education, facilitating its continuous development and optimisation in interactive teaching. By integrating professional knowledge and practical experiences from different perspectives, this study provides in-depth insights into the application of intelligent voice classroom technology in interactive teaching. It proposes practical strategies for the development of educational technology. This is important for enhancing the quality of higher education and promoting technological innovation.

Keywords: Intelligent Voice Classroom, Interactive Teaching, Qualitative Study, Educational Technology, Personalized Learning.

Introduction

With the rapid development of information technology and the advent of the intelligent era, the field of education is undergoing unprecedented transformations. With the rapid development of information technology, intelligent technology has become a key force driving educational innovation and reform. In particular, intelligent voice classroom technology, as a significant technology in the field of artificial intelligence, not only changes the traditional modes of information retrieval and virtual assistant services but more importantly, it is revolutionizing educational teaching methods. The introduction of intelligent voice technology has made teaching interactions more natural and efficient, greatly enhancing learning experiences and educational quality. The application of intelligent voice classroom technology, a key technology in artificial intelligence, has begun demonstrating its vast potential across various sectors. In education, the application of intelligent voice classroom technology is not limited to providing information retrieval and virtual assistant services; more importantly, it is revolutionising traditional teaching and learning methods (Deng et al., 2019).

Particularly in interactive teaching, it has shown great potential in promoting teaching interaction, enhancing student learning experiences, and supporting personalised learning (Korkmaz, 2019). Despite the potential benefits of intelligent voice classroom technology, there are significant gaps in our understanding of its full capabilities and limitations in real-world educational settings. Current applications often focus on basic functionalities without tapping into the deeper, more transformative educational potential such technology could offer. Moreover, existing studies have not sufficiently addressed the challenges of integrating this technology in diverse educational contexts, where factors such as technological readiness, teacher acceptance, and educational equity play crucial roles. This study seeks to fill these gaps by investigating the practical applications and challenges of intelligent voice technology in interactive teaching environments. By exploring these areas, this research aims to contribute valuable insights into how these technologies can be better tailored and optimized for educational use, ultimately supporting more effective learning outcomes. Recognizing the transformative potential of intelligent voice classroom technology, this study goes beyond merely documenting its current uses and challenges. It aims to demonstrate how this technology can significantly enhance educational outcomes and address systemic issues within the educational sector. The research findings are expected to provide strategic insights for educational practitioners on implementing and maximizing the benefits of intelligent voice technology effectively.

Additionally, this study offers crucial guidance for policymakers on creating supportive frameworks that promote technological equity and accessibility in education. By addressing these critical areas, the research contributes to the broader discourse on educational innovation, offering a blueprint for leveraging technology to foster a more engaging and inclusive learning environment. This study not only investigates the current applications and challenges of intelligent voice classroom technology but also evaluates its effectiveness in real educational settings. By conducting in-depth analyses and gathering empirical evidence, the research aims to validate the utility of this technology in enhancing teaching efficiency, student engagement, and learning outcomes.

The practical application of the findings will showcase how intelligent voice technology can be integrated into daily teaching practices, making it a valuable tool for educational innovation. Furthermore, the study will offer insights into the scalability of this technology across different educational levels and contexts, highlighting its versatility and broad applicability. With the proliferation of smart devices and advancements in voice recognition technology, the application prospects of intelligent voice classroom technology in education are broad, promising improved teaching efficiency and quality through more natural interaction methods (Y. et al., 2022). The demand for this technology in the education sector is growing due to its significant potential to enhance interactivity and personalized learning pathways. Although initial research and applications have shown success, there are still many unexplored areas and challenges in fully realizing the educational potential of intelligent voice classroom technology. Therefore, this study aims to delve deeply into the current application status, challenges, and optimization strategies of intelligent voice classroom technology in interactive teaching, to provide a scientific basis and practical guidance for the further development of educational technology.

However, despite the numerous advantages of intelligent voice classroom technology, its application in education also faces considerable challenges (Gao et al., 2022). Technological limitations, uneven distribution of educational resources, the adaptability of teachers and students to technology, and the long-term impact on educational quality and outcomes are pressing issues that need to be addressed. Therefore, exploring the effective application of intelligent voice classroom technology in interactive teaching and identifying and addressing these challenges is of significant importance for developing intelligent voice classroom technology (Jing, 2022).

This study explores the current application status of intelligent voice classroom technology in interactive teaching, analyse the challenges faced, and proposes corresponding optimisation strategies (Badshah et al., 2023). Through qualitative research methods and in-depth interviews with three experts from different backgrounds at a higher normal university P in Henan Province, China, this study hopes to reveal the potential of intelligent voice classroom technology in promoting educational interaction and personalised learning, as well as the practical difficulties in its application (Yang et al., 2020).

The significance of this study lies in its in-depth analysis and discussion of the application of intelligent voice classroom technology in interactive teaching. It not only provides references and guidance for educational practitioners on applying intelligent voice classroom technology but also offers empirical foundations for the research and development of educational technology, thereby promoting the improvement of educational quality and the continuous development of educational technology (Deng et al., 2019). Additionally, this study attempts to provide strategies and suggestions to address the challenges encountered in the application of intelligent voice classroom technology, pointing out directions for future applications and research in educational technology (Korkmaz, 2019).

Literature Review

1 The Development and Educational Application of Intelligent Voice Classroom Technology

In recent years, with the enhancement of computing power and algorithm optimisation, the application of intelligent voice classroom technology in the education field has become

increasingly widespread (Korkmaz, 2019). Research indicates that intelligent voice classroom technology can effectively support teaching management, assist language learning, and promote personalised learning for students, thus bringing innovation to traditional educational models (Yang et al., 2020). The integration of cloud computing, artificial intelligence, and mobile computing further enhances the potential of these technologies in educational settings (Li & Wu, 2023).

2 Theoretical Foundations and Practical Research on Interactive Teaching

Interactive teaching, as a student-centred teaching method, emphasises interaction between teachers and students and among students themselves (Shi, 2022). Vygotsky's sociocultural theory and Piaget's constructivist theory provide the theoretical foundation for interactive teaching, positing that learning is a cognitive process through social interaction (Jing, 2022). Practical research highlights that effective interactive teaching can foster critical thinking, enhance learning motivation, and improve learning outcomes (Y. et al., 2022).

3 The Application of Qualitative Research in the Field of Educational Technology

Through data collection and analysis, qualitative research methods explore behaviours, attitudes, and experiences, offering deep insights into educational technology (Zhang et al., 2019). In studies on the educational application of intelligent voice classroom technology, qualitative research helps reveal teachers' and students' perceptions, challenges encountered during use, and the actual impact of the technology, providing empirical support for the development of educational technology (Terzopoulos & Satratzemi, 2019).

4 Theoretical Framework

This study constructs a conceptual model guided by social constructivism theory and the technology acceptance model. Social constructivism emphasises that knowledge is constructed through social interaction, while the technology acceptance model explains the psychological process of users accepting and using new technologies. Combining these two theories, this study explores how intelligent voice classrooms facilitate educational interaction and analyses the factors influencing their application in the educational field.

Research Methodology

This study adopts a qualitative research design, including sample selection, developing an interview guide, and data collection and analysis strategies. Firstly, based on the research objectives, three representative experts from a higher normal university P in Henan Province were selected as interview subjects (Ponce et al., 2022). Secondly, according to the research questions, a detailed interview guide was developed to ensure an in-depth exploration of the application and challenges of intelligent voice classroom technology in interactive teaching (Leko et al., 2021). During data collection, semi-structured interviews were conducted to obtain rich and deep qualitative data. Finally, through content analysis, the collected data were coded and thematically analysed to reveal the key influencing factors and optimisation strategies for applying intelligent voice classroom technology in the educational field (Burdine et al., 2021).

Data Collection

The data collection process of this study adhered to the principles of qualitative research, employing semi-structured in-depth interviews with three experts from a higher normal

university (coded as P) in Henan Province, China. During this process, this research carefully selected three representative experts from different fields of educational technology to provide valuable perspectives and deep insights for the study (Gusho et al., 2023).

Expert A is a senior professor with extensive experience in the research and application of intelligent classroom technology. He profoundly understands how intelligent voice technology promotes student interaction and engagement. Expert B is the Chief Technology Officer of an educational technology company and has accumulated rich experience in developing and practically applying intelligent voice teaching platforms. Expert C is a policymaker focusing on educational technology policy research, particularly concerning the equity and accessibility of intelligent voice classroom technology. These experts represent diverse perspectives on applying intelligent voice classroom technology in the educational field: academic research, technical practice, and policy making. Before the interviews, our research team developed a series of open-ended questions designed to guide the experts in sharing their insights and experiences regarding applying intelligent voice classroom technology, the challenges faced, and potential optimisation strategies. The interviews were conducted face-to-face, each lasting approximately 20 to 30 minutes to accommodate the experts' schedules and ensure thorough discussions.

To ensure the accuracy and completeness of the data, this research employed a dual recording method during the interviews. First, with the prior consent of the experts, this research recorded the entire interview process using audio devices. Second, team members took real-time notes, documenting key information and viewpoints while respecting the interviewees' privacy. After the interviews, the audio recordings were transcribed into textual data for subsequent analysis.

Data Analysis

The research employed content analysis in the data analysis stage to systematically organise, code, and thematically analyse the interview transcripts. Initially, each research team member independently read through all the interview transcripts and preliminarily marked key concepts and viewpoints in the texts (Park, 2019). Subsequently, through team discussions, the preliminarily marked content was categorised, forming a series of predetermined codes as follows:

Coding Themes	Description	Experts	Key Quotations
Application Status of Technology	Overview of the application of intelligent voice classroom technology in education and interactive teaching	A, B, C	"Making teaching more personalised and dynamic."
Successful Cases	Sharing successful applications and specific outcomes of intelligent voice classroom technology in education	A, B	"Conversation-based learning systems have improved the learning experience."
Promoting Student Engagement	Exploring how intelligent voice classroom technology enhances	A, B, C	"Increased student engagement through personalised feedback"

	student engagement and personalised learning		
Technical Challenges	Discussing the main technical challenges encountered in implementing intelligent voice classroom technology	A, C	"Understanding and adaptability are the current major technical challenges."
Educational Resource Inequality	Analysing whether intelligent voice classroom technology exacerbates the unequal distribution of educational resources	B, C	"Technology promotion needs to focus on its accessibility and equity."
Adaptability Challenges	Describing the challenges educators and students face in adapting to intelligent voice classroom technology.	A, B	"Improving usability and accessibility is key to addressing adaptability challenges."
Optimisation Strategies	Proposing strategies to optimise the application of intelligent voice classroom technology in education	A, B	"Improve voice recognition algorithms to enhance learning interaction."
Promotion and Practice Suggestions	Discussing specific strategies and practical suggestions to address challenges and promote the effective use of intelligent voice classroom technology	A, C	"Develop more applications based on educational psychology principles."
Policy and Developer Actions	Exploring actions that education policymakers and technology developers should take to promote the sustainable development of intelligent voice classroom technology	B, C	"Invest in infrastructure, formulate supportive policies, and ensure equitable access to technology."

Building on the predetermined codes, this research further refined the text through detailed coding, comparing, merging, and elaborating to determine the thematic codes of the study ultimately. For each theme, this research conducted an in-depth data analysis, extracting the experts' viewpoints, experiences, and suggestions while paying attention to the similarities and differences between their perspectives (Xu & Zammit, 2020). This process revealed the key influencing factors, major challenges, and potential optimisation strategies for applying intelligent voice classroom technology in interactive teaching, providing empirical foundations and theoretical references for future research (Constantinou et al., 2023).

Thematic Categories	Description
Application of Technology and Educational Outcomes	This paper explores the current application status of intelligent voice classroom technology in education, particularly in interactive teaching. It includes an analysis of successful cases and how the technology enhances student engagement and personalised learning.

Challenges and Obstacles	Analyzes the technical challenges encountered during the implementation of intelligent voice classroom technology, issues of educational resource inequality, and the adaptability challenges faced by educators and students. It examines the impact of these challenges on educational practice.
Optimisation Strategies and Promotion Practices	Based on the identified challenges, it proposes strategies to optimise the application of intelligent voice classroom technology in education and offers specific promotion practice suggestions aimed at improving the educational effectiveness and dissemination of the technology.
Policy Recommendations and Development Directions	Explores the necessary policy support and action guidelines for technology developers to promote the sustainable development of intelligent voice classroom technology in the educational field. It emphasises the importance of equitable access and investment in infrastructure.

Research Results

1 Application Status and Effectiveness Analysis of Intelligent Voice Classroom Technology in Interactive Teaching

The study found that intelligent voice classroom technology has achieved preliminary applications and outcomes in interactive teaching. At a higher normal university (coded as P) in Henan Province, this technology assists language learning, facilitates interactive questioning, and delivers personalised learning content. Experts generally believe this technology can significantly enhance students' motivation and engagement, particularly in language learning and practice (Tao, 2019). Through interactive learning enabled by intelligent voice technology, students receive immediate feedback, effectively improving learning efficiency (Sanchez-Gonzalez et al., 2023).

However, the application of intelligent voice classroom technology is not without limitations. Currently, its use is largely concentrated on the auxiliary functions of classroom teaching, while its application in course design, teaching evaluation, and learning behaviour analysis is relatively limited (Umetani et al., 2023). This restricts the broader application of intelligent voice classroom technology in the educational field (Jing, 2022).

2 Discussion of Major Challenges and Issues

Despite the promising application prospects of intelligent voice classroom technology, several challenges have been encountered in its practical application. According to expert interviews, these challenges mainly include The accuracy of recognition and natural language processing capabilities of intelligent voice classroom technology need improvement, especially in handling complex contexts and dialects (Lei, 2021). There is an unequal distribution of intelligent voice educational resources, particularly in remote areas where students have fewer opportunities to access and use this technology. Some teachers and students have low acceptance and adaptability to new technology and lack the necessary technical training and psychological preparation (Shi, 2022).

3 Optimization Strategies and Practical Suggestions

To address the above challenges, this study proposes the following optimisation strategies and practical suggestions: Continuously invest in the research and development of intelligent voice classroom technology, especially to improve the accuracy of voice recognition and the capabilities of natural language processing to meet more diverse teaching needs (Long & Wang, 2021). Through policy guidance and financial support, promote the balanced distribution of intelligent voice educational resources across different regions and types of schools to bridge the digital divide. Organise systematic technical and psychological adaptation training to improve the acceptance and usage capabilities of intelligent voice classroom technology among teachers and students (Yang et al., 2020).

Discussion

1 Potential and Limitations of Intelligent Voice Classroom Technology

The findings of this study reveal the significant potential of intelligent voice classroom technology in interactive teaching, particularly its value in enhancing student engagement, promoting personalised learning, and improving language learning efficiency. This technology brings new possibilities to the educational field by providing immediate feedback and supporting multimodal learning interactions (Butler, 2020). However, the limitations of technological implementation, the unequal distribution of resources, and the adaptability issues in educational practice constitute major obstacles to the widespread application of intelligent voice classroom technology (Yan et al., 2020).

2 Novelty and Contribution Compared to Existing Literature

Compared to existing literature, this study demonstrates novelty and contribution in several aspects. Firstly, through in-depth interviews from the practitioners' perspective, this study systematically explores the current application status and challenges of intelligent voice classroom technology in interactive teaching, filling a gap in empirical research in this field (Tao, 2019). Secondly, by comparative analysis, this study reveals the specific application effects and existing issues of intelligent voice classroom technology in educational practice, providing new perspectives and data support for subsequent research (Terzopoulos & Satratzemi, 2019). Lastly, the optimisation strategies and practical suggestions proposed in this study offer concrete guidance for the further development and application of educational technology, bearing significant theoretical and practical implications (Y. et al., 2022).

3 Implications for Educational Practice, Policy Making, and Technology Development

This study provides important educational practice, policy-making, and technology development implications. For educational practitioners, understanding the potential and limitations of intelligent voice classroom technology can better utilise this technology to enhance teaching effectiveness (Shi, 2022). For policymakers, this study emphasises the importance of equitable distribution of educational resources and strengthening technical training for teachers and students, suggesting that policies should support the popularisation of technology and educational equity (Bai & Zhang, 2020). For technology developers, the findings of this study indicate the development direction of intelligent voice classroom technology, particularly the need to improve technological adaptability and optimise user experience.

Conclusion

1 Major Findings

This study employs qualitative analysis methods to explore the current application status, challenges, and optimisation strategies of intelligent voice classroom technology in interactive teaching. The findings indicate that intelligent voice classroom technology holds significant potential to enhance student engagement, support personalised learning, and improve language teaching efficiency. However, the main obstacles to its widespread application are technological limitations, unequal distribution of educational resources, and adaptability issues for teachers and students (Y. et al., 2022).

2 Theoretical and Practical Significance

The theoretical significance of this study lies in providing an empirical foundation for the application of intelligent voice classroom technology in the educational field, enriching the theoretical framework of interactive teaching and educational technology (Butler, 2020). Practically, the study's findings and recommendations offer references for educational practitioners in applying intelligent voice classroom technology and guide policymakers and technology developers in optimising technology use and promoting educational equity (Terzopoulos & Satratzemi, 2019).

3 Policy and Practice Recommendations

Based on the study results, the following policy and practice recommendations are proposed: Policymakers should increase support for the research and application of intelligent voice classroom technology, especially in under-resourced areas, by guiding policies and funding to promote equitable distribution of educational technology resources. Technology developers should continuously optimise the accuracy and adaptability of current intelligent voice classroom technology to address the challenges encountered in educational applications and enhance user experience. Educational practitioners should actively explore innovative applications of intelligent voice classrooms in teaching and organise corresponding training to improve the adaptability of teachers and students to technology (Shi, 2022).

4 Research Limitations and Future Research Directions

This study has certain limitations, such as the restricted sample range and the inherent limitations of qualitative research methods, which may affect the generalizability and depth of the findings (Yang et al., 2020). Future research can expand the sample range, adopt quantitative research methods, or combine qualitative and quantitative methods to explore further the application effects and challenges of intelligent voice classroom technology in different educational environments and how technological innovations can address the current problems (Jing, 2022).

In summary, this study not only provides in-depth insights into the application of intelligent voice classroom technology in interactive teaching but also offers practical guidance and recommendations for decision-makers and technology developers in the educational field. It holds significant theoretical and practical value for promoting the development and optimisation of educational technology (Korkmaz, 2019).

References

- Badshah, A., Nasralla, M. M., Jalal, A., & Farman, H. (2023). Smart Education in Smart Cities: Challenges And Solution. *2023 IEEE International Smart Cities Conference (ISC2)*, 01–08. <https://doi.org/10.1109/ISC257844.2023.10293615>
- Bai, H., & Zhang, Q. (2020). WITHDRAWN: English smart classroom teaching system based on 5G network and internet of things. *Microprocessors and Microsystems*, 103421. <https://doi.org/10.1016/j.micpro.2020.103421>
- Butler, L. (2020). "HEY GOOGLE, HELP ME LEARN" Voice Assistant Devices in the New Zealand Primary School [Thesis, Open Access Te Herenga Waka-Victoria University of Wellington]. <https://doi.org/10.26686/wgtn.17148497.v1>
- Constantinou, M., Polvara, R., & Makridis, E. (2023). THE TECHNOLOGISATION OF THEMATIC ANALYSIS: A CASE STUDY INTO AUTOMATISING QUALITATIVE RESEARCH. *INTED2023 Proceedings*, 1092–1098. 17th International Technology, Education and Development Conference. <https://doi.org/10.21125/inted.2023.0323>
- Deng, T., Wang, X., Xu, Z., Zhang, L., Hei, X., & Wang, Z. (2019). The Intelligent Classroom Client Software Design. *2019 IEEE International Conference on Engineering, Technology and Education (TALE)*, 1–5. <https://doi.org/10.1109/TALE48000.2019.9226003>
- Gao, J., Wan, G., Wu, K., & Fu, Z. (2022). Review of the application of intelligent speech technology in education. *Journal of China Computer-Assisted Language Learning*, 2(1), 165–178. <https://doi.org/10.1515/jccall-2022-0004>
- Gao, Y., & Li, L. (2022). Intelligent Structure Design of Learning Seats in University Smart Classroom under the Background of Intelligent Education. *Computational Intelligence and Neuroscience*, 2022(1), 7986426. <https://doi.org/10.1155/2022/7986426>
- Gusho, L., Mucaj, A., Petro, M., & Vampa, M. (2023). The Use of Educational Technology to Improve the Quality of Learning and Teaching: A Systematic Research Review and New Perspectives. *International Journal of Emerging Technologies in Learning (IJET)*, 18(15), Article 15. <https://doi.org/10.3991/ijet.v18i15.39641>
- Jing, L. (2022). Application of Artificial Intelligence Algorithm and VR Technology in Vocal Music Teaching. *Mobile Information Systems*, 2022(1), 2320198. <https://doi.org/10.1155/2022/2320198>
- Korkmaz, M. (2019). Smart Class Applications for Education. *2019 4th International Conference on Computer Science and Engineering (UBMK)*, 498–503. <https://doi.org/10.1109/UBMK.2019.8907108>
- Lei, L. (2021). Design of Acoustic System in Smart Classroom. *2021 6th International Conference on Intelligent Computing and Signal Processing (ICSP)*, 916–920. <https://doi.org/10.1109/ICSP51882.2021.9408811>
- Leko, M. M., Cook, B. G., & Cook, L. (2021). Qualitative Methods in Special Education Research. *Learning Disabilities Research & Practice*, 36(4), 278–286. <https://doi.org/10.1111/ldrp.12268>
- Li, Y., & Wu, F. (2023). Design and Application Research of Embedded Voice Teaching System Based on Cloud Computing. *Wireless Communications and Mobile Computing*, 2023(1), 7873715. <https://doi.org/10.1155/2023/7873715>
- Long, C., & Wang, S. (2021). Music classroom assistant teaching system based on intelligent speech recognition. *Journal of Intelligent & Fuzzy Systems*. <https://doi.org/10.3233/jifs-219154>

- Park, G. J. (2019). The Study on the Software Educational Needs by Applying Text Content Analysis Method: The Case of the A University. *Journal of the Korea Academia-Industrial cooperation Society*, 20(3), 65–70. <https://doi.org/10.5762/KAIS.2019.20.3.65>
- Ponce, O. A., Gomez-Galan, J., & Pagan-Maldonado, N. (2022). Qualitative research in education: Revisiting its theories, practices and developments in a scientific-political era. *IJERI: International Journal of Educational Research and Innovation*, 18, Article 18. <https://doi.org/10.46661/ijeri.5917>
- Sanchez-Gonzalez, M., Terrell, M., Sanchez-Gonzalez, M., & Terrell, M. (2023). Flipped Classroom With Artificial Intelligence: Educational Effectiveness of Combining Voice-Over Presentations and AI. *Cureus*, 15. <https://doi.org/10.7759/cureus.48354>
- Shi, G. (2022). Design and Implementation of IoT Data-Driven Intelligent Law Classroom Teaching System. *Computational Intelligence and Neuroscience*, 2022(1), 8003909. <https://doi.org/10.1155/2022/8003909>
- Tao, Y. (2019). An Intelligent Voice Interaction Model Based on Mobile Teaching Environment. *2019 International Conference on Intelligent Transportation, Big Data & Smart City (ICITBS)*, 377–380. <https://doi.org/10.1109/ICITBS.2019.00099>
- Terzopoulos, G., & Satratzemi, M. (2019). Voice Assistants and Artificial Intelligence in Education. *Proceedings of the 9th Balkan Conference on Informatics*, 1–6. <https://doi.org/10.1145/3351556.3351588>
- Thompson B. J., Thorne, S., & Sandhu, G. (2021). Interpretive description: A flexible qualitative methodology for medical education research. *Medical Education*, 55(3), 336–343. <https://doi.org/10.1111/medu.14380>
- Umetani, K., Toyota, Y., Ishihara, M., & Hiraki, E. (2023). Artificial-Voice-Based Conversational Lecture Video Clips for Flipped Classroom. *2023 IEEE 32nd International Symposium on Industrial Electronics (ISIE)*, 1–7. <https://doi.org/10.1109/ISIE51358.2023.10228017>
- Xu, W., & Zammit, K. (2020). Applying Thematic Analysis to Education: A Hybrid Approach to Interpreting Data in Practitioner Research. *International Journal of Qualitative Methods*, 19, 1609406920918810. <https://doi.org/10.1177/1609406920918810>
- Yan, F., Niu, H., Feng, N., & Meng, Q. (2020). Intelligent Classroom Control System with Early Warning Function. In J. H. Abawajy, K.-K. R. Choo, R. Islam, Z. Xu, & M. Atiquzzaman (Eds.), *International Conference on Applications and Techniques in Cyber Intelligence ATCI 2019* (pp. 1898–1903). Springer International Publishing. https://doi.org/10.1007/978-3-030-25128-4_251
- Yang, D., Oh, E. S., & Wang, Y. (2020). Hybrid Physical Education Teaching and Curriculum Design Based on a Voice Interactive Artificial Intelligence Educational Robot. *Sustainability*, 12(19), Article 19. <https://doi.org/10.3390/su12198000>
- Zhang, R., Chen, W., Xu, M., & Yang, Y. (2019). Analysis and Design of Voice Assisted Learning System Based on Baidu AI. *2019 IEEE International Conference on Computer Science and Educational Informatization (CSEI)*, 334–336. <https://doi.org/10.1109/CSEI47661.2019.8938894>