



Study on Secondary School Mathematics Teaching Based on Blended Teaching Model in China

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Blended teaching is of great significance for improving the quality of secondary school mathematics teaching and students' interest in learning mathematics. In recent years, some scholars have done research on the blended teaching model of secondary school mathematics, but there has not been any literature to sort out and summarize them. In order to determine the aspects included in the current research on secondary school mathematics teaching based on blended teaching, and to identify the deficiencies in the current research. This paper adopts the method of literature analysis to analyze the previous studies. That's 14 articles in all and draws the following conclusions: (1) Previous research mainly focuses on five aspects, the analysis of the current situation, the connotation of blended teaching, the advantages and significance of blended teaching, the implementation strategy of blended teaching in secondary school mathematics, and specific cases. (2) The research methods are relatively single, mainly qualitative research and less quantitative research. (3) The researchers are mostly teachers in secondary schools, and there are fewer

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studies by university professors and educational experts. (4) The research content are similar, most scholars have divided the blended teaching into three phases: before, during and after class, respectively, starting from how to do it online and offline, and the combination of online resources and offline teaching is shallow. (5) There are still some blank spots to be researched. For example, the challenges and deficiencies of blended teaching in secondary schools in China and how to deal with them; how blended teaching should be carried out in rural and remote areas; how to evaluate under blended teaching of mathematics in secondary schools. Therefore, it is necessary for future research to conduct deeper research on secondary school mathematics teaching under blended teaching with diversified research methods.

Keywords: Secondary school mathematics; blended learning; online and offline teaching.

1. INTRODUCTION

Blended teaching mode is a new teaching mode born on the basis of the development of "Internet +", which combines traditional teaching methods with online teaching methods, utilizing online resources and platforms for independent learning, as well as face-to-face classrooms for deeper discussions and practical operations (Zhao & Li, 2024; Xiang et al., 2023; Zhou, 2023). This teaching method not only retains the advantages of traditional teaching methods, which can provide a place for students to communicate and interact with each other, but also highlights the role of technology in promoting teaching and providing students with a good platform for self-learning (Liu, 2024; Shi, 2024; Liao, 2024). China launched the education digitalization strategy in 2022, and took the lead in building the world's largest smart education platform, the National Smart Teaching Platform, and to this day, the application of blended teaching in school education is becoming more and more common, and will be a key part of the construction of education modernization (Tong et al., 2020; Wang & Guo, 2018; Park, 2017). In the subject of mathematics, the use of blended teaching can deepen students' understanding of mathematical concepts, principles and so on, cultivate independent learning ability, improve digital literacy, and realize personalized teaching (Lo & Hew, 2021; Fazal & Bryant, 2019; Egara & Mosimege, 2024). Therefore, it is of great practical significance to study the application of blended teaching mode in mathematics teaching (Tan, 2021; Ma, 2024). However, at present, most of the results of blended teaching are concentrated in the field of higher education and are commonly used in medicine and engineering, and there are relatively few studies on blended teaching at the secondary school level, and even fewer studies specifically for the subject of mathematics (Wang & Zhao, 2024; Hu, 2022; Yang, 2024). In order to systematically analyze

the current research, this paper intends to review and sort out the current research and summarize the previous research. (Abdissa et al., 2024; Indrapangastuti et al., 2021; Samura, 2023) The value of this study lies in the following: on the one hand, it can provide ideas and directions for how to apply blended teaching in secondary school mathematics teaching; on the other hand, it can discover the deficiencies of the current research, so as to provide references for the subsequent research.

This study was guided by the following questions:

- (一) What are the aspects included in the current research on secondary school mathematics teaching based on blended teaching model?
- (二) What are the shortcomings of the current research on secondary school mathematics teaching based on blended teaching model?

2. LITERATURE SOURCES

2.1 Sources of Materials

The literature involved in this paper comes from the China Knowledge Network (CNKI) database, which is the most authoritative literature search tool for academic journals in China, and basically includes the contents of all domestic journals in a complete manner, including various subject areas, so the selection of this database in this paper ensures the persuasiveness and credibility of the study.

2.2 Data Collection

To avoid omissions, four different keywords were entered into the literature search: "blended teaching," "middle school math," "high school math," and "online and offline teaching." A total of 14 papers were mentioned through the advanced

search; therefore, this paper provides an analysis for these 14 papers in depth.

2.3 Data Sorting

The author categorized all the literature into two categories: middle school and high school, and carefully read the literature and took notes to summarize and sort out the research findings, research methods and sample information.

3. RESULTS

Among these 14 papers, 10 are researches on the blended teaching of junior high school and 4 are researches on the blended teaching of senior high school, and almost all of them are from the teachers of secondary schools. However, the research results are roughly focused on three aspects: analysis of the current situation, theoretical research and applied research. The three types of research are not fragmented, but always combined together.

3.1 Analysis of the Current Situation of Mathematics Teaching in Secondary Schools

Scholars have found that the teaching of mathematics in junior and senior high schools is generally characterized by problems such as a single teaching method and lagging thinking of teachers. Among them, Minmin Hu thinks that the teaching method of junior middle school mathematics is solidified, although teachers use modern information technology to teach in the teaching process, but lack of effective interaction with students, and do not pay attention to creating situations or raising questions to mobilize students' interest in learning, some teachers even use rote learning to let students master problem solving skills, and do not pay attention to learning new teaching modes; Qingliu Bai thinks that the teaching modes of junior high school mathematics classroom is rigid, lack of innovation, most of the classroom is the traditional teaching, teachers are mostly based on the content of the preparation of the lecture, the role of the teacher is slow to change; Demiao Tan believes that the current junior high school mathematics teachers are still commonly used in the lecture, and the interaction with the students is limited to the teacher-student question-and-answer session; Ling Zhou believes that the traditional classroom teaching mode was born in the industrial era, originating from the factory standardization, assembly line type education and talent training mode, standardized classroom,

uniform content and time of instruction, standardized assessment and evaluation methods and so on; while Xuemei Xiang, Ying Wang, Chengguan Xiang investigated the situation of rural junior middle school mathematics teaching and found a gap with the conditions of blended teaching, learning hardware facilities in rural areas can not keep up with the standard, and at the same time, teachers lack specialized training, and there were dilemmas on how to complete teaching activities, how to choose resources, and how to use technology in limited class time. In schools without boarding system, the quality of online learning is also difficult to ensure after class; Yuliang Yang believes that the blended teaching of senior high school mathematics is not all students are suitable for online learning, and that many teachers are not can really implement the requirements of online teaching in the process of teaching, but offline teaching is limited by time and space, which directly affects the progress of the teacher's teaching, and also weakens the interaction between teachers and students, and the students' learning experience cannot be guaranteed.

3.2 Theoretical Research on Blended Teaching in Secondary School Mathematics

Regarding the theoretical research on blended teaching in secondary school mathematics, scholars have mainly focused on two aspects: the connotation of blended teaching mode, and the advantages and significance of blended teaching.

3.2.1 The meaning of blended learning

Different scholars have different understandings of blended teaching. Xuemei Xiang, Ying Wang, and Chengguan Xiang believe that blended teaching is an organic combination of educational technology and traditional classroom, which not only overcomes the "uncontrolled" gallop of online learning without the participation of teachers, but also enriches the diversity of offline classroom and personalized teaching strategies; Ling Zhou believes that blended teaching is a combination of the advantages of traditional teaching and networked teaching, which not only plays the leading role of teachers in guiding, inspiring and monitoring the teaching process, but also embodies the initiative, enthusiasm and creativity of students; Minmin Hu believes that blended teaching is an effective

combination of informatization and teaching; Moujie Tang and Lin Cui elaborated that blended teaching is a broad mix of online and offline teaching strategies, teaching methods, teaching resources, teaching content, teaching organization and teaching media on the basis of blending; Zhongjie Wang and Shunan Guo believe that blended teaching refers to the use of "suitable" teaching methods to communicate with learners at the "right" time in the "right" way. "; Chuanhong Tong , Zheng Ruan , and Depin Wei believe that blended teaching, also known as blended learning, refers to the integration of the advantages of classroom teaching and online teaching, and is a form of collective teaching in which the teacher's lecture is the main focus and is a form of online teaching in which self-directed learning is the main focus. Self-directed learning as the main form of online teaching and practical teaching.

3.2.2 Advantages and implications of blended learning

Many scholars have put forward their views on the advantages of blended teaching mode compared with traditional teaching mode and the significance of blended teaching. Xuesheng Wan thinks that blended teaching can improve the quality of teaching, avoid the outstanding problems caused by traditional classroom teaching, such as insufficient teacher ratio, insufficient internal motivation of students' learning, and a single learning mode, to build a good learning ecological environment for all the students; Minmin Hu thinks that blended teaching can enhance the flexibility of teaching and learning; Zhonghua Zhao and Chaonan Li think that the promotion and practice of blended teaching can help the development of informatization in education and accelerate the modernization process of education, and become the new normal of teaching in the future under the background of "Internet + Education" and the post-epidemic era; Yuliang Yang believes that blended teaching on-line and off-line can help to make up for the shortcomings of the off-line mode of teaching and effectively broaden the learning space of students, which is beneficial to the excavation and cultivation of students' in-depth thinking; Xueyi Lin believes that blended teaching strengthens cooperative and mutual mathematical communication, and also improves the teaching ability and comprehensive quality of secondary school teachers; Maojie Tang and Lin Cui believe that the new blended teaching in the era of big data can give full play to the student's main position and the teacher's role in guiding

and assisting, realizing the pre-course learning of junior high school mathematics courses, classroom inversion and post-course reinforcement and consolidation, enhancing the students' awareness of active learning, and Improve students' ability to analyze and solve problems independently; Qingliu Bo found that the blended teaching mode is conducive to improving students' mathematical performance, as well as stimulating students' interest in mathematical learning, and improving students' ability of cooperative inquiry and independent learning.

3.3 Applied Research on Blended Learning in Secondary School Mathematics

Regarding the research on the application of the blended teaching model in secondary school mathematics, scholars have mainly focused on two aspects: the implementation strategy of the blended teaching model in secondary school mathematics and specific cases.

3.3.1 Implementation strategies for blended learning in secondary school mathematics

Almost all scholars have put forward their suggestions and implementation strategies for blended teaching and learning in secondary school mathematics. Xuemei Xiang, Ying Wang, and Chengguan Xiang believe that we should choose appropriate teaching resources and methods in appropriate teaching environment and time, and adapt students' appropriate learning personalities, exploring in terms of resource adaptation, technology integration, and subject synergy; while Ling Zhou and Jun Shi put forward the "336" blended teaching model. The model is based on the three dimensions of "teacher, network, and student", the three phases of "before class, during class, and after class", and the six links of "independent learning, testing and feedback (diagnostic testing), questioning and expanding, testing and feedback (formative testing), and summarization, cloud remediation" ; Xuesheng Wan gave the specific measures of online and offline: online on the one hand, preset micro-lessons, pre-study summarization, cultivate students' self-learning habits, on the other hand, method guidance, guide training, strengthen students' learning ability; offline on the one hand, create a situation, stimulate the interest of the introduction to awaken students' enthusiasm for learning, on the other hand, predetermined questions, exchange of inquiry to

improve the effectiveness of classroom teaching. Minmin Hu believes that the application of blended teaching should be the use of micro-teaching pre-study sheets, online teaching, offline teaching, the application of homework, and the construction of multiple evaluations; Moujie Tang, Lin Cui put forward a new blended teaching model in the era of big data, which is divided into three parts: before, during and after class, and the feedback of big data is carried out throughout each part of the blended teaching. Teachers analyze the data of the three stages, broaden the teaching dimension, and guide students to carry out inquiry-based learning to help them form a complete knowledge structure system; Zhongjie Wang and Shunan Guo start from the mixing of teaching theories, the mixing of teaching methods, the mixing of teaching resources, and the mixing of teaching environments; Qingliu Bai also divides the blended teaching into the three stages of pre-course, in-course, and post-course, and adopts the junior high school mathematics teaching platform before the class, using the flipped classroom teaching methods; Zhonghua Zhao and Chaonan Li divide blended teaching into four aspects from the perspective of high school mathematics: before class, during class, after class, and throughout the whole process. Before class, independent pre-study. During class, creating situations, cooperative inquiry. After class, consolidation and expansion, layered homework. And throughout the process, analyze the learning situation and scientific evaluation; Yuliang Yang advocates the creation of a "student-oriented, teacher-led" blended teaching mode, combining regular classroom teaching activities with online classroom teaching mode, and focusing on the integration of textbook resources and online resources.

3.3.2 Specific examples of blended learning in secondary school mathematics

Almost all scholars cite specific cases after introducing the implementation strategies of blended teaching in secondary school mathematics. Xuemei Xiang, Ying Wang, and Chengguan Xiang cited the "Code Academy" teaching platform developed by the School of Mathematics and Big Data of Guizhou Normal University; Ling Zhou cited the lesson "Parallelogram Review Lesson - Finding the Coordinates of the Vertices of a Parallelogram from the Perspective of Translations" by Ms. Zhao of Pingdong Middle School in Fuzhou; Xuesheng Fang cited the lessons "Plane Right Angle Coordinate System" and "Plane Right

Angle Coordinate System" as examples; and Xuesheng Fang cited the examples of "plane coordinate system", "addition and subtraction of integers", "quadratic function", "perfect square formula", "hook and loop formula", "parallelogram", "application of the collinearity theorem", "understanding quadratic equations", and the contents of the "Nine Chapters on Arithmetic"; Minmin Hu cited examples of "quadratic equations", "congruent triangles", "pythagorean theorem", "positional relationships between circles and straight Lines", "planar coordinate system"; Zhongjie Wang, Shunan Guo elaborated a case "using calculator to investigate square root and cube root"; Qingliu Bai cited the case "the nature of parallel lines"; Zhonghua Zhao, Chaonan Li around the senior high school mathematics of "conic curve"; Yuliang Yang took "logarithmic function" and part of "statistics" as examples; Qianchao Yu took "parity of function" as an example; Demiao Tan cited the examples of "the rich world of shapes", "Intercepting a geometric body", "looking at the shape of an object from three different directions", "the positional relationship between two straight lines"; Chuanhong Tong, Ruan Zheng and Derbin Wei cited an example of "the nature of inequality"; Meina Liao cited an example of "the determination of parallelograms".

3.4 Shortcomings of Blended Instruction in Secondary Mathematics

While promoting blended teaching, some scholars have also put forward the challenges faced by blended teaching in secondary school mathematics, but they are relatively few. Among them, Xuemei Xiang, Ying Wang, and Chengguan Xiang put forward the implementation dilemmas of blended teaching in rural secondary school mathematics, including the theoretical dilemma, the subject-object dilemma, the disorientation dilemma, the temporal and spatial dilemmas, and the creation dilemmas; Zhonghua Zhao and Chaonan Li put forward a series of challenges faced by blended teaching: how to further strengthen the construction of blended teaching network and hardware facilities, how to further improve the construction of digital curriculum resources; how to further enhance teachers' modern informational technology literacy, technology application ability and innovation ability of teaching design, how to further establish an effective online learning supervision mechanism in response to the problem of insufficient self-control of students' online learning.

4. DISCUSSION

Through the search and statistics of the above studies, we can find that scholars have carried out research on the teaching of secondary school mathematics based on blended teaching from different aspects and perspectives. Among them, there are more studies on blended teaching in middle school mathematics than in high school, but almost all of them are from the teachers in middle school, and the research results are also roughly focused on three aspects: Analysis of the situation on secondary school mathematics' teaching, theoretical research and application research, and there are fewer researches on the shortcomings.

The analysis of the current situation mainly reflects that the current mathematics' teaching methods of junior and senior high schools are single, still dominated by the traditional lecture style, teachers and students lack effective interaction, teachers' thinking lag behind, do not pay attention to the innovation of teaching mode and the creation of problem situation, and do not adapt to the use of teaching technology, even through rote memorization to let the students memorize the problem-solving skills, resulting in low interest in learning. The rigidity of the mode of instruction, which is not conducive to the play of the student's subjective position and personalized teaching. Therefore, there is an urgent need for new ways to change this situation.

Theoretical research mainly focuses on two aspects: the connotation of blended teaching and the advantages and significance of blended teaching. According to the scholars' discussion on the advantages of blended teaching, it can be found that blended teaching has the functions of improving teaching quality, enhancing students' interest in mathematics learning, strengthening cooperative and mutual mathematical communication, enhancing students' awareness of independent learning, and accelerating the process of modernization of education. Therefore, it is very meaningful to study the use of blended teaching in secondary school mathematics teaching.

Applied research mainly focuses on two aspects: the implementation strategy and specific cases of blended teaching in secondary school mathematics. After statistics, it can be found that most scholars have divided the blended teaching mode into three phases: before, during and after

class, respectively, starting from how to do it online and offline, and mentioning that more is through online learning and independent pre-study before class, group discussion, cooperative inquiry or collective face-to-face teaching during class, and consolidation practice or group discussion after class. It can be seen that scholars lack innovation and deep understanding of the research on blended teaching mode, and the combination of online resources and offline teaching is relatively shallow and lacks deep integration. According to the above summary, it can be seen that there are still some shortcomings in the previous studies. On the one hand, in terms of research methodology, the previous studies are all qualitative studies without quantitative studies; on the other hand, in terms of research content, the number of studies on this topic is relatively small, especially for high school mathematics, and most of them are researched by secondary schools' teachers, and there are fewer researches conducted by university professors, educational experts, etc., and the contents of the researches are relatively homogeneous and lack innovation, and there are few researches on the challenges existing in blended teaching and there are few studies on how learning assessment is carried out under blended teaching.

Therefore, future research should apply more quantitative means to scientifically analyze the effects brought by the blended teaching model. At the same time, the research should also break the current thinking stereotypes, and secondary school teachers can cooperate with university professors to come up with more innovative ideas. In addition, researchers can pay more attention to how blended teaching is carried out in rural or remote areas and the problems of the current blended teaching model.

5. CONCLUSION

This study analyzes and summarizes the literature related to secondary school mathematics' teaching based on blended learning and draws the following conclusions:

- (1) The study mainly started from the analysis of the current situation, the connotation of blended teaching, the advantages and significance of blended teaching, the implementation strategy of blended teaching in secondary school mathematics and specific cases.

- (2) The research methods are relatively single, mainly qualitative research and less quantitative research.
- (3) Most of the researchers are teachers in secondary schools, and there are fewer studies by university professors, education experts, and so on.
- (4) The research content are similar, most scholars have divided the blended teaching model into three phases: before, during and after class, respectively, starting from how to do it online and offline, and the combination of online resources and offline teaching is shallow and no new theories have been put forward.
- (5) There are still some blank spots to be researched. For example, the challenges and deficiencies of blended teaching in secondary schools in China and how to deal with them; how blended teaching should be carried out in rural and remote areas; the lack of research on blended teaching of mathematics at the high school level; and how learning assessment should be carried out under blended teaching of mathematics in secondary schools.

It is necessary for future research to build on existing research with diverse research methods on blended learning model of secondary school mathematics teaching to conduct deeper and more innovative research, so that blended teaching is put into practice, effectively improving students' learning motivation and promoting the modernization of education.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (Chat GPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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