Research on Mathematical Dyslexia of Middle School Students in China

Abstract: Mathematics reading ability is an important factor affecting students' mathematics learning. Current studies have found that middle school students have mathematical dyslexia. Mathematical dyslexia often leads to students' difficulties in learning and even frustrates students' enthusiasm and initiative in learning mathematics. Therefore, many researchers begin to pay attention to mathematical dyslexia problems in middle school students. This study used the literature analysis method to summarize and sort out the previous research on mathematical dyslexia of middle school students and found that: (1) Current domestic studies mainly focus on the following six aspects: Types of mathematical dyslexia; manifestations of mathematical dyslexia; analysis of causes of mathematical dyslexia; Analysis of the content of the material causing mathematical dyslexia; suggestions and strategies to overcome mathematical dyslexia. (2) The main types of mathematical dyslexia are comprehension barrier and translation barrier; Previous studies have discussed the manifestations of mathematical dyslexia from learning attitude, learning ability, and knowledge mastery. The formation of mathematical dyslexia is mainly influenced by the characteristics of mathematical language itself, students' factors, teachers' factors, and teaching modes. There are few studies on the influencing factors of mathematical dyslexia and the content of the materials causing mathematical dyslexia. Most studies put forward improvement suggestions for teachers and students. (3) Researchers mainly used self-written test papers and self-written interview outline to conduct investigations, and some researchers drew conclusions based on theoretical speculation or teaching experience. Therefore, based on existing research, future research needs to adopt scientific research tools, develop a localized research framework, expand the scope of research, increase the verification research of suggestions and strategies and put forward practical and effective overcoming strategies, to make this research more comprehensive, systematic and in-depth.

Keywords: Mathematics; Dyslexia; Middle School; Students

1. INTRODUCTION

Mathematical dyslexia refers to the phenomenon that students with normal intelligence cannot timely and effectively obtain information, properly process and use information, accurately summarize and understand the reading content and fail to achieve the reading purpose when reading mathematical materials consistent with their knowledge level [1]. The study of middle school students' mathematical dyslexia has certain references and guiding significance for teachers to improve mathematics teaching and promote students' mathematics learning [2]. Since the 21st century, Chinese researchers have gradually begun to pay attention to the problem of middle school students' mathematical dyslexia, trying to provide some directions and references for teachers' teaching and students' mathematical learning. So far, there have been many studies on

mathematical dyslexia. However, there is no research to comprehensively sort out and review these contents. To find out the current situation, deficiencies, and gaps in the research on middle school students' mathematical dyslexia, the author arranges and analyzes the previous relevant research to promote the continuous development and deepening of this direction.

The main research questions of this paper are as follows: (1) what are the aspects of the current research on middle school students' mathematical dyslexia, and what are the results of each aspect? (2) What are the deficiencies and gaps in the current research on middle school students' mathematical dyslexia?

2. METHOD

2.1 Data Source

This paper adopts the method of literary analysis and takes the literature in the database of China Knowledge Network (CNKI) as the data source. CNKI is the most authoritative document retrieval tool for national academic journals. It covers a wealth of literature and materials, including various disciplines, and has great academic influence. Therefore, this database is selected to ensure the persuasiveness and reliability of the research.

2.2 Data Collection

To avoid literature omission, the author searched with *mathematical dyslexia*, *mathematical reading difficulty*, and *the current situation of mathematical reading* as the subject words, and a total of 244 results were retrieved. Taking *mathematical dyslexia* as the search term and *subject* as the search item, 73 results were retrieved, after reading through and screening, 25 pieces of literature were selected. After that, taking *mathematical dyslexia* as the search term and *subject* as the search item, a total of 22 results were retrieved, after excluding the literature irrelevant to the subject of this study, and the remaining 4 articles were selected. Taking *the current situation of mathematics reading* as the search term and *subject* as the search item, 149 results were retrieved. Through reading analysis, the literature that does not involve the research topic of this paper is eliminated, and finally, 13 articles are selected. There are two duplicates in the selected literature above, so finally there are 41 pieces of literature left, and the 41 literature is sorted and analyzed.

2.3 Data Collation

Firstly, the above literature is read in detail, and then the research aspects, research views, and research methods mentioned therein are recorded and coded. Finally, the above codes are counted and summarized.

3. RESULTS

After sorting out and analyzing the previous studies, it is found that the current domestic research on mathematical dyslexia mainly focuses on the following six aspects: types of mathematical dyslexia; manifestations of mathematical dyslexia; analysis of the causes of mathematical dyslexia; influencing factors of mathematical dyslexia; analysis of the content of the material causing mathematical dyslexia; suggestions and strategies to overcome mathematical dyslexia. The results of each aspect are discussed below.

3.1 Types of Mathematical Dyslexia

With the advancement of the research on mathematical dyslexia, researchers use different research methods to get the classification of its types and describe its specific manifestations. Their views are as follows:

Pan and Wu were the first to divide the types of mathematical dyslexia. They conducted an investigation and research based on Newman's theory and proposed that the mathematical dyslexia of junior middle school students includes difficulties in mathematical language understanding, problem-solving strategies, mathematical operation, and mathematical expression. The difficulty in understanding mathematical language is embodied in the students' inability to correctly understand the meaning of mathematical words, symbols, graphics, and sentences. The difficulty in problem-solving strategies is that students cannot find relevant problem-solving strategies according to the requirements of the problem after reading mathematical materials. The difficulty in mathematical operation shows that students have obstacles in the process of using mathematical language for conversion, operation, reasoning, and proof. The difficulty in mathematical expression is that students know how to solve problems, but they don't know how to write and speak. Among them, the difficulties in mathematical language understanding and problem-solving strategies are more serious [3].

He analyzes mathematical dyslexia from the perspective of junior middle school students' reading behavior, investigated junior middle school students with the method of a questionnaire, and put forward that mathematical dyslexia caused by junior middle school students' reading behavior mainly includes mathematical reading material recognition obstacles, understanding obstacles, and conversion obstacles. He points out that the obstacles to mathematical reading material recognition are that they cannot recognize the basic attributes of mathematical reading materials and the objects they represent, cannot recognize the suggestive function in mathematical reading materials, and cannot grasp the keywords in reading materials. The mathematical reading material comprehension obstacles include the lack of relevant information or failure to activate the relevant information in memory, leading to the inability to understand the mathematical ideas and methods contained in reading materials. The obstacles to the conversion of mathematical reading materials are mainly manifested in the conversion of mathematical language, the difficulties in the conversion between written language, symbolic language, and image language, and the obstacles in converting mathematical language into its own language [1].

Yang studies mathematical dyslexia from the perspective of psychology. According to the core elements of mathematical reading in psychology, mathematical reading is divided into three dimensions. Based on this, she self-made a test paper for investigation and research, and three dimensions corresponding to mathematical dyslexia are obtained: character (the smallest unit of language) coding obstacles, language (sentence) translation obstacles, and comprehensive (text) understanding obstacles. Yang points out that character coding obstacles are embodied in natural language coding obstacles and mathematical language coding obstacles. Language translation obstacles are mainly manifested in the difficulty of mutual translation between characters, symbols, and graphics, and comprehensive understanding

obstacles are mainly manifested in the rigidity of concept understanding, inability to grasp the text structure, and difficulty in generalization [4].

Ning identifies four types of mathematical dyslexia through a test questionnaire and interview survey: selective coding obstacles, language translation obstacles, understanding obstacles, and reasoning obstacles. Furthermore, the selective coding obstacle is further divided into graphic coding obstacle, character coding obstacle, and symbol coding obstacle, the language translation obstacle is divided into character graphic translation obstacle, symbol graphic translation obstacle, and character symbol translation obstacle, and the understanding obstacle is divided into three aspects: unable to understand a mathematical element or symbol, unable to understand a mathematical sentence, and unable to understand the context or mathematical discourse structure. The reasoning obstacle is divided into two aspects: reasonable reasoning and deductive reasoning [5].

Song divides mathematical dyslexia into the following categories: mathematical reading material structure obstacle, mathematical reading material operation obstacle, mathematical reading material organization obstacle, and mathematical reading material expression obstacle [6].

Tao conducts a questionnaire survey and interview with grade two students to analyze the dyslexia of junior high school students in mathematical sign language and divided it into the following types: difficulty in mathematical symbolic language recognition, difficulty in mathematical symbolic language association, difficulty in mathematical symbolic language conversion and difficulty in mathematical symbolic language representation. The difficulty in mathematical symbolic language recognition refers to that students cannot recognize the basic attributes of mathematical symbolic language, master mathematical symbolic language inaccurately, and cannot make an in-depth analysis of mathematical symbolic language; the difficulty in the association of mathematical symbolic language is mainly manifested in the difficulty in the internal association of mathematical symbolic language, and it is difficult to realize the vertical and horizontal association of mathematical symbolic language; the difficulty in the conversion of mathematical symbolic language is mainly manifested in the difficulties in the conversion of mathematical symbolic language into written language or mathematical symbolic language into graphic language, and the internal conversion of mathematical symbolic language; the difficulty in mathematical symbolic language representation is embodied in the inability to represent, the error of representation, the incompleteness or inaccuracy of representation [7].

Some researchers classify mathematical dyslexia from the perspective of mathematical language. Zhang divides high school students' mathematical dyslexia into four types: difficulty in identifying mathematical language, difficulty in understanding mathematical language, difficulty in transforming mathematical language, and difficulty in constructing mathematical language [8]. Liu believes that high school students' mathematical dyslexia includes language comprehension obstacles of characters, symbols, and graphics, and three language transformation obstacles [9]. Wang divides mathematical dyslexia into mathematical language comprehension obstacle, mathematical language conversion obstacle, mathematical language

recognition obstacle, and mathematical language operation obstacle [10]. Through the analysis of interviews, Tang believed that the types of junior high school students' mathematical dyslexia include mathematical language comprehension obstacles, mathematical language transformation obstacles, reading material analysis obstacles, and reading induction and generalization obstacles [11]. Chen divided mathematical dyslexia into language comprehension obstacles, reading reasoning obstacles, associative memory obstacles, and abstract generalization obstacles [12]. Lian pointed out that mathematical dyslexia is mainly referred to as the three language conversion difficulties [13].

3.2 Manifestations of Mathematical Dyslexia

Previous studies mainly discussed the manifestations of middle school students' mathematical dyslexia from three aspects: learning attitude, learning ability, and knowledge mastery. The specific views are as follows:

In terms of learning attitude, Su and Zhou pointed out that students are not careful in reading and have the psychology of rejecting reading, and giving up when they encounter some difficulties [14,15]. Yang pointed out that students are careless in reading and reject reading [16]. Ding, Yang, and others all pointed out that students with mathematical dyslexia are careless and inattentive in mathematical reading, they often miss or mistake the known conditions and problems. When they don't understand the known, unknown, and the relationship between various quantities in the topic, they solve problems blindly, they make mistakes in examining the topic and are afraid of reading, they give up reading when they encounter problems with more narration and complex structure or difficulties in reading, reject reading from the heart [2,17-21].

In terms of learning ability, most researchers mentioned that the performance of students' mathematical dyslexia is their poor ability to extract and process information. Hou and Gao pointed out that students can't dig out the hidden conditions in the problem-solving process [20,21]. Xiong pointed out that students have poor information processing ability and abstract thinking ability, and cannot understand abstract mathematics problems in connection with life reality [18]. Fei believed that students cannot correctly analyze graphics and are not good at mining the information contained in graphics. They have poor conversion ability between written language, graphic language, and symbolic language, and cannot correctly express and describe the thinking process in the mathematical language [22]. Zhou and Fan contended that students' dyslexia is that when tables and images appear, they cannot be understood in combination with the text narration in the probability problem, and could not effectively integrate, process, and summarize the extracted probability information to achieve an understanding of the whole material [15,23]. Ding and Yin think that students feel that the mathematics course is too abstract to start reading, and their understanding of the reading content is inconsistent with the meaning of the material [2,19]. Yang believes that the mathematical reading difficulties of special ethnic groups are the expression difficulty caused by language differences [24].

In terms of knowledge mastery, Ding and others mentioned that students' mathematical dyslexia is manifested in their inability to read some mathematical symbols, mathematical concepts, and mathematical nouns in reading materials or confusion with

some similar contents, and inability to read graphics and charts [2,16,18,20-22]. Zhou and others contended that students' mathematical dyslexia in probability problems is manifested in their inability to understand or distinguish mathematical terms and terms in probability materials [16-21].

According to previous studies, Cao summarized all the manifestations of mathematical dyslexia, a total of 10. A questionnaire survey was conducted on 38 junior middle school teachers according to these ten manifestations. The results show that the lack of mastery of basic mathematical knowledge, poor self-monitoring ability, and low level of information extraction constitute three typical manifestations of mathematical dyslexia in junior middle school students [25].

It can be seen that the manifestations of middle school students' mathematical dyslexia in learning attitude mainly include careless reading, rejection of reading, easy giving up reading, and so on; in terms of learning ability, it is mainly poor information processing ability and abstract thinking ability; in terms of knowledge mastery, including weak basic knowledge, confusion of similar knowledge, etc.

3.3 Analysis of the Causes of Mathematical Dyslexia

As for the causes of mathematical dyslexia, researchers mainly analyze and discuss it from four aspects: the characteristics of mathematical language itself, students' factors, teachers' factors, and the influence of teaching mode.

3.3.1 Characteristics of Mathematical Language Itself

Yang contended that the abstraction, generality, and conciseness of mathematical language itself is one of the reasons for students' mathematical dyslexia [4]. Pan pointed out that the particularity of mathematical reading comprehension, frequent semantic transformation, and abstraction of mathematical language are the reasons for the formation of mathematical dyslexia [26]. Tao believed that the abstractness of mathematical symbolic language increases the difficulty of students' mathematical reading [7]. Zhu believed that the unique nature of mathematical language leads to students' reading difficulties. Specifically, the preciseness of mathematical materials expands the severity of incomplete information acquisition; the abstraction of mathematical language increases the difficulty of semantic understanding; professional mathematical vocabulary and symbols make it difficult for students to understand the meaning of questions [27]. Zhou pointed out that the reason for the dyslexia of senior high school students' probability problems is the factor of mathematics subject [15]. Wang believed that the complexity of mathematics itself causes mathematical dyslexia [28].

3.3.2 Students' Factors

3.3.2.1 Students' Mathematics Learning Aspect

In terms of students' mathematics learning, Ding and others pointed out that students' lack of perfect mathematical cognitive structure is one of the reasons for mathematical dyslexia [2,4,29]. Yang and Yu pointed out the difficulty in reading mathematical texts—the difficulty in understanding mathematical language leads to students' mathematical dyslexia [30]. Yang and others believed that students' weak basic knowledge, insufficient mastery of reading methods and skills, unable to contact before and after knowledge, weak ability to understand information, and so on lead to

mathematical reading disabilities [3,30-32]. Ding and others contended that poor reading ability and incorrect reading methods of students in mathematics will also cause obstacles [2,16,17,19]. Ning believed that the direct cause of mathematical dyslexia is the lack of students' mathematical reading ability, including mathematical coding ability, language translation ability, mathematical understanding ability, and mathematical reasoning ability, and the indirect cause is the lack of mathematical knowledge and knowledge in life [5]. Zhou and fan pointed out that students' failure to master mathematical probability knowledge and their weak learning ability will lead to reading disabilities on probability topics [15,23]. Gu believed that students' unclear grasp of concepts is the cause of dyslexia [33]. Tao contended that students' low cognitive level leads to mathematical dyslexia, including ignoring the *semantic grammar* problem of mathematical symbolic language, not deeply understanding the meaning of mathematical symbolic language under different backgrounds, and not finding the connection between old and new mathematical symbolic language [7].

3.3.2.2 Non-intellectual Factors Aspect

In terms of non-intelligence factors, researchers put forward that the causes of students' mathematical dyslexia include bad reading habits, bad reading psychology, and bad learning attitude.

Ding and Ning both mentioned that the reasons for mathematical dyslexia include improper reading attitude, bad reading habits and so on [2,5]. Ding and others pointed out that poor reading motivation, reading fear, reading dependence, reading boredom, inattention, laziness or inability to take reading notes, and lack of understanding in reading will lead to mathematical dyslexia [2,16,18]. Fan believed that the negative learning attitude of senior high school students will lead to mathematical dyslexia, including low interest in reading, rejection of reading, and easily giving up [23]. Yang and others pointed out that the negative effects of attitudes, habits, interests, and dependence on teachers will cause mathematical dyslexia [30-32]. Cai contended that the lack of reading motivation will lead to mathematical dyslexia, which is specifically manifested in that students only stay in a spontaneous and fuzzy reading state, do not know why to read, and cannot clearly understand the goal to be achieved after reading, and do not know how to use some appropriate strategies to assist reading [29]. Wang and others believed that students' willpower is relatively weak, lack of interest in mathematics, lack of patience in reading math problems, and fear will arise when they encounter problems with a large amount of reading, which will lead to mathematical dyslexia [28,34].

3.3.2.3 Self-monitoring Ability Aspect

Yang and others pointed out that the lack of self-monitoring ability will lead to students' mathematical dyslexia [4,5,29].

Yang believed that the failure of the reading process monitoring is mainly manifested in the lack of self-evaluation and the omission of important information [4]. Cai pointed out that the performance of students' lack of self-monitoring ability is that when they encounter difficulties in mathematical language understanding, they do not take the initiative to find solutions to problems, and cannot actively establish reading goals and make reading plans [29].

3.3.2.4 Age Limit Aspect

Yang believes that high school students are limited by their age, their cognitive level is limited, their logical thinking mode is not stable, and their logical analysis and reasoning ability are not strong enough, which are the factors leading to mathematical dyslexia [17].

3.3.3 Teachers' factors

Zhou and others put forward that some teachers only pay attention to improving students' performance, and their understanding of reading is not in place, they ignore math reading or fast reading mathematic topics, do not teach students effective reading skills and methods, and do not actively carry out reading training, which is one of the reasons for students' mathematical dyslexia [15,23]. Gu pointed out that teachers' careless explanation of concepts led to students' difficulties in mathematics reading [33]. Wang pointed out that teachers leave too little time for students to read is the reason for students' mathematical dyslexia [28]. Ma and others believed that the deficiency of teachers' classroom teaching is the reason for students' mathematical dyslexia, including teachers do not take cultivating students' mathematical reading ability as the focus of classroom teaching, the lack of guidance for students' efficient reading, and the lack of scientific and effective ways and methods to guide students' reading [31,32].

3.3.4 Influence of Teaching Mode

Cai pointed out that the traditional teaching mode dominated by lecturing in schools leads to teachers' reluctance to leave time for students to read independently, which leads to students' mathematical dyslexia [29]. Gu also pointed out that cramming teaching makes students passively accept knowledge, lose interest in mathematics, and gradually produce dyslexia [33].

It can be seen that previous researchers have analyzed the causes of mathematical dyslexia in detail. Researchers mainly analyzed and discussed four aspects: the characteristics of mathematical language itself, students' factors, teachers' factors, and the influence of teaching mode. The main reasons include the abstract and difficult understanding of mathematics itself, students' poor understanding and analysis ability, students' bad reading habits, students' lack of self-monitoring consciousness, teachers' lack of attention to mathematics reading, and the influence of traditional teaching model.

3.2 Influencing Factors of Mathematical Dyslexia

Cao tested 192 eighth-grade students, and through the analysis of the test results, it is concluded that students' mathematical reading behavior, CPFS structure, and self-monitoring ability are the influencing factors of students' mathematical dyslexia. Then, multiple regression analysis is carried out to determine the weight of each factor, pointing out that the influence of reading behavior is the largest, CPFS is the second, and self-monitoring is the smallest [25].

Zheng and others conducted a questionnaire survey on 227 junior middle school students, and then conducted factors analysis on 18 factors in the questionnaire analysis results to obtain the influencing factors of mathematical dyslexia: the first is the personal ability, psychological factors, and external environmental factors, the second

is personal subjective initiative factors, carefulness and time factors, and the third are learning habits, logical thinking ability, and teachers' guiding factors [35].

3.3 Content Analysis of Mathematical Dyslexia

Through testing and interviewing 150 junior middle school students in a school in Hebei Province, Wang found that the materials that caused students to have mathematical dyslexia included seven categories. The first is the content with more mathematical symbols and more abstract symbols; the second is the content with abstract formulas, especially the content of simple explanations of formulas; the third is the content with professional terms; the fourth is the content involving the conversion between the three languages; the fifth is the content with scattered knowledge points and requiring students' induction and analogy; the sixth is the content with a strong sense of space and involving practical operations such as drawing, the seventh is the content of abstract mathematical knowledge related to real problems [36].

Through a questionnaire survey of 331 junior middle school students, Yang concluded that the theorems, formulas, and their proof derivation in mathematics textbooks and linking questions between junior and senior high schools were the most likely to cause junior high school students to have mathematical dyslexia [37].

3.4 Suggestions and Strategies for Overcoming Mathematical Dyslexia

Previous studies have put forward countermeasures to overcome middle school students' mathematical dyslexia from the aspects of teachers, students, and families.

3.4.1 Teacher's level

He and others proposed that teachers should appropriately create situations to strengthen mathematical language training, stimulate students' interest, optimize teaching methods, strengthen the teaching of mathematical language vocabulary understanding, strengthen the training of mathematical language conversion, cultivate students' mutual translation ability of various languages, improve students' reasoning ability, and teach students how to read mathematics correctly [1,35,38]. Yang and Yu pointed out that teachers should strengthen their awareness of scientific research, guide students' reading learning strategies and leave space for students' development [30]. Pan and others suggested that teachers should help students learn to construct a structured knowledge system and properly train students' mathematical expression ability [3,16,23]. Cao proposed that different teaching designs should be used for different course types, and teachers should adopt the teaching strategy of mathematical reading to implement teaching, and carry out teaching reflection on mathematical reading [25]. Wang designed a recommendation table for junior high school students to study the geometry section independently to help teachers in teaching [36]. Fei and others proposed that teachers should optimize the mathematics classroom teaching model, encourage students to read questions in class and build a reading guide outline, encourage students to read questions in class, and build a reading guide outline [22,29]. Liu and others suggested that teachers implement diversified mathematics reading evaluation ways and establish a reading evaluation mechanism based on encouragement [9,19,33]. Wang and others proposed that teachers should stimulate students' interest in reading and cultivate students' good reading habits [28,34]. Zhang Jing suggested that teachers should provide personalized guidance for different types of

courses [8]. Yang pointed out that teachers should pay attention to the reading of mathematics textbooks and improve students' reading awareness [24].

3.4.2 Student's level

Cao mentioned that students should strengthen the learning and understanding of mathematical theorems, formulas, and symbols, establish an overall mathematical structure framework, train their active reading, and form the habit of loving reading and active reading [25]. Zheng and others suggested that students should train themselves to transform symbolic language and graphic language into understandable language and strengthen the simplification training of written language [30]. Tang and others pointed out that students should set a reading plan for themselves before reading and summarize and reflect after reading [11,14]. Zhou and Fan contended that students should correct their attitude towards learning mathematics and remove psychological obstacles [15,23]. Xie and others pointed out that students should learn to use metacognition to self-monitor the process of mathematics reading, use the whole and part relationship to deconstruct the connotation of the text, and establish the relationship between old and new knowledge [38,39]. Zhu suggested that students should enrich extracurricular reading and increase the number of extracurricular reading materials with mathematical content in their spare time [27]. Yang and others put forward that students should grasp the details of keywords in the process of mathematics reading [17,21,40,41]. Wang and Yu contended that when reading and understanding the meaning of the topic, students can't rely on their feelings, can't skip reading, and can't ignore the grammatical rules and take it out of context [40]. Su and Hou pointed out that students should strengthen their reading will and read carefully [14].

3.4.3 Family's level

Tang proposed that parents should pay more attention to mathematics reading. It is suggested that parents properly guide students to go to bookstores for mathematics reading, to increase students' interest in learning mathematics, improve students' mathematics reading ability and overcome mathematics dyslexia [11].

It can be seen from the above that previous studies mainly put forward suggestions for teachers and students. The suggestions to teachers mainly include guiding students on reading methods, creating situations for teaching, encouraging students to read questions, etc. The suggestions to students include establishing mathematical framework structure, correcting mathematical reading attitude, conducting language conversion training, etc. Only one researcher mentioned that parents should pay more attention to mathematical reading, and give specific suggestions.

4. DISCUSSION

In terms of research content, domestic research on mathematical dyslexia mainly focuses on the following six aspects: types of mathematical dyslexia, manifestations of mathematical dyslexia, analysis of the cause of mathematical dyslexia, influencing factors of mathematical dyslexia, analysis of the content of the material causing mathematical dyslexia, and suggestions and strategies to overcome mathematical dyslexia. In terms of the types of mathematical dyslexia, researchers obtained different types of mathematical dyslexia from different angles. However, most researchers have

mentioned understanding obstacles and translation obstacles, which shows that researchers generally agree on these two obstacles. In terms of manifestations of mathematical dyslexia, researchers mainly analyze and discuss three aspects: learning attitude, learning ability, and knowledge mastery. The manifestations proposed by researchers overlap in many places. It can be seen that previous studies have reached a certain consensus on the manifestations of mathematical dyslexia.

In terms of the causes of mathematical dyslexia, the researchers analyzed it from four aspects: the characteristics of mathematical language itself, students' factors, teachers' factors, and the influence of teaching mode. The researchers pay more attention to students' factors and pay less attention to other aspects. The reasons put forward by the researchers intersect with each other. Among them, the reason for students' bad reading habits is mentioned by almost every researcher. It can be seen that the formation of mathematical dyslexia is a complex process and the result of the interaction of many factors. Students' bad reading habits are one of the reasons leading to mathematical dyslexia, which has been recognized by most researchers. Few scholars have studied the content and influencing factors of mathematical dyslexia. Only two researchers mentioned each aspect. In terms of the influencing factors of mathematical dyslexia, researchers believe that they are affected by reading behavior habits. In terms of the content of the material causing mathematical dyslexia, researchers mentioned that the content containing abstract formulas and theorems will cause students to have mathematical dyslexia. In terms of suggestions for improvement made by researchers, previous studies have mostly put forward the proposal to teachers and students.

It can be seen that there are some deficiencies in previous studies. Firstly, there are few studies on the influencing factors of mathematical dyslexia and the content of the material causing mathematical dyslexia. Secondly, in terms of the causes of mathematical dyslexia, most scholars pay attention to students' factors and pay less attention to other factors. Finally, although most researchers in China use questionnaire tests and interviews for investigation and research, there are still some that are based on theoretical speculation or classroom teaching experience. They only start from personal experience and lack strict demonstration. Therefore, it can be seen that the current research is not very scientific and rigorous.

There are some gaps in previous studies. First of all, in terms of suggestions and strategies to overcome mathematical dyslexia, there is a lack of suggestions and strategies from the aspects of life, family, society, and education departments. Secondly, the improvement suggestions put forward by researchers lack practical verification, which makes it impossible to scientifically judge whether these suggestions and strategies are effective. Finally, in those research that used questionnaire tests and interview methods, the test paper and interview outline are designed by the researchers themselves, and the standards are different. Also, due to different national conditions, different classroom environments, and other external factors, the foreign analysis framework may not apply to China, so China lacks localized research tools and analysis frameworks.

5. CONCLUSION AND RECOMMENDATIONS

Through the analysis of the previous research results on mathematical dyslexia, the

following conclusions are obtained:

(1) The current domestic research on mathematical dyslexia mainly focuses on the following six aspects: types of mathematical dyslexia; manifestations of mathematical dyslexia; analysis of the causes of mathematical dyslexia; influencing factors of mathematical dyslexia; analysis of the content of the material causing mathematical dyslexia; suggestions and strategies to overcome mathematical dyslexia.

(2) The types of mathematical dyslexia are diverse and overlap with each other. Understanding and translation obstacles are generally recognized by researchers; previous studies have reached a consensus on the manifestations of mathematical dyslexia, mainly from three aspects: learning attitude, learning ability, and knowledge mastery; the formation of mathematical dyslexia is the result of the interaction of many factors, including the characteristics of mathematical language, students' factors, teachers' factors and the influence of teaching mode; there are few studies on the influencing factors of mathematical dyslexia and analysis of the content of the material causing mathematical dyslexia, these two parts need to be expanded; most studies put forward improvement suggestions for teachers and students, there is a lack of suggestions and measures to improve middle school student's mathematical reading ability from the aspects of life, family, society and education departments, and lack of verification research on the measures to overcome mathematical dyslexia.

(3) Researchers mainly use self-made test papers and self-made interview outlines for investigation. Localized research tools and analysis frameworks need to be developed. Some studies draw conclusions based on theoretical speculation or teaching experience, which is not scientific and rigorous enough.

Therefore, based on existing research, future research needs to adopt scientific research tools, develop a localized research framework, expand the scope of research, increase the verification research of suggestions and strategies and put forward practical and effective overcoming strategies, to make this research more comprehensive, systematic and in-depth.

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