A review on the effect of integrating AI-based technology into flipped learning

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ABSTRACT

This mini-review mainly examines the effects of integrating the AI-based technology into flipped learning on students' motivation and performance. As the research topic supported by artificial intelligence in the classroom is a relatively frontier topic, further exploration is needed. Exploring the integration of AI-based technology into flipped learning holds great potential for enhancing personalized learning experiences, automating tasks, and improving learning outcomes. This review concluded findings from a study between 2019 and 2023, articles were evaluated and screened using keyword flipped classroom and artificial technology, and duplicate papers were removed from the study. Finally, 12 empirical papers are selected according to the research focus. This paper summarizes the research methods, research fields, and data analysis. The results of this study show that in terms of technical challenges, the alignment of teaching objectives with AI techniques, ethical considerations, and human-computer interaction are important considerations for practitioners and researchers in integrating AI into the field of flipped learning. Addressing these limitations is critical to ensuring the successful implementation and ethical use of AI technologies. This review provides a foundation for future research to explore effective implementation strategies, evaluate the impact of AI integration on learning outcomes, and develop guidelines for the ethical and responsible use of AI in flipped learning environments.

Keywords
Flipped learning Artificial intelligence (AI) technology Students' motivation Flipped classroom AI-based technology

Introduction

The field of education is experiencing the widespread integration of intelligent technology, particularly artificial intelligence, which is a significant scientific and technological force contributing to societal growth. This integration is occurring because of the rapid advancement of a new generation of information technology. The artificial intelligence embedded model is a non-traditional teaching model, in which students frequently use modern information technology and learn by themselves under the guidance of teachers. Flipped classroom breaks the traditional teaching model of teachers talking and students listening. The main body status of students in learning is fully reflected, and more time and opportunities for active learning are provided for them (Chen, 2020). The utilization of artificial intelligence integrated into the flipped classroom model offers students a platform for autonomous learning and skill development, facilitates conducive learning environments, and enhances educational outcomes.

Certainly, in the field of education, the changes brought by the development of artificial intelligence in education are obvious. Artificial intelligence (AI) is a relatively complex concept that has a wide range of applications in the field of education, providing support for personalized learning, intelligent-assisted instruction, automated assessment, and educational management (Sharma, Tomar, Bhardwaj & Sakalle, 2021). The so-called artificial intelligence embedded model is a teaching model that embeds artificial intelligence into the classroom (Diwanji, Hinkelmann & Witschel, 2018). The implementation of artificial intelligence (AI) in the field of education holds significant value due to its capacity to enhance and streamline instructional processes, foster effective learning experiences, and support informed decision-making. The incorporation of artificial intelligence (AI) technology has the potential to stimulate students' inclination to develop opinions, make judgments, or generate forecasts, hence facilitating various learning processes (Lin & Mubarok, 2021). Artificial intelligence gives full play to the advantages of teachers in

mobilizing students' subjective motivation and insists on the dominant position of teachers in the whole teaching process. The division of labor of "man-machine co-education" in the era of intelligence is clear.

Many advantages push artificial intelligence into flipped classrooms for students and teachers. The learning content is greatly enriched under the combination of artificial intelligence and flipped classroom. In the information age, learning resources are unified as digital resources. The advantage of digital resources is to improve the sharing degree of resources and reduce the difficulty of acquiring knowledge. Artificial intelligence technology provides customized learning plans according to students' characteristics and learning conditions, which can help realize individualized learning based on their aptitude. Learners have the opportunity to engage in a multi modal learning experience that combines both real and virtual environments, facilitated by the integration of artificial intelligence and virtual reality technologies. One additional benefit of incorporating Artificial Intelligence technology into the educational realm is the ability to analyze patterns of learning activity. The primary components of the Artificial Intelligence learning platform encompass monitoring and tutoring functionalities, which serve to enhance the implementation of flipped learning (Li & Peng, 2022).

Artificial intelligence technology in education was still in its infancy at the time of the emergence of the flipped classroom; Now, artificial intelligence technology is emerging, and related educational products are becoming increasingly mature, which is the maturity period of the combination of the two. The implementation of artificial intelligence technology in the flipped classroom model can effectively integrate the benefits of both approaches, hence enhancing the efficiency of the instructional process. Artificial intelligence technology provides personalized learning experiences in the flipped classroom according to students' differences and learning needs to meet students' learning preferences and interests and stimulate their learning enthusiasm (Lv, 2023). In flipped learning, students can explore and solve problems independently by using AI-assisted tools, online learning platforms, and resource libraries, and cultivate their active learning ability and self-drive. This personalized learning design can stimulate students' motivation and students' outcomes in learning, making them more engaged and actively involved in the learning process (Huang, Lu & Yang, 2023).

However, the lack of literature highlights the necessity for education and explains how AI is used in flipped learning. The study was designed to examine the influence of AI's flipped classroom on students, particularly student motivation, and consequently classroom quality and student accomplishment.

Purpose of the review

The main purpose of the review is to illustrate the current understanding of the issue. Through the integration and review of scientific research, it aims to answer the research questions developed through the research process. The research questions are presented through the literature review：

- What is the previous study about the effect of integrating AI-based technology into flipped classroom?
- What is the main finding about integrating AI-based technology into flipped classroom?

Based on the research questions, the research objectives are shown as follows:

- A preliminary summary of the relevant literature identifies data differences that can be applied to prepare, document, and describe current resources, supplementary criteria, and discourse.
- Check out the article on the impact of AI on the flipped classroom.

Methodology

The literature review serves as a means of integrating research findings by providing data at a higher level of analysis and identifying gaps in knowledge that warrant further investigation. This process is crucial in establishing a theoretical framework and constructing a conceptual model (Snyder, 2019). A systematic review of the scientific literature in a particular field can identify research questions and provide justification for future research in that field. It is necessary to take a systematic approach to understand the work carried out so far in the field of science, the methodologies used (population, sample, statistics), the results obtained, and the recommendations made by the

authors (Torres-Carrión, González-González, Aciar& Rodríguez-Morales, 2018). Therefore, the literature review provides a comprehensive and systematic overview and summary of existing research in a specific field. It can help researchers understand the development status, main research directions, and trends of the current research field, so as to establish the basic knowledge and understanding of the field. It can also evaluate and synthesize evidence from existing research to provide a comprehensive analysis of a particular issue or topic. By integrating the results of multiple independent studies, literature reviews can provide more convincing conclusions and inferences.

The Research Design of the review will follow these parts and will show more detail in this paper. The primary objective of this systematic literature review will find out the two purposes of the review and critically analyze and synthesize existing research on the impact of integrating AI-based technology into flipped learning environments.

Inclusion and Exclusion Criteria: The criteria for including studies in the review will involve a focus on publications from a specified time range, peer-reviewed articles, and empirical studies conducted in diverse educational settings. Exclusion criteria may include studies with insufficient relevance to AI-based technology in flipped learning.

Search Strategy: A comprehensive search strategy will be implemented across major academic databases. Keywords will be carefully selected to capture the diverse aspects of AI in flipped learning.

Screening Process: A two-phase screening process will be employed. Initially, titles and abstracts will be screened for relevance, followed by a full-text review for eligibility.

Quality Assessment: Included studies will undergo a quality assessment using established criteria relevant to the research question. This will ensure the inclusion of high-quality, methodologically sound research.

Data Extraction: Relevant data points, such as study design, participant characteristics, AI technologies employed, and key findings, will be systematically extracted from each included study.

The procedure of the literature review is as follows:

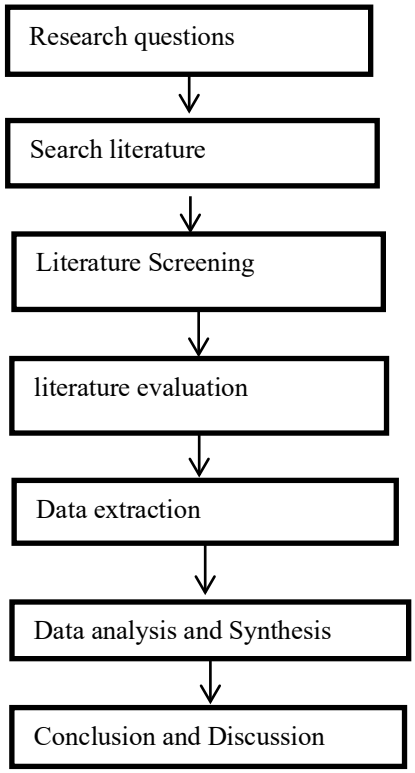

Figure 1.The steps of the literature review(modified by author)

Figure 1 indicates that the purpose and problem of the research should be clarified first, and the areas and scope that need to be reviewed should be determined. Then formulate a clear search strategy, including the selection of appropriate databases and keywords, to obtain relevant literature. According to the pre-set inclusion and exclusion criteria, the retrieved literature was preliminarily screened, and the literature that was irrelevant to the research question or did not meet the criteria was removed. A detailed evaluation of the selected literature, including an assessment of the quality, credibility, and relevance of the literature, was conducted to determine inclusion in the review analysis. In order to extract important information from the included literature, such as the study design, sample characteristics, main results, etc. Analyze and synthesize the extracted data, such as subject analysis, content analysis, statistical summary, etc. Finally, the results of the review are presented clearly and accurately, and can be displayed in forms such as tables, charts, and text descriptions. Summarizing the main findings of the review, discussing the limitations and shortcomings of the study, and making suggestions for future research. It provides a valuable reference for later decision-making, theory construction, and further research.

Searching strategies:

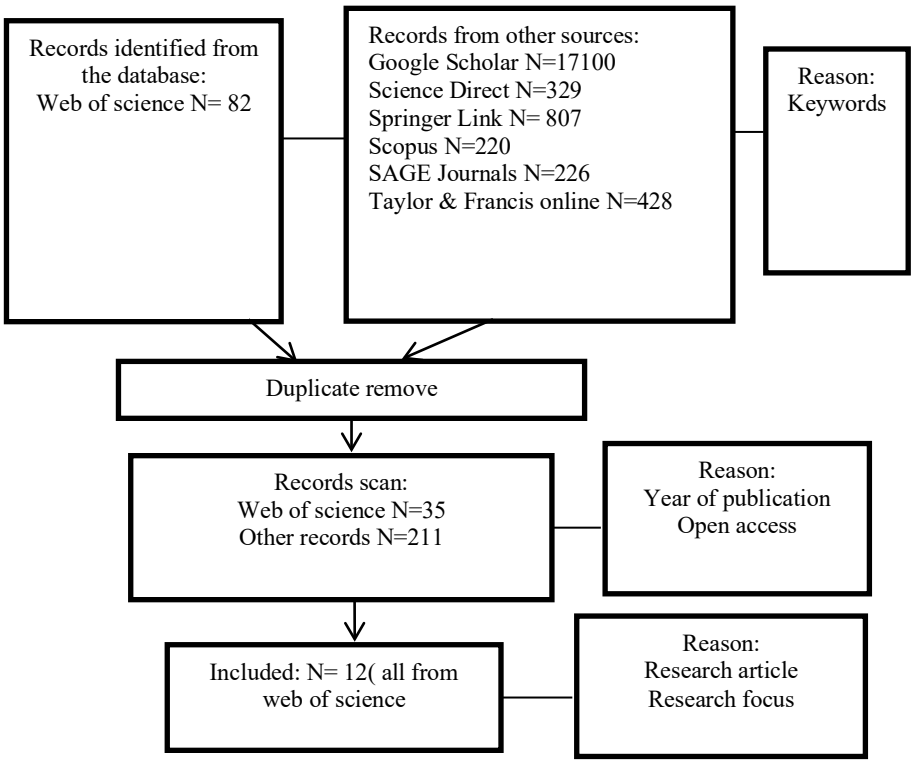

Figure 2: article selection procedure (Source: Author's own elaboration)

The present systematic review concentrates on empirical peer-reviewed studies closely associated with the impact of incorporating AI-based technology into flipped learning. To guarantee transparency and quality, we adopted the updated Preferred Reporting Items for Systematic Reviews. Prior to initiating our literature search, we identified key terms frequently utilized in the realms of flipped classrooms and AI-based technology research by scrutinizing prior studies. Our analysis revealed a predominant focus on terms such as "flipped learning," "flipped classroom," "AI-based technology," and "technology." Therefore, employing these specific terms was deemed essential to retrieve the most pertinent literature.

When conducting the literature search, we should adopt certain strategies to obtain relevant articles. The first is the

keyword search, choosing keywords and terms related to the research topic and using these keywords in a database or search engine: artificial intelligence and flipped classroom. The search area is the database of the school library, which mainly uses Science Direct, Scopus, Springer Link, SAGE Journals, Taylor & Francis Online, Web of Science. In this study, Web of Science is the main database to choose articles from.

As needed, the time frame of the search is limited to improve the accuracy and efficiency of the search, the search scope is mainly all journals and conferences, and the time is set for the last five years: from January 2019 to June 2023. On the other hand, open access is an important part of the article screening process, and when applied to publication time and open access, most articles are screened out. Then, the research focus and research article could be the final criteria for the selection of articles.

In addition, Google Scholar is another popular search engine. Google Scholar is a global academic search engine that covers academic resources in various subject areas. It can search a variety of academic documents, including journal papers, dissertations, conference papers, patents, etc., providing a wide range of academic resources for researchers. At the same time, Google Scholar provides the function of literature citation analysis, you can check the number of times an article has been cited and the list of literature that cite it. Researchers can find high-quality literature related to their research topics through Google Scholar to support the depth and accuracy of their research work.

Literature Selection and Assessment

The main purpose of this study is to find out the impact of artificial intelligence on flipped learning. Therefore, this search is limited to subject areas, which include education and social sciences, humanities, arts, etc. Searches were conducted using Google scholar from 2019 to 2023. The analysis does not include any papers written before 2019. Because advanced search can not be used in Google Scholar, when moved to next step, the focus resource is Web of Science.

In the further selection of articles, select the most recent research papers and conferences, in the advanced search if the title contains subject words artificial intelligence and flip learning, the scope is reduced, so consider using synonyms, synonyms, and related terms to expand the search scope. Duplicate parts are thoroughly identified to maintain the integrity of the review. Abstracts of publications are rigorously verified for evaluation to ensure that the quality of the articles meets the search requirements. After extensive screening, 12 papers were selected for literature review analysis from the Web of Science.

Data extraction and analysis

The information extracted from the literature is mainly about the impact of artificial intelligence on flipped learning, which is summarized from the following aspects:

- The extraction of student learning data: through AI technology, learning data generated by students in flipped learning integrated with AI technology can be extracted. By extracting these data, we can gain insight into students' learning progress, learning behavior, and learning outcomes. Artificial intelligence is capable of providing assistance and personalized guidance in flipped learning (Lo, & Hew, 2023).

- Extraction of student participation: Flipped learning enables students to learn actively, which is a general term for activities in which students participate in the learning process, including collaborative learning, cooperative learning, and problem-based learning (Ekici, 2021). AI technology can help extract data on student engagement in flipped learning that incorporates AI technology. For example, students' participation data can be extracted through log records of learning platforms and participation in online discussion platforms to help assess students' participation in learning activities and further understand students' learning motivation.

- Extraction of the learning resources: AI technology can be used to extract and analyze learning resources used in flipped learning integrated with AI technology. This includes online courses, instructional videos, interactive learning modules, and more. By extracting the data of learning resources, the quality and effectiveness of learning resources can be evaluated, and the teaching design can be further improved and optimized.

- Extraction of learning process: AI technology can be used to extract the learning process data of students in flipped learning integrated with AI technology. Big data is the fuel for AI development. Learning enormous amounts of data is an essential foundation in the development of artificial intelligence (Hu, 2021). For example, the learning process data of students can be extracted through the learning path record of the learning platform and the analysis of the learning behavior pattern. This data can help teachers understand students' learning paths and learning strategies, so as to guide students' learning in a personalized way.

- Extraction of teacher feedback: AI technology can be used to extract teacher feedback data on student learning. The feedback data of teachers are extracted through the teacher comments on the learning management system and the automatic grading of online tests. This data can help teachers keep abreast of student learning and provide personalized guidance and support. For example, in an English course, an examination of survey data is conducted to assess learners' proficiency levels, attitudes towards English learning, and their experiences in a flipped classroom setting that incorporates artificial intelligence fusion algorithms. Subsequently, the teacher provides feedback, allowing for an evaluation of the current state and identified issues pertaining to English listening instruction. Moreover, the curriculum objectives and contents are analyzed(Hu, 2021) to provide a scientific basis and guidance for improving and optimizing flipped learning.

Findings and Discussions

A total of 12 articles were selected through the database search, which aims to examine the findings and find out the research gap. These articles were chosen for comparison because the combination of AI and flipped learning is apparent from their titles. There is a close relationship between Artificial Intelligence (AI) and Flipped Learning. Flipped learning is a model of instruction in which students preview the material before class through self-directed study, while class time is devoted to in-depth discussion and application of knowledge. Artificial intelligence technology can provide support and enhance the effect of flipped learning, improve the quality of teaching, and promote students' active participation and in-depth learning. A summary of the studies that were reviewed is as follows:

Table 3 A summary of the findings

Author	Title	Research method	Findings
Lin and Mubarok (2021)	Learning analytics for investigating the mind map-guided AI chatbot approach in an EFL flipped speaking classroom.	Quasi-experimental design	The combination of artificial intelligence chatbot strategy and mind mapping guidance in the English flipped oral class not only helps students improve their academic performance but also improves the interaction between students and chatbots, making group cooperation more creative.
Li and Peng (2022)	Integration of an AI-Based Platform and Flipped Classroom Instructional Model	Quantitative and qualitative methods	By preparing students before class in flipped learning, the AI-powered language learning platform monitors students' pre-class preparation, analyzes students' practice, provides immediate feedback. The workload of some cognitive processing in class can be reduced, and students' nervousness can be reduced and their confidence in participating in class discussion can be enhanced through pre-class activities.

Author	Title	Research method	Findings
Peng and Wang (2022)	Online Education of a Music Flipped Classroom Based on Artificial Intelligence and Wireless Network	Quantitative method	In the flipped classroom, music education students use computer-based instrument software and can contribute to research on the usage of mobile services and online instruction in the field of music education.
Huang., Lu and Yang(2023)	ffect of artificial Intelligence–Enabled personalized recommendations on learners' learning engagement, motivation, and outcomes in a flipped classroom.	Quantitative method	For students with moderate levels of motivation, AI-personalized videos in flipped learning can improve grades and engagement
Hu(2021)	English listening teaching model in flipped classroom based on artificial intelligence fusion control algorithm	Quantitative method	Through the integration of artificial intelligence and control algorithms, the flipped classroom becomes more intelligent, resulting in a more lively and exciting classroom that enhances students' learning interest and improves their English results.
Lv (2023)	Innovative music education: Using an AI-based flipped classroom	Quantitative method：experimental study	The flipped learning based on artificial intelligence enables students to participate more deeply in the learning course and improves the learning effect of piano lessons
Zhang et al. (2022).	Artificial Intelligence and Edge Computing Technology Promote the Design and Optimization of Flipped Classroom Teaching Models for Higher Vocational, Ideological, and Political Courses	Quantitative method	AI standardizes the classroom teaching plan in the flipped classroom, which will help improve students' learning abilities. Due to the increasing number of courses in career-related subjects, a new dimension is provided to the teaching process.
Wu and Wang (2021)	Artificial intelligence-based simulation research on the flipped classroom mode of listening and speaking teaching for English majors.	Quantitative method	To a certain extent, artificial intelligence technology can promote the flexible classroom instructional model, enhance students' ability to recognize learning outcomes, and boost their overall motivation during the learning process.
Shan and Liu (2021)	Blended teaching design of college students' mental health education course based on artificial intelligence flipped class.	Quantitative method	Artificial intelligence technology can promote the flexible classroom instructional model, enhance students' ability to recognize learning outcomes, and boost their overall motivation during the learning process
Yoon and Na-Young (2022).	The Use of Metadiscourse Markers in Mobile-Assisted Flipped Learning in L2 Writing	Quantitative and Qualitative methods	In flipped learning, the use of a meta discourse generator helps second-language learners better their language output

Author	Title	Research method	Findings
Zhang and Fang(2022).	Exploring University EFL Teachers' Technological Pedagogical Content Knowledge and Teacher Efficacy in Technology-integrated Flipped Classroom.	Qualitative method	This study provides a comprehensive analysis and develops a new TPACK framework based on FC. Enhanced comprehension of teacher efficacy, especially as it pertains to FC instruction.
Tan and Cao (2022)	Evaluation of the online music flipped classroom under artificial intelligence and wireless networks.	Quantitative method	The present study's concept addresses the limitations inherent in conventional evaluation methods and establishes a foundation for enhancing the instructional efficacy of online flipped classrooms.

While the summary effectively outlines the positive outcomes resulting from the integration of artificial intelligence (AI) and the flipped classroom approach, a more thorough exploration of the findings can provide deeper insights and critical analysis. The studies reviewed consistently indicate favorable results, including heightened student engagement, improved classroom dynamics, increased student-teacher interaction, and enhanced academic achievement.

For instance, the incorporation of chatbots in flipped learning has demonstrated the capacity to offer personalized support, foster group discussions, and facilitate collaboration within the classroom. Moreover, chatbots contribute to the post-class assessment of student work, supporting self-directed learning and boosting student engagement and motivation (Baskara, 2023).

Furthermore, students exhibit positive attitudes toward artificial intelligence, as evidenced by their active involvement in personalized learning using AI technology. Students not only express interest and enthusiasm but also demonstrate a willingness to explore and utilize the learning resources and tools provided by AI. The integration of AI technology empowers students to proactively manage their learning time and progress, leveraging features such as learning plans and reminders to enhance efficiency and self-discipline (Wu & Wang, 2021).

In addition to their proactive approach to learning, students actively participate in discussions and interactions during class, reflecting a positive disposition toward collaborative learning with both teachers and peers (Shan & Liu, 2021). This positive attitude extends to an openness to the exploration and learning of new technologies, indicating a willingness to accept and adapt to a changing learning environment. Expanding upon these findings, a more in-depth analysis could delve into the nuances of these positive outcomes. Consideration of potential challenges, limitations, and areas for future research would contribute to a richer discussion, enhancing the overall depth and critical insights presented in the paper.

For the research methods in these articles, most researchers used the quantitative method, especially the experimental method. The experimental groups and control groups to find out the impacts of the implementation of artificial intelligence integrating flipped learning (Kong, Zhang & Cheung, 2022). Besides, two researchers adopted both the quantitative method and the qualitative method, while one of the researchers chose the qualitative method.

However, these studies suggest that AI-based technology can improve student motivation and learning outcomes in flipped learning needs to be effectively planned and deployed to be effective (Baskara, 2023). Therefore, through these articles to conclude the limitation can gain a better understanding of integrating artificial intelligence into flipped learning.

Limitation

In these studies, there are certain limitations in the application of experimental research in quantitative research. Firstly, the influence of participants on the experiment and the selection of participants will also affect the

experimental results (Lin & Mubarok, 2021). Secondly, the length of the experiment also has an impact on the learning time requirements in the study (Li & Peng, 2022). Finally, with fewer subjects to choose from, less data is available, which weakens the power of persuasion (Wu & Wang, 2021). The research plan should be improved in time during the research process. Despite a large number of database searches, there are still relatively few empirical articles, and only these 12 articles are selected for comparison, which indicates that this cutting-edge research topic needs further exploration.

Additionally, the application of AI-based technology in the flipped classroom is still in the development stage, and there are some technical limitations. Artificial intelligence in the flipped classroom often requires the collection and analysis of student's personal data. This is an issue of data privacy and security (Baskara, 2023). Students have individual differences and diverse needs in learning. The personalized learning function of artificial intelligence technology can provide a customized learning experience according to the characteristics and needs of students.

Recommendation

According to the current review, the impact of AI-based technology combined with flipped classrooms in different disciplines is the main focus, but further study can be devoted to developing new integrated teaching techniques, constructing applicable alternative intelligence systems, and investigating the effects of implementing new teaching methods on indicators such as student motivation and learning effectiveness (Lv, 2023). In the teaching process, this method can provide a new dimension to the teaching strategy in the classroom (Zhang, Wei, Zhang & Wang, 2022).

Overall, AI-based technology combined with the flipped classroom can provide the benefits of personalized learning, real-time feedback and support, and facilitating interaction and collaboration. The appropriate technology tools need to be selected according to the specific situation, and teachers need to adapt to the changing role and constantly evaluate and improve teaching practices. In this way, the potential of artificial intelligence in the flipped classroom can be better utilized to enhance the students' learning effect.

Conclusion

This review is to summarize and evaluate the impact of artificial intelligence on flipped classroom in related articles, mainly aiming at the students' motivation and which can affect students' learning experience and academic performance. After identifying the research questions, 12 articles were selected for analysis, and the analyzed data were extracted for discussion. The benefits and potential challenges of combining artificial intelligence with flipped classroom were found in the findings. This can provide important information for teachers implementing flipped learning as well as innovative teaching methods. At the same time, it can also provide some suggestions and research directions for researchers interested in artificial intelligence combined with flipped classroom. However, more future research is needed to further address the limitations and to explore in depth the potential and application of AI-based technology in the flipped classroom.

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