**Research on Online Mathematics Teaching in High Schools from 2020 to 2025 in China**

**Abstract:** Online teaching has the advantages of being able to overcome time and space constraints as well as sharing resources, which have been studied by a number of scholars at present. However, there is currently no literature that summarizes and organizes this research. This paper uses the literature review method to review and organize relevant literature on online mathematics teaching in high schools, drawing the following conclusions: (1) Current research on online mathematics teaching in high schools mainly focuses on two aspects: strategies to improve the effectiveness of online teaching and the advantages and disadvantages of online teaching. (2) The current research on online mathematics teaching in high schools is rich in content, covering teaching strategies, teaching effectiveness, advantages and disadvantages, and other aspects, but the research lacks systematicity and depth. Most studies remain at the theoretical level, lacking empirical support and long-term follow-up research. (3) Existing research addresses the overall situation of online mathematics teaching in high schools broadly, without in-depth analysis of specific aspects.

***Keywords*:** Middle School, Mathematics, Online Teaching

**1. INTRODUCTION**

Online teaching is a teaching model that applies multimedia and network technologies under the guidance of certain teaching theories and ideas, achieving teaching goals through multi-directional interactions among teachers, students, and media, as well as the collection, transmission, processing, and sharing of various media teaching information (Zhu, 2020). Affected by the epidemic (pandemic or epidemic disease), online teaching has become a hot topic of concern. Although the impact of COVID-19 has gradually diminished and normal offline teaching has resumed, online teaching still holds great potential for development due to its ability to overcome time and space limitations and share resources (Ren, 2023). As one of the core subjects of basic education, middle school mathematics is undoubtedly an important area for researching online teaching practices. Therefore, studying online mathematics teaching in high schools is of great significance. To date, there has been much research on online mathematics teaching in high schools, but there is a lack of systematic organization and summarization of this research. This paper aims to review and organize the current research status of online mathematics teaching in high schools, systematically analyze its research status, summarize successful experiences and existing problems in current practices, and provide scientific strategic references for improving the effectiveness of online mathematics teaching in high schools. More importantly, by identifying gaps and shortcomings, this paper aims to encourage further in-depth research by scholars.

The research question of this paper is: What is the current research status of "online mathematics teaching in high schools"? Specifically, it includes the following two aspects:

(1)What aspects have scholars studied regarding "online mathematics teaching in high schools"?

(2) What research results have scholars provided for each aspect?

**2. Literature Sources**

2.1 Data Sources

This paper selects literature from the China National Knowledge Infrastructure (CNKI) database as the data source. CNKI is the most authoritative literature retrieval tool for Chinese academic journals, and it comprehensively covers the content of all journals in China. Selecting this database ensures the persuasiveness and reliability of the research.

2.2 Data Collection

To avoid missing relevant literature, the search process involved using different combinations of keywords: "middle school mathematics" and "online," "middle school mathematics" and "network," and "middle school mathematics" and "online teaching." A total of 20 articles meeting the research criteria were selected.

2.3 Data Organization

Through intensive reading of the literature and the method of note-taking, we summarized and organized the research contents and results of the previous studies.

**3. Results**

Comprehensive research on online mathematics teaching in high schools in China can be found that its content mainly focuses on the strategies to improve the effectiveness of online mathematics teaching in high schools and the strengths and weaknesses of online mathematics teaching in high schools, and some scholars have also studied the attitude and feedback of online mathematics teaching in high schools, the effectiveness of teaching, the teaching interaction and the design of homework, and so on.

3.1 Strategies for Improving the Effectiveness of Online Mathematics Teaching in High Schools

A number of (Several) scholars have given strategies to improve the effectiveness of online mathematics teaching in high schools from different perspectives based on the findings of their studies. The scholars' strategies mainly involve various aspects such as online platforms and equipment, resource development and integration, teaching content design, and teaching strategy adjustment. Most of the literature mentioned teaching strategy adjustment, accounting for 67%, and some of the literature mentioned online platform (platforms) and equipment, teaching content design, and teaching interaction, accounting for 39%.

3.1.1 Online platform and equipment

From the perspective of building an online teaching platform to achieve personalized learning, Zhu Guangqing proposes to establish class learning communities, QQ learning groups or WeChat groups, develop or utilize online teaching systems, and carry out online tutoring and question-answering (Zhu, 2024). Shen Xucong (2024) proposes organizing learning communities, establishing online “study rooms”, and posting inquiry content on various teaching platforms (Shen, 2024). Wu Shouzhen() believes that the curriculum can be innovated in the form of “micro-forums” through “videoconferencing” (Wu, 2020). Han Xue and Li Xiaohong believe that in order to effectively carry out online mathematics teaching in high schools in the classroom,( school classroom) it is necessary to prepare the equipment before class (Han, 2021). Zhang Xin advocated the construction of an online teaching platform for mathematics in order to (to) improve the quality of teacher-student interaction and enhance the effectiveness of mathematics classroom teaching (Zhang, 2021). Liu Xi, from the perspective of the platform, puts forward the suggestions of( suggestions for) improving the load of the platform, optimizing the interaction function, and improving the teaching supervision function (Liu, 2021). Gao Xiaoyun proposes to make good use (the benefits use) of online teaching ~~means~~ so that students have a good learning experience platform (Gao, 2022).

3.1.2 Resource development and integration

Shen Xucong, Ji Anqi and Bai Fangjing believe that based on resource allocation, high-quality online resources can be introduced to build an online library and strengthen communication among educators. Based on resource development, curriculum resources are expanded? (Shen, 2024, Ji, 2023, Bai, 2021). Luo Shifang believes that teachers should work together to help each other and share teaching resources (Luo, 2022). ~~Wu Zijun, Xiong Haijin, Li Yanqi~~ Other researchers believe that it is necessary to rationally plan, use and deploy various online resources, and enrich and update online resources ~~in a timely manner~~ promptly (Wu, Xiong, Li, Qin, & Yang, 2022). Liu Xi believes that emphasis should be placed on the integration of mathematics online resources to enrich the classroom (Liu, 2021).

3.1.3 Teaching content design Content Design

Sun Qibin believes that it is necessary to change from combing knowledge and explaining example problems to sharing homework and evaluating methods; from one-dimensional to multi-dimensional, and from the linear presentation of problem-solving methods to the generalization of multi-perspective thinking (Sun, 2020). Luo Shifang believes that it is necessary to carefully reconstruct the teaching content, dig deep into the teaching materials, integrate and expand the teaching content; find the fit between the core literacy of mathematics and the teaching content; and improve the effect of courseware assistance (Luo, 2022). Wu Zijun, Xiong Haijin, Lai Yanqi, Qu Shangbing, and others believe that we should ensure the rationality of online teaching content and make the content of lesson preparation different from the previous offline teaching (Wu, Xiong, Li, Qin, & Yang, 2022, Qu, 2021). Han Xue thinks that the teaching content should be fully prepared before class (Han, 2021). Cui Yujia thinks that it is necessary to focus on problem training, teach problem-solving skills, and rationalize the teaching design (Cui, 2021). Gao Xiaoyun thinks that we should focus on the fun of teaching content and ~~cultivate~~ cultivating students' mathematical ~~emotion~~ emotions(Gao, 2022).

3.1.4 Teaching strategy adjustment

Shen Xucong believes that it is necessary to implement individualized strategies, set ~~up graded~~ upgraded learning tasks; assess the existing resources and implement tailored teaching; optimize teaching strategies based on the delivery of resources, collect learning data, online grouping, and use cyberspace to display excellent assignments and typical errors; reflect on and adjust teaching strategies in time according to the learning situation; give guidance on strategies, motivate deep learning, provide clear learning strategies or knowledge guidance to form an effective task chain (Shen, 2024). Wu Shouzhen believes that the teaching unit should be compressed, adopting a new mode of delivery every 5 minutes; strengthening the rhythm of the course, teachers increase the proportion of case studies in teaching, and enhance the interest and timeliness of knowledge (Wu, 2020). Sun Qibin believes that it is necessary to change from class instruction to group learning, and from knowledge delivery to tracking and monitoring based on asynchronous attainment (Sun, 2020). Bai Fangjing believes in diversified reorganization to meet the teaching needs of corresponding online courses (Bai, 2021). Luo Shifang thinks that online teaching language should be refined (Luo, 2022). Qu Shangbing thinks that teachers need to give full play to their guiding role to make the content of the lectures more standardized; give full consideration to students' learning ability as well as different students' ways of thinking (Qu, 2021). Han Xue believes that shallow learning and deep learning should be articulated to promote students' deep learning (Han, 2021). Zhang Xin believes that the roles of teachers and students should be accurately positioned based on the concept of mathematics education (Zhang, 2021). Liu Xi believes that the teaching strategy should be adjusted, online teaching needs to integrate fun under the premise of order, fully consider the psychological dynamics of students in the adaptation period of the new environment, to enhance the attractiveness of the classroom; to strengthen the mathematical understanding of the students, to develop divergent thinking as well as to develop good mathematical learning habits, and to enhance the level of computer skills; to optimize the teaching strategy, to design the “appropriate” online teaching (Liu, 2021). Cui Yujia believes that reasonable and effective teaching methods should be adopted to penetrate mathematical thinking and improve mathematical literacy (Cui, 2021). Xu Jin believes that online teaching design should be based on contextual experience, focusing on social hotspots and creating an introductory context; creating a game context to identify function concepts; drawing function graphs to show an intuitive context; and creating an application context to reflect ideological and political integration (Xu, 2021). Gao Xiaoyun believes that it is necessary to establish multidimensional teaching objectives to promote the synergistic development of students' knowledge, skills and abilities (Gao, 2022).

3.1.5 Teaching concepts and principles

Shen Xucong believes that it is necessary to implement individualized strategies and set up graded learning tasks; assess the existing resources and implement tailored teaching; Ren Chunmiao and Gao Xinghui believe that it is necessary to change the concept of online teaching and correctly understand the value of online teaching (Ren, 2023, Ren, & Gao, 2022). Lu Yuan believes that it is necessary to change the attitude of teachers and students towards online distance learning (Lu, 2020). Zhang Xin believes that it is necessary to cultivate ~~the a~~ sense of presence and view online teaching rationally (Zhang, 2021). Liu Xi believes that the concept of “lifelong learning” should be ~~practiced~~  practised(Liu, 2021). Cui Yujia believes that interest is the best teacher (Cui, 2021).

3.1.6 Teaching interaction

Shen Xucong believes that it is necessary to improve student participation, promote in-depth interaction, and organize interactive activities online that are closely related to teaching (Shen, 2024). Ji Anqi believes that it is necessary to enrich the teaching interaction between teachers and students to ensure the quality of online teaching (Ji, 2023). Wu Shouzhen believes that it is necessary to build an interactive scoreboard to maintain the motivation of students' interaction; to strengthen the live broadcasting scene, and to use the “interactive panel” to create a real-time interaction (Wu, 2020). According to Bai Fangjing, it is necessary to provide a platform for teachers and students, and students and students to communicate and interact with each other on mathematical theories and applications, and mathematical ideas and methods (Bai, 2021). Han Xue and Li Xiaohong believe that interactive teaching and group cooperative learning should be enhanced; set up robbing questions to enliven the classroom atmosphere; and propose one problem with multiple solutions to enhance the classroom activity (Han, 2021). Zhang Xin thinks ~~to set~~ of questions from multiple perspectives to stimulate the effectiveness of interaction; to use ~~the~~ core math literacy as a carrier to improve the interactive initiative; to provide technical interactive equipment support in schools; and ~~to~~ improve the technical interactive initiative of teachers (Zhang, 2021). Liu Xi believes in multi-dimensional online interaction, such as the use of voice, video, ~~dialog~~  dialogue boxes, and mathematics online teaching platforms (Liu, 2021).

3.1.7 Student participation

Shen Xucong believes that we should take students as the main body, invite students to be “little teachers”; promote the independent practice, release students' learning outcomes to the public; and encourage students to participate in the development of curriculum resources and content (Shen, 2024). Ren Chunmiao believes that it is necessary to change the way of learning so that students can actively participate in the classroom (Ren, 2023, Qu, 2021). Wu Shouzhen thinks that the polling function should be skillfully used to stimulate students' curiosity (Wu, 2020). Sun Qibin believes that learners should be forced onto the stage and the pedagogue should exit the stage appropriately (Sun, 2020).

3.1.8 Teaching management

Ji Anqi believes that to develop an online teaching system, and form the monitoring form of teaching affairs-teachers-students (Ji, 2023). Ren Chunmiao thinks that it is necessary to strengthen teachers' informatization training, improve teachers' instructional design ability, and optimize the teaching process (Ren, 2023, Ren, & Gao, 2022). Wu Zijun and Xiong Jinhai believed that the management of online teaching and teachers should be strengthened, and the management of teaching quality should be improved (Wu, Xiong, Li, Qin, & Yang, 2022). Qu Shangbing believed that it is necessary to improve the online teaching level of teachers (Qu, 2021).

3.1.9 Teaching evaluation

Wu Zijun believes that we should do a good job in the evaluation of online teaching, such as teaching content, teaching effect and other aspects, ~~so as to~~ to achieve “all aspects of evaluation” (Wu, Xiong, Li, Qin, & Yang, 2022). Gao Xiaoyun believes that we should focus on the process of teaching evaluation to improve students' independent learning ability (Gao, 2022).

3.1.10 Home-school cooperation

Shen Xucong believes that parents and social forces should properly participate in the development of curriculum resources (Shen, 2024). Ren Chunmiao believes that it is necessary to maintain family-school communication and build a harmonious parent-child relationship (Ren, 2023). Qu Shangbing believes that home-school teaching should be carried out (Qu, 2021). Liu Xi believes that learning scenarios are mainly built by students' parents (Liu, 2021).

3.1.11 Environmental support

Ji Anqi thinks that it is necessary to create a good classroom atmosphere, so that the teaching process is no longer monotonous and boring (Ji, 2023). Ren Chunmiao thinks that it is necessary to improve the network teaching equipment and teaching environment to ensure that online teaching is carried out normally (Ren, 2023, Ren, & Gao, 2022). Lu Yuan believes that it is necessary to mobilize all departments of the school to actively participate in distance network teaching; cultivate professional and technical personnel to promote the effective development of online distance teaching (Lu, 2020).

3.2 Advantages and Disadvantages of Online Mathematics Teaching in High Schools

3.2.1 Advantages

Some scholars believe that online mathematics teaching in high schools is resource-rich and sharing, with 54% of scholars mentioning this aspect. Shen Xucong believes that online mathematics teaching in high schools provides rich resources and accelerates the speed of information transfer, and online teaching platforms, WeChat public numbers and video websites provide teachers and students with rich mathematical knowledge content (Shen, 2024). Ji Anqi believes that online mathematics teaching in high schools provides massive information, saves space and time for teachers and students, and improves teaching efficiency (Ji, 2023). Ren Chunmiao believes that online mathematics teaching in high schools can be repeatedly watched (in) the explanation video, (is) rich in learning resources, and has network sharing (Ren, 2023). Wu Shouzhen believes that online mathematics teaching in high schools is conducive to the optimization of resource sharing by “Internet + Microteaching”. Lu Yuan believes that online mathematics teaching in high schools is conducive to enriching teaching resources and realizing resource sharing (Wu, 2020). Wu Zijun believes that online teaching has ~~a~~ wide popularity, for the same teaching content, there is no restriction on the number of people, school years, or time, and can be repeated learning; online teaching is cost-effective, through less expenditure and resources can realize a wide range of high-quality teaching (Wu, Xiong, Li, Qin, & Yang, 2022). Cui Yujia believes that online mathematics teaching in high schools can enjoy the same learning resources for students in different regions, which promotes equality in education (Cui, 2021).

Some scholars believe that online mathematics teaching in high schools has diversified forms and means, and 38% of scholars mentioned this aspect. Shen Xucong believes that online mathematics teaching in high schools provides a platform for expression, and students can express their mathematical views and share their mathematical insights in cyberspace, highlighting their personalized characteristics (Shen, 2024). Ji Anqi believes that online mathematics teaching in high schools is targeted, different levels of students can take different ways and methods, has the characteristics of intuitive image, can overcome ~~the~~ abstract problem; can mobilize learning enthusiasm through the graphic and audio-visual multi-metacognitive and multi-sensory stimulation; can simulate the dynamic process, effectively presenting the teaching of the important and difficult points; can be a virtual reality, breaking through the visual limitations, especially for obscure knowledge points in science subjects, reproduce the origin of things; through the combination of live recording and video recording, to strengthen the memory of knowledge points to overcome forgetting (Ji, 2023). Ren Chunmiao believes that online mathematics teaching in high schools has more options and diversified forms of learning (Ren, 2023, Ren, & Gao, 2022). Wu Zijun believes that online mathematics teaching in high schools is highly targeted, and can make targeted supplementary and intensive training for knowledge points and teaching content that cannot be emphasized too much in class (Wu, Xiong, Li, Qin, & Yang, 2022).

Some scholars believe that online mathematics teaching in high schools can improve learning efficiency and interest, with 54% of scholars mentioning this aspect. Shen Xucong believes that social media tools such as chat software and communication forums improve the efficiency of information transfer within the learning field (Shen, 2024). Ren Chunmiao believes that online mathematics teaching in high schools has led to increased learning efficiency and increased interest in learning (Ren, & Gao, 2022). Wu Shouzhen believes that online mathematics teaching in high schools is conducive to dispersing students' thinking and mobilizing students' motivation to learn; it is conducive to breaking through the important and difficult points of teaching and teacher-student communication, answering questions and solving problems; it is conducive to opening up the learning horizons of middle school students (Wu, 2020). Bai Fangjing believes that online mathematics teaching in high schools can cultivate students' innovative consciousness and stimulate students' interest in learning by using activities as a carrier (Bai, 2021). Lu Yuan believes that online mathematics teaching in high schools is conducive to cultivating students' mathematical thinking and simplifying the difficulty of mathematical knowledge (Lu, 2020). Wu Zijun believes that online mathematics teaching in high schools can give full play to students' subjectivity and innovation (Wu, Xiong, Li, Qin, & Yang, 2022). Cui Yujia believes that based on big data statistical analysis, it can intuitively understand the state of teaching and guide the benign development of teaching (Cui, 2021).

Some scholars believe that online mathematics teaching in high schools is highly interactive, with 38% of scholars mentioning this aspect. Ren Chunmiao and Shen Xucong believe that online mathematics teaching in high schools promotes interaction between teachers and students (Ren, 2023, Shen, 2024). Ji Anqi believed that online mathematics teaching in high schools is characterized by timely interaction and timely feedback, which is easy for teachers and students to interact (Ji, 2023). Wu Shouzhen believes online mathematics teaching in high schools is conducive to zero distance interaction between parents and teachers (Wu, 2020). Bai Fangjing believes that online mathematics teaching in high schools is interactive learning, which can enhance students' learning motivation (Bai, 2021).

Some scholars believe that online mathematics teaching in high schools is conducive to teacher development, with 23% of scholars mentioning this aspect. Wu Shouzhen believes that online mathematics teaching in high schools is conducive to improving teachers' information literacy and changing their teaching philosophy (Wu, 2020). Wu Zijun believes that online mathematics teaching in high schools can maximize the teacher's leading position and show the teacher's inspiring and guiding role (Wu, Xiong, Li, Qin, & Yang, 2022). Cui Yujia believes that online mathematics teaching in high schools can urge teachers to improve the teaching process, create quality lesson plans, enhance the fun and knowledge of classroom teaching, keep up with the times and push the boundaries, and provide an exchange platform for teachers around the world, so that young teachers can learn from the experience of veteran teachers, and improve the quality of comprehensive teaching (Cui, 2021).

Some scholars also believe that online mathematics teaching in high schools is conducive to the dissemination of mathematical culture and the development of teaching modules (Wu, 2020). It is able to determine the status of subjectivity in student learning and facilitates the full mastery of modern online information tools (Bai, 2021). It meets the diversified educational needs of learners (Cui, 2021).

3.2.2 Disadvantages

Some scholars believe that online mathematics teaching in high schools affects students' autonomy and learning effectiveness, with 54% of scholars mentioning this aspect. Shen Xucong believes that redundant and fragmented resources online affect the orderly generation of students' knowledge, as well as the lack of students' self-management ability leads to low learning efficiency (Shen, 2024). Ji Anqi believes that the excessive use of multimedia technology leads to students no longer hold a strong interest, students' attention is diverted from the classroom, and their self-control ability is poor (Ji, 2023). Ren Chunmiao believes that online teaching is not as effective as it should be (Ren, & Gao, 2022). Wu Shouzhen thinks that students are free and loose, and their learning attitude is not positive (Wu, 2020). Wu Zijun thought that the teaching effect appeared weak (Wu, 2020). Han Xue thinks that in-depth learning is ineffective (Han, 2021). Cui Yujia thinks that online teaching makes students' attention unfocused; students find answers to their homework with the help of powerful online resources, which is not conducive to students' habit of independent thinking; online teaching is not as effective as the traditional classroom; some high school students can not discipline themselves well, and it is very easy for them to slip away from listening to lectures (Cui, 2021).

Some scholars believe that online mathematics teaching in high schools leads to insufficient teacher-student interaction and emotional communication, with 77% of scholars mentioning this aspect. Ji Anqi believes that online mathematics teaching in high schools strips away the interactive communication and emotional connection between teachers and students, and ignores the interaction with students in the classroom (Ji, 2023). Ren Chunmiao believes online mathematics teaching in high schools lacks teacher peer-to-peer communication and timely feedback (Ren, 2023, Ren, & Gao, 2022). Wu Shouzhen believes that students' participation is not strong and teacher-student communication and teacher-student interaction are weakened (Wu, 2020). Sun Qibin believes that not all students insist on being online at all times, and face-to-face real-time interaction is difficult to implement; online teaching is missing students' thinking participation, and it is easier to deviate from the real learning needs (Sun, 2020). Bai Fangjing believes that online mathematics teaching in high schools affects the emotional communication between teachers and students (Bai, 2021). Luo Shifang believes that online mathematics teaching in high schools lacks efficient interactive communication between teachers and students (Luo, 2022). Wu Zijun believes that the degree of students' practice and operation is greatly reduced (Wu, Xiong, Li, Qin, & Yang, 2022). Han Xue believes online mathematics teaching in high schools lacks teacher-student interaction and student-student interaction (Han, 2021). Cui Yujia believes that online mathematics teaching in high schools leads to reduced communication between teachers and students (Cui, 2021).

Some scholars believe that online mathematics teaching in high schools has technology and resource problems, with 62% of scholars mentioning this aspect. Ji Anqi believes that educators hardly communicate with each other about educational resources, it is difficult to improve their teaching skills, and there is excessive use of multimedia teaching (Ji, 2023). Ren Chunmiao believes that there are problems with the use of online teaching platforms, insufficient information technology support, and unstable back-end construction (Ren, 2023, Ren, & Gao, 2022). Wu Shouzhen believes that there is insufficient technical support, poor network broadband and platform stability; the relevance, applicability, and systematic nature of resources and services are difficult to meet the needs of teachers and students, and the supply of high-quality online education is insufficient; the teachers and teaching resources of the community have failed to substantially participate in online teaching (Wu, 2020). Bai Fangjing believes that network technology tools are misused (Bai, 2021). Luo Shifang believes that there is a lack of efficient online teaching equipment (Luo, 2022). Wu Zijun thinks there are equipment problems (Wu, Xiong, Li, Qin, & Yang, 2022). Cui Yujia believes that some online education APPs have teachers who are not qualified, hide online games, imply vulgar information, and push advertisements (Cui, 2021).

Some scholars believe that online mathematics teaching in high schools poses some challenges to teachers, with 54% of scholars mentioning this aspect. Ji Anqi believes that teachers have problems with distraction and inability to give timely feedback to students in distance teaching (Ji, 2023). Ren Chunmiao and Wu Shouzhen believe that teachers have problems in information literacy and lack of ability in online teaching design (Ren, 2023, Wu, 2020, Ren, & Gao, 2022). Wu Shouzhen believes that most schools and teachers are unable to deftly design and organize instruction according to the characteristics of online teaching and learning, and that teachers tend to neglect the holistic nature of teaching and learning (Wu, 2020). Wu Zijun believes that online math teaching has lost the “inspiration” of teachers, which is an important part of traditional offline teaching (Wu, Xiong, Li, Qin, & Yang, 2022). Qu Shangbing believes that teachers are not sufficiently prepared for online teaching (Qu, 2021). Cui Yujia believes that older teachers are not proficient in the operation of lecture software and waste time easily, and younger teachers struggle with how to mobilize the classroom atmosphere and how to arrange the class (Cui, 2021).

Some scholars believe that online mathematics teaching in high schools leads to problems in students' physical and mental health, with 31% of scholars mentioning this aspect. Ren Chunmiao and Shen Xucong suggested that students have problems such as addiction to the Internet and anorexia (Ren, 2023, Shen, 2024). Ren Chunmiao and Cui Yujia believe that online teaching affects students' eyesight (Ren, 2023, Cui, 2021). Bai Fangjing believes that online teaching affects students' health (Bai, 2021). Cui Yujia believes that online mathematics teaching in high schools leads to students' lack of communication among peers and easy to be withdrawn (Cui, 2021).

Some scholars believe that online mathematics teaching in high schools has the problem of insufficient supervision, with 54% of scholars mentioning this aspect. Ren Chunmiao, Wu Shouzhen, and Cui Yujia et al. believe that the lack of supervision in the class, students' poor learning autonomy, and inability to concentrate on the class (Ren, 2023, Wu, 2020, Cui, 2021). Luo Shifang, Qu Shangbing, and Han Xue believed that there was a lack of scientific and reasonable supervision of online teaching (Luo, 2022, Qu, 2021, Han, 2021). Wu Zijun believed that online math teaching is difficult to achieve timely monitoring and supervision of students (Wu, Xiong, Li, Qin, & Yang, 2022).

Some scholars have also argued that online mathematics teaching in high schools leads to increasing student-to-student differences, exacerbating the contradiction between large classes and individualized learning (Sun, 2020), lack of effective teaching evaluation (Bai, 2021), lack of depth in online teaching and learning as well as students' maladjustment (Qu, 2021).

3.3 Relevant Factors

3.3.1 Attitude and feedback

Most teachers have positive attitudes towards online teaching (Ji, 2023), but the acceptance of secondary school math teachers is low (Ren, & Gao, 2022). Most students have a good psychological state of learning and a favorable attitude towards online mathematics teaching (Ren, & Gao, 2022), and there is no significant effect of different grades and different genders on middle school students' satisfaction with online teaching of mathematics (Liu, 2021), and students have a satisfactory attitude towards teaching ability, teaching attitude, preparation before class, and homework assignments, and an average and unsatisfactory attitude towards platform interaction and interactive Q&A. Most parents think that online teaching as a method is effective overall, and a few parents think it is not effective (Ren, 2023).

3.3.2 Teaching effectiveness

In Ji Anqi's survey study, nearly half of the students had ~~a~~ little improvement in their grades, mainly because the dryness and obscurity of science subjects were well solved; secondly, the wide range of network resources and more open eyes made students collect better quality exercises and learning styles on the Internet (Ji, 2023). In Ren Chunmiao's research study, 45% of the students' performance remained the same, 17% of the students' performance improved, and 38% of the students' performance decreased. The main reason for this is that the content of recorded classes is relatively shallow, which reduces students' interest in learning; the mode of live teaching still copies the traditional teaching mode, which is not compatible with the goals required to be achieved by online teaching; online teaching lacks substantive interactive dialogue between teachers and students, which reduces the initiative and enthusiasm of students' learning, and greatly reduces the learning effect (Ren, 2023). In the survey study of Ren Chunmiao and Gao Xinghui, students' performance is in a state of decline compared with traditional school learning, and more than half of the students think that the math knowledge points are not well understood when learning online (Ren, & Gao, 2022).

3.3.3 Teaching interaction

In Ren Chunmiao's survey study, 40% of the teachers were very satisfied with the interactive effect of the teacher's question and answer session, and the students were able to give timely feedback and ask questions when they encountered difficult problems; 32% of the teachers expressed basic satisfaction, and the majority of the students were able to keep up with the teaching progress and master the teaching content, so that they could complete the assignments on time; 28% of the teachers thought that online teaching is difficult to implement effective teacher-student interaction, and they are not satisfied with the interaction situation during online teaching (Ren, 2023). In Ren Chunmiao and Gao Xinghui's research study, most students were satisfied with their preparation before class, and some students were satisfied with their in-class activities, such as asking or answering questions in real-time by opening the microphone or pop-up screen. Compared with the interaction before and during class, students were less satisfied with after-class homework assignments, homework formats, and tests (Ren, & Gao, 2022). Zhang Xin pointed out the current characteristics of teacher-student interaction in her investigation: the teaching structure in online teaching classrooms is relatively single, and the teacher's language and classroom silence account for most of the teaching time; the classroom atmosphere between teachers and students in online teaching classrooms is heavy and not conducive to the development of students' initiative; the teacher cannot give appropriate feedback on the student's responses, and there is a lack of motivational discourse; the teacher focuses on the use of closed questions, the level of the questions is moderate, lack of open questions to cultivate students' divergent thinking; online teaching teachers ask fewer questions and are subjectively reluctant to ask questions; online teaching students' interaction initiative is high, and the number of student interactions is high (Zhang, 2021).

3.3.4 Homework design

Ouyang Luanrong and Yan Yumin put forward the basic strategy of online homework design, emphasizing the overall design, based on the unit, emphasizing the teaching material, advanced thinking, and rich types; optimize optimizing resource allocation; enhanced feedback visualization (Ouyang, & Yan, 2023). Yu Ge and Hua Jing proposed that the thinking of reflective job design is to clarify homework objectives and focus on homework content; control the total amount of homework, distinguish the level of difficulty, and formulate the level of reflection. The implementation path of online homework includes the selection of topics by students before class and the guidance by teachers; online teaching in class, interactive evaluation and analysis between teachers and students; after-class resource sharing, students' reflection and consolidation (Yu, & Hua, 2022).

**4. Discussion**

By analyzing the relevant literature on online mathematics teaching in high schools found in the China Knowledge Network, it can be found that Chinese scholars' research on online mathematics teaching in high schools presents diversified characteristics, which involve~~s~~ the strategies to improve the effectiveness of online mathematics teaching in high schools, the advantages and disadvantages of online mathematics teaching in high schools, the attitudes and feedbacks, the teaching effects, the teaching interactions, and the design of assignments, among which, there are relatively more studies on strategies and advantages and disadvantages. However, most of the existing studies focus on the overall situation of online mathematics teaching in high schools.

For the research on strategies to improve the effectiveness of online mathematics teaching in high schools, scholars mainly focus on the aspects of online platform and equipment, resource development and integration, design of teaching content, adjustment of teaching strategies, teaching philosophy and principles, and teaching and learning interaction, which is a relatively comprehensive study. Among them, in terms of online platforms and equipment, scholars have put forward a variety of suggestions for the construction and optimization of online teaching platforms, focusing on the importance of equipment preparation. These suggestions take into full consideration the technical needs of online teaching, emphasize the diversity of platforms and the perfection of functions, which help to meet different teaching scenarios and students' needs, and pay attention to equipment preparation and platform experience, which can effectively improve the fluency of online teaching. In terms of resource development and integration, it emphasizes the introduction of high-quality online resources, the construction of resource libraries and the expansion of course resources, and puts forward suggestions for mutual sharing among teachers, rational resource planning and updating resources. By integrating and sharing resources, the richness and diversity of teaching content can be enhanced. These strategies help to keep the teaching content current and effective. However, it should be noted that resources need to be further modified after their introduction to suit teaching needs. As far as the design of teaching content is concerned, it is proposed to shift from traditional knowledge lectures to multidimensional thinking and sharing assignments, emphasizing the careful reconstruction of teaching content, and focusing on the interest, reasonableness, and difference from offline teaching. These suggestions help to break the limitations of traditional teaching models, but the suggestions are more generic and lack in-depth design for the specific subject of mathematics. Suggestions for individualized strategies, setting sub-gradient tasks, collecting learning data, and conducting online grouping were made in terms of adjusting teaching strategies, emphasizing the compression of teaching units, the enhancement of case studies, and the diversification of teaching methods. These suggestions take into full consideration the individual differences of students and the characteristics of online teaching, and can effectively improve the relevance of teaching. However, they are too demanding on teachers' ~~ability~~  abilities and the implementation of these strategies requires teachers to have high instructional design ability and data analysis ability. In terms of teaching concepts and principles, they emphasize teaching according to students' abilities, changing teaching concepts, and correctly recognizing the value of online teaching. These suggestions help teachers establish correct online teaching concepts and improve the adaptability and foresight of teaching. In the aspect of teaching interaction, suggestions such as constructing interactive scoreboards and interactive panels are put forward, emphasizing multi-dimensional online interaction. These suggestions can effectively improve the interactivity and student participation of online teaching, enhance the teaching effect, and focus on multi-dimensional interaction, which can meet the learning styles of different students. In terms of student participation, we propose inviting students to be “little teachers” and encouraging them to participate in the development of course resources and content. These suggestions can effectively enhance the students' subjective position and increase their initiative and motivation in learning. In terms of teaching management, it is proposed to formulate an online teaching system, form a form of monitoring by the teaching staff-teachers-students, and strengthen the informatization training of teachers. These suggestions help to standardize the online teaching process and improve the level of teaching management. In the aspect of teaching evaluation, suggestions are made to evaluate all aspects and emphasize process evaluation. These suggestions can comprehensively assess the effect of online teaching, pay attention to the learning process of students, and help improve the quality of teaching. However, the recommendations are more general and lack specific evaluation indicators and methods. In the area of home-school cooperation, suggestions are made for parents and social forces to participate in the development of curriculum resources, maintain communication between home and school, and carry out home-school co-teaching. These suggestions can effectively integrate family and social resources, create a favorable learning atmosphere and enhance teaching effectiveness. In terms of environmental support, suggestions are made to create a good classroom atmosphere, improve online teaching equipment, mobilize the participation of various departments, and train professional and technical personnel. These suggestions can effectively improve the external environment of online teaching and enhance the ability to guarantee teaching. These suggestions provide rich theoretical support for the practice of online mathematics teaching in high schools, but the strategies about teaching evaluation and home-school cooperation do not have ~~the~~ relevance to online teaching and the depth and systematicness of the research still need to be improved, and there are fewer empirical studies on these strategies and a lack of long-term tracking and evaluation of the effect of strategy implementation.

For the advantages and disadvantages of online mathematics teaching in high schools, scholars mainly focus on online teaching resources, teaching interaction, students and teachers. online mathematics teaching in high schools is rich in resources and sharing, online teaching breaks the time and space limitations of traditional teaching, and students can access rich learning resources anytime and anywhere. Online teaching forms and means of diversification, with the help of multimedia technology, can be a more intuitive display of mathematical knowledge, especially for abstract mathematical concepts and complex geometric shapes, can effectively reduce ~~the~~ learning difficulty. Through live broadcasts, video broadcasts, interactive discussions and other forms, students can choose the appropriate learning mode according to their own learning pace, which meets the needs of students at different levels. Online teaching is conducive to teacher development. Online teaching requires teachers to master new teaching techniques and tools, which helps to improve their information literacy. Teachers can exchange experiences with other teachers through online platforms and learn advanced teaching methods, thus improving teaching quality. Some scholars believe that online teaching can improve learning efficiency and interest, and the interactivity and personalized design of online teaching can better attract students' attention and stimulate their interest in learning. Students can watch the teaching video repeatedly according to their own needs and consolidate their knowledge. However, some scholars believe that online teaching affects students' autonomy and learning effectiveness. Online teaching lacks face-to-face supervision and constraints, and students are susceptible to external interference, resulting in a lack of autonomy. Too many online resources may make students fall into information overload, making it difficult to form a systematic knowledge system, thus affecting the learning effect. Similarly, some scholars believe that online teaching is highly interactive, and teacher-student interaction is realized through chat software and discussion forums. Some scholars also believe that online teaching leads to insufficient teacher-student interaction and emotional communication. Although online teaching provides interactive channels, it lacks the immediacy and emotional resonance of face-to-face communication. Online teaching also has technical and resource problems, online teaching is highly dependent on the network and technical equipment, network congestion, platform failure and other problems are common technical challenges. Online teaching also brings challenges to teachers, requiring them to master new teaching techniques and tools. To a certain extent, online teaching affects students' physical and mental health. Prolonged use of electronic devices has a negative impact on students' eyesight and physical health, and the lack of peer interaction and outdoor activities may lead to students' isolation. Online teaching also has the problem of insufficient supervision, due to the lack of real-time supervision of students and the lack of scientific and reasonable supervision mechanism, which makes it difficult to ensure the learning effect of students. Scholars' analysis of the advantages and disadvantages is reasonable, and different scholars have different perceptions of students' learning effectiveness and teacher-student interaction.

In summary, although the research on online mathematics teaching in high schools has achieved certain results, most of them have been conducted on the overall situation of the broad online mathematics teaching in high schools, and ~~there are fewer researches focusing on~~ (fewer researchers are focusing on ) a certain aspect. If we can conduct in-depth and systematic investigation and research on a certain aspect, fully discuss specific problems and situations, and enhance the combination of theory and practice, the practical guidance performance will be further strengthened. By filling the gaps in the existing research, stronger support can be provided for the continuous development of online mathematics teaching in high schools.

**5. Conclusions**

Through the systematic combing of the literature related to online mathematics teaching in high schools, the following conclusions can be summarized:

(1) At present, scholars' research on online mathematics teaching in high schools mainly contains two aspects, which are the strategies to improve the effect of online mathematics teaching in high schools and advantages and disadvantages of online mathematics teaching in high schools.

(2) The current research on online mathematics teaching in high schools is rich in content, involving many aspects such as teaching strategies, teaching effects, advantages and disadvantages, etc., but the systematicity and depth of the research are insufficient. Most of the research stays at the level of theoretical discussion and lacks empirical support and long-term tracking research.

(3) Existing studies focus on the overall situation of online mathematics teaching in high schools in a broad sense, without in-depth analysis of specific aspects.

In summary, although the research on online mathematics teaching in high schools has achieved certain results, it still needs to be further strengthened in terms of research depth, systematicity and practical guidance. By filling the gaps in existing research, stronger support can be provided for the continued development of online mathematics teaching in high schools.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

**REFERENCES**

Zhu, M. (2020). Practical research on deep learning for high school students based on online teaching. Famous Teachers Online, (24), 22-24.

Ren, C. (2023). Investigation and practical research on the current situation of online mathematics teaching in middle schools under the background of the pandemic (Master's thesis, Yan'an University). <https://link_cnki_net.libwg.sdnu.edu.cn/doi/10.27438/d.cnki.gyadu.2023.000692doi:10.27438/d.cnki.gyadu.2023.000692.>

Zhu, G. (2024). Strategies for the application of information technology in middle school mathematics teaching. Research on Solving Problems in Mathematics, Physics, and Chemistry, (36), 63-65.

Shen, X. (2024). Exploration and reflection on strengthening the learning field of middle school mathematics based on cyberspace—Taking the inquiry activity of the "Graphic Movement" chapter as an example. Educational Communication and Technology, (02), 24-29.

Wu, S. (2020). An empirical study on the teaching and learning of junior high school mathematics from the perspective of "Internet+" (Master's thesis, Fujian Normal University). <https://link_cnki_net.libwg.sdnu.edu.cn/doi/10.27019/d.cnki.gfjsu.2020.002299doi:10.27019/d.cnki.gfjsu.2020.002299.>

Han, X., & Li, X. (2021). How to effectively carry out online teaching in middle school mathematics classrooms. Academy, (14), 35-37.

Zhang, X. (2021). A comparative study of teacher-student interaction in online and offline teaching of high school mathematics (Master's thesis, Ludong University). https://link\_cnki\_net.libwg.sdnu.edu.cn/doi/10.27216/d.cnki.gysfc.2021.000301doi:10.27216/d.cnki.gysfc.2021.000301.

Liu, X. (2021). Analysis of factors influencing satisfaction with online learning of junior high school mathematics (Master's thesis, Jimei University). https://link\_cnki\_net.libwg.sdnu.edu.cn/doi/10.27720/d.cnki.gjmdx.2021.000211doi:10.27720/d.cnki.gjmdx.2021.000211.

Gao, X. (2022). New paths for cultivating students' self-directed learning ability through online education. Science Every Day (Educational Frontier), (03), 43-44.

Ji, A. (2023). Research on the current application and improvement strategies of remote information-based teaching in middle school mathematics (Master's thesis, Yan'an University). https://link\_cnki\_net.libwg.sdnu.edu.cn/doi/10.27438/d.cnki.gyadu.2023.000960doi:10.27438/d.cnki.gyadu.2023.000960.

Bai, F. (2021). Reflections on the pros and cons of online teaching in middle school mathematics. Knowledge Library, (13), 153-154.

Luo, S. (2022). Exploration of improvement paths for online mathematics teaching in high schools. Exam Weekly, (44), 94-97.

Wu, Z., Xiong, H., Li, Y., Qin, L., & Yang, L. (2022). Insights and reflections on online and offline teaching from the perspective of indifference curves—Taking middle school mathematics as an example. University Education, (06), 125-129.

Sun, Q. (2020). Some problems and solutions encountered in online mathematics teaching in high schools. Shanghai Education, (12), 42-43.

Qu, S. (2021). Some problems and solutions encountered in online mathematics teaching in high schools. Good Parents, (76), 65-66.

Cui, Y. (2021). Research on online teaching strategies for high school solid geometry courses (Master's thesis, Liaoning Normal University). <https://link_cnki_net.libwg.sdnu.e>

Xu, J. (2021). Research on online teaching design based on situational experience—Taking the teaching of "Exponential Functions" in mathematics as an example. Light Industry Science and Technology, (08), 169-170.

Ren, C., & Gao, X. (2022). Exploration of online mathematics teaching in high schools in the information age. New Wisdom, (07), 19-21.

Lu, Y. (2020). Application of remote online teaching in middle school mathematics teaching. Parents, (33), 50-51.

Ouyang, L., & Yan, Y. (2023). Adaptive assignment design and visual feedback in online mathematics teaching in high schools—Taking the unit assignment design of "Similar Triangles" as an example. New Curriculum Guide, (24), 79-82.

Yu, G., & Hua, J. (2022). Design of reflective assignments for middle school mathematics under the "Double Reduction" policy. Information Technology Education in Primary and Secondary Schools, (07), 39-41.