



Research on the Influencing Factors of Junior High School Students' Mathematical Operation Ability in China

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Authors' contributions

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

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ABSTRACT

Under the background of core literacy, how to improve the mathematical operation ability of junior high school students has received more and more attention in China. Therefore, many scholars explore the training strategies of junior high school students' mathematical operation ability by studying the influencing factors of junior high school students' mathematical operation ability. However, there are few general studies on the influencing factors of junior high school students' mathematical operation ability. This paper uses the literature analysis method to summarize the research on the influencing factors of junior high school students' mathematical operation ability since the core literacy of our country was put forward and draws the following conclusions: The researchers mainly include two categories: middle school teachers and master degree students. Middle school teachers often use the method of experience summary to explore the influencing factors of junior high school students' mathematical operation ability. Master degree students often study the influencing factors of junior high school students' mathematical operation ability through

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literature method, questionnaire survey method, interview method and statistical analysis method; The influencing factors obtained by predecessors mainly include objective and subjective aspects. Objective factors include school, social and family environment and teacher factors. The subjective factors mainly include five aspects: knowledge and skills, ability and thinking, interest, emotion attitude and habit; The influencing factors obtained by the predecessors are more extensive, but lack detailedness and specificity; Few researchers have verified the authenticity of the influencing factors. In the future, researchers can study the factors that affect the improvement of junior high school students' mathematical operation ability in a more detailed and specific way. The influencing factors, the authenticity of them can be verified by empirical research methods such as experimental methods.

Keywords: Core literacy; mathematical operation ability; junior high school students; influencing factors.

1. INTRODUCTION

In 2022, the "Compulsory Education Mathematics Curriculum Standards" promulgated by the Ministry of Education of the People's Republic of China regards operation ability as one of the manifestations of core literacy, emphasizing the cultivation of students' core literacy. Students are required to think about the real world with mathematical thinking. In the stage of compulsory education, one of the main manifestations of mathematical thinking is operation ability. Operation ability helps to form the quality of standardized thinking and develop a meticulous, rigorous and realistic scientific attitude [1]. Therefore, it is very necessary to improve the mathematical operation ability of junior high school students. In order to improve students' operation ability, it is necessary to start with the influencing factors of students' operation ability. At present, many scholars explore the training strategies of junior high school students' mathematical operation ability by studying the influencing factors of junior high school students' mathematical operation ability. However, there are few general studies on the influencing factors of junior high school students' mathematical operation ability. In order to fully understand the previous research results and blank points on the influencing factors of mathematical operation ability, this paper intends to summarize the previous research. On the one hand, this study can provide teaching reference for junior high school teachers. On the other hand, this paper can point out the direction for future research.

The research question of this paper is: What is the current research status of the influencing factors of junior high school students' mathematical operation ability under the background of core literacy?

It mainly includes the following three aspects:

- (1) What are the main influencing factors proposed by the predecessors?
- (2) What are the previous research methods for this topic?
- (3) What are the blank spots in previous studies?

2. METHODS

2.1 Data Source

This paper selects the literature in the CNKI database as the data source. CNKI is the most authoritative literature retrieval tool for national academic journals, which basically contains articles of various types and directions in China. Based on the integrity of its literature collection and its great academic influence in China, this paper chooses this database as the data source to ensure the persuasiveness and reliability of the research.

2.2 Data Collection

In this paper, 167 results were retrieved by using the advanced retrieval function of China National Knowledge Infrastructure (CNKI) with the themes of "mathematical operation ability", "core literacy" and "junior high school". The retrieved results are arranged in chronological order, and it is found that the earliest literature on the mathematical operation ability of junior high school students under the background of core literacy was published in 2017. The criteria for selecting literature in this paper are as follows: (1) Chinese literature published in China; (2) Referring to the influencing factors of junior high school students' mathematical operation ability under the background of core literacy. After the screening,

this paper finally identified 41 articles as the source of data for this study.

2.3 Data Collation

In this paper, the method of taking notes is used to read the selected literature one by one, and the research methods, research categories and research results of the selected literature are summarized.

3. RESULTS

3.1 Research Categories

Most scholars mainly study the influencing factors of junior high school students' mathematical operation ability from both objective and subjective aspects. The objective influencing factors mainly include school, social and family environment and teachers. Subjective influencing factors mainly refer to students' own factors, including knowledge and skills, abilities and thinking, interests, emotions and attitudes, and habits. See Table 1 for details.

3.2 Research Method

This paper summarizes the research methods of the selected literature and obtains the following results. The results are shown in Table 2.

3.3 Main Factors

3.3.1 Objective influencing factors

(1) Social, school and family environment factors: Liu and Sun pointed out that some parents do not give more care or participation to students' learning, which is not conducive to students' learning of mathematics [2,3]. Sun pointed out that the content of teaching materials and teaching aids, the development of information technology and the influence of family atmosphere will affect students' mathematical operation ability [3]. Huang pointed out that the higher the degree of parents' education, the higher the degree of parents' attention to students' operation ability, and the higher the level of students' operation ability [4]. Wang pointed out that in the face of the pressure of the senior high school entrance examination, many schools require the completion of the course in advance, resulting in a growing gap between the students in the ordinary class and the students in the key class. Students will also think that mathematical operation is a mathematical activity that wastes time. The

content arrangement of teaching aids will also affect students' operation ability [5]. Liu and Chen pointed out that the number of students has increased, and the shortage of teachers has led to teachers' powerlessness, and the teaching effect has deteriorated. The influence of exam-oriented education is still great, leading to the phenomenon of "high score and low ability" [6,7]. Zheng and Xiao pointed out that the large-scale emergence of electronic products will have an impact on students' operation ability [8,9]. Zhang pointed out that without the guarantee of family education, it is difficult for students to develop good behaviour habits, and it is difficult to develop good learning habits. With the increase of knowledge in middle school, the requirements for students' ability become higher, which makes it difficult for students to adapt to the mathematics learning life in middle school. Over time, they have developed bad habits and learned slack psychology [10]. Wen pointed out that the content of teaching materials and teaching aids will affect students' operation ability [11]. Liu pointed out that in today's society, some students are deeply influenced by money-only theory and interest-only theory. Most schools still follow the idea of exam-oriented education. Almost every subject has homework every day. Mathematics homework requires a lot of thinking time, so it is often lost in the end. When time is not enough, students can only copy others' homework. Such a process will have an impact on students' mathematical operation ability [12]. Xu pointed out that the negative impact of exam-oriented education in junior high school mathematics teaching still exists, and the effect of cultivating students' operation ability in junior high school mathematics teaching is naturally unsatisfactory [13]. Ruan pointed out that the pressure of entering a higher school, the disconnection of the mathematics curriculum between primary school and junior high school, and the too-basic setting of exercises in textbooks will affect the mathematical operation ability of junior high school students [14].

(2) Teacher factors: Zhang pointed out that teachers' educational concepts will affect students' mathematical operation ability [15]. Wang and Zhang pointed out that teachers' knowledge structure and mathematical literacy will affect students' mathematical operation ability [5,15]. Liu, Sun, and others pointed out that the teaching level and teaching ability of teachers will affect the mathematical operation ability of junior high school students [2,3,16,5,17,10]. Liu, Yang and Wang pointed out

that teachers' interpretation of curriculum standards will affect junior high school students' mathematical operation ability [2,18,5]. Sun, Bao, and others pointed out that teachers' teaching methods will affect students' mathematical operation ability [3,19,18,20,21,22,17,23,10,24,13]. Sun pointed out that teachers can use the existing mathematical knowledge of students to carry out teaching, to help students better integrate new content into the original cognitive structure. Provide a certain amount of training, and the use of variant strategies, so that students understand the mathematical operation skills and use them [3]. Bao, Chen, Fang and Zhao pointed out that another reason for the weak operation ability of junior high school students is the single teaching method of junior high school mathematics teachers [19,22,23,24]. Yang pointed out that in the teaching process, some teachers do not pay attention to the refinement and infiltration of mathematical thinking methods, ignore the explanation of specific operation processes, and only pay attention to the explanation of problem-solving ideas and methods. As a result, students' mathematical operation ability is not improved [18]. Yu pointed out that teachers' lack of operation skills will affect students' mathematical operation ability [20]. Yan pointed out that teachers can't pay attention to both algorithms and arithmetic in operation teaching, which leads to students' poor operation ability [21]. Zhang pointed out that some teachers only pay attention to the form and ignore the quality of teaching, and teachers do not fundamentally find the problems existing in students' operation, which will affect students' mathematical operation ability [10]. Xu pointed out that from the perspective of the overall teaching methods, many junior high school mathematics teachers still tend to strengthen students' operation ability through a large number of exercises. In this state, although the operation ability of junior high school students can be trained to a certain extent, junior high

school students have to spend a lot of time and energy. Over time, junior high school students' interest in mathematical operations and mathematics knowledge learning has repeatedly decreased [13]. Sun pointed out that teachers' treatment of teaching materials will affect students' mathematical operation ability [3]. Yang, Yan, and others pointed out that teachers' emphasis on mathematical operation will affect students' mathematical operation ability [18,25,20,8,7]. Yang pointed out that teachers' emphasis on arithmetic teaching will affect students' mathematical operation ability [18]. Chen pointed out that teachers also take students' exams as the teaching purpose. Naturally, in the teaching of operation, they do not pay much attention to the cultivation of students' abilities. This teaching attitude of teachers is extremely unfavourable to the cultivation of students' operation abilities [7]. Wang and Liu pointed out that the relationship between teachers and students and the attitude of teachers to students will affect students' mathematical operation ability [5,12]. Huang and Xiao pointed out that teachers' teaching habits will affect students' mathematical operation ability [4,9]. Teachers' cognition, teachers' knowledge structure and thinking mode, mathematics teachers' comprehensive quality, teachers' education level and experience level are also the influencing factors of students' mathematical operation ability [20,10,11,12].

3.3.2 Subjective factors

(1) Knowledge and skill factors: Liu, Zhang, and others pointed out that students' mastery of basic knowledge will affect students' mathematical operation ability [26,15,2,27,18,21,22,28,29,30,31,23,32,33,34,35,36,10,37]. Guan, Yan, and others pointed out that mastering certain operation skills is conducive to the improvement of mathematical operation ability [27,21,28,29,30,32,33,35,36,37].

Table 1. Research categories

| Research categories | | Number of literature | |
|---------------------|---------------------------------------|----------------------|----|
| Objective factor | Social, school and family environment | 13 | |
| | Teacher | 22 | |
| Subjective factor | Knowledge and skill | 19 | |
| | Ability and thinking | 13 | |
| | Non-intellectual factor | Interest | 17 |
| | | Emotion and attitude | 23 |
| Habit | | 23 | |

Table 2. Research method

| Research method | Number of literature |
|---------------------------------|----------------------|
| The experiential summary method | 28 |
| The literature method | 13 |
| The questionnaire survey method | 11 |
| The interview method | 11 |
| The test volume method | 8 |
| The experimental method | 2 |
| The statistical analysis method | 13 |
| The observation method | 1 |

(2) Ability and thinking factors: Liu, Yang and Wen pointed out that in junior high school, the study of mathematical thinking methods is of great help to improve the ability of mathematical operation. For example, mathematical thinking methods such as number-shape combination, classification discussion, transformation and reduction [26,18,11]. Zhang pointed out that the development of students' logical reasoning ability can promote the improvement of mathematical operation ability. In junior high school, students' overall thinking, reverse thinking, divergent thinking and other mathematical thinking factors affect students' mathematical operation ability [15]. Sun and Wang pointed out that thinking sets will affect students' mathematical operation ability [3,5]. Zheng pointed out that students' understanding ability will affect the development of students' mathematical operation ability [16]. Xu pointed out that mathematical abstract thinking ability, mathematical modelling ability, data analysis and processing ability will have an impact on students' mathematical operation ability [38]. Chen pointed out that in the process of mathematics teaching, teachers only pay attention to the inculcation of basic knowledge of textbooks, but lack the narration of operation skills, which will lead to students' inability to diverge their own thinking, thus limiting students' thinking and making them unable to master the correct operation mode, resulting in students' slow operation speed and low accuracy [22]. Gong pointed out that some students do not have clear logic [31]. Fang pointed out that students' ability to examine questions is weak. Students can't analyze the known conditions and hidden information of the problem, especially when the number of words or the type of the problem is novel, students can't split the sentence from it and transform it into mathematical language, or only pay attention to some conditions of the problem, so as to lack or ignore the key conditions, which makes the operation impossible. In the process of problem-solving, students can not flexibly use the

knowledge and methods they have learned, limited to a certain problem-solving method, and their thinking is relatively limited [23]. Yang pointed out that some students' logic is not rigorous, their thinking is not flexible, and they are accustomed to adopting a single-operation method to solve problems. Although some students' operation results are correct, the operation steps are very complicated and cumbersome, and it is easy to make mistakes without attention [34]. Ruan pointed out that the influence of students' mathematical thinking on the improvement of mathematical operation ability is particularly prominent [14].

(3) Interest factors: Through the survey, Liu found that there is a significant positive correlation between students' interest in learning and their performance in the test of operation ability [26]. Zhang pointed out that the low interest in mathematical operation learning is the cause of mathematical operation errors [15]. Sun pointed out that teachers should actively guide students to be interested in mathematics and mathematical operations so that students' mathematical operation abilities can be gradually improved [3]. Guan, Chen, and others found that interest is related to students' mathematical operation ability according to their own experience [27,22,28,29,32,33,35,37]. Through investigation and analysis, Yang found that students' mathematical operation ability and various performance dimensions are significantly positively correlated with students' interest in operation, that is, to a certain extent, students' strong interest in operation has a positive effect on improving their mathematical operation ability [18]. Huang found that the higher the students' interest in learning, the higher the level of students' operation ability [4]. Wang pointed out that interest is the best teacher, which will affect students' mathematical operation ability [5]. Yan pointed out that many students are not interested in mathematics learning, especially mathematical operations, which can also lead to poor operation

ability [21]. Through investigation and analysis, Fang found that the degree of interest was significantly positively correlated with the level of operation, and the higher the students' interest in mathematical operations, the higher the level of operation [23]. Wen pointed out that students' interest in learning mathematical operations affects the operational ability of junior high school students [11].

(4) Emotion and attitude factors: Liu pointed out that learning motivation and consciousness quality will affect students' mathematical operation ability [26]. Zhang pointed out that students' fear of difficulty and inertia will affect students' mathematical operation ability [15]. Through the investigation, Liu found that students do not have a positive attitude towards operation, which will produce a series of inactive problem-solving phenomena, resulting in a low level of operation ability. Students' lack of mathematical self-confidence is also one of the factors that affect students' mathematical operation ability [2]. Sun pointed out that students should pay more attention to operation ability, start from their daily lives, and pay attention to the cultivation of mathematical operation ability [3]. Bao pointed out that due to the lack of good research spirit, junior high school students can not completely solve more complex mathematical problems in the process of mathematical problem operation, but only solve relatively simple mathematical problems [19]. Zheng pointed out that students' negative psychology will indirectly affect students' mathematical operation ability [16]. Through investigation and research, Yang found that the higher the students' attention to mathematical operation, the faster the students' mathematical operation ability improved. The stronger the willpower of students, the more helpful it is to cultivate students' mathematical operation abilities [18]. He pointed out that many students do not lack ability, but do not correct their learning attitude, do not focus on mathematics learning, resulting in the inability to master the principles and criteria of operation, and ultimately can not flexibly and efficiently solve problems [39]. Yan pointed out that students themselves have low requirements for operation ability [25]. Yu pointed out that some students have a deviation in their understanding of operations. It is generally believed that as long as they are serious and careful in the calculation process, they do not need to waste more time and energy on practice, which eventually leads to a decrease in their mathematical operation ability [20]. In the

teaching practice, Lin found that in the process of mathematics learning, most students are reluctant to seriously carry out the special training of operations. Some students are willing to think but not necessarily do the calculation, resulting in slow problem-solving, and even have ideas but can not calculate the correct answer [40]. Wang pointed out that some students lack the confidence to learn mathematics well, which will directly affect the cultivation of mathematical operation ability [5]. Wang pointed out that the situation of high eye and low hand is very common in students' calculations. One look will, one do wrong seriously affected the students' confidence in mathematical calculation and learning [30]. Gong pointed out that most students often lose patience and confidence when they encounter complex calculations and give up solving problems. Over time, the operation ability of these students is naturally not effectively improved [31]. Zheng pointed out that students themselves are not interested in operation, which in turn affects their mathematical operation ability [8]. Fang found that some students did not pay enough attention to mathematics through teacher interviews [23]. Through investigation and research, Zhang found that impetuous and careless, high-minded and low-skilled, poor psychological quality of the examination room, and contempt for algorithms will affect students' mathematical operation ability [10]. Wen pointed out that the attitude of students toward mathematical operations determines their seriousness of mathematical operations, which affects their level of mathematical operations [11]. Zhao pointed out that junior high school students have not yet studied the spirit of research, so that students in the face of these complex problems, it is easy to choose to give up [24]. Xiao pointed out that when students encounter unfamiliar problems or problems, they often cannot settle down to carry out careful calculations. At the same time, students pay more attention to the results, thinking that the results have come out and the process is not important [9]. Liu pointed out that many students think that they should learn mathematics well, as long as they can understand it in class and remember the formula theorem summarized by the teacher. They think that the operation problems that can be understood do not need to be written, and writing is also a waste of time. Many students are not confident in learning mathematics, and in the long run, their operation ability declines [12]. Liu pointed out that students lack patience and confidence, and they do not pay enough

attention to the operation psychologically. In the long run, their operation ability will decline [41]. Ruan believes that inert psychology will affect students' mathematical operation ability [14].

(5) Habit factors: Through investigation and research, Liu found that careless examination of questions, non-standard answer format, random use of draft paper, excessive use of calculators, and lack of inspection and reflection will affect the development of students' mathematical operation ability [26]. By sorting out the causes of mathematical operation errors, Zhang found that operation habits are one of the factors that affect students' mathematical operation ability [15]. Liu pointed out that we should pay attention to cultivating students' good operation habits, so as to reduce the phenomenon of losing points [2]. Sun pointed out that good mathematical operation habits can promote the improvement of students' mathematical operation ability [3]. Bao pointed out that from the perspective of core literacy, the key factor that weakens students' mathematical operation ability is that they do not develop good learning habits [19]. Through investigation and analysis, Yang found that students' good operation habits will contribute to the cultivation of mathematical operation ability [18]. Through investigation and analysis, Huang found that the most important internal factor affecting students' overall operation ability is students' learning habits [4]. Feng pointed out that some students simplify the steps of solving problems in order to improve efficiency in the process of doing problems, which makes them unable to recall the thinking mode at that time when they review after class, which affects the effect of review [42]. He pointed out that good habits can make students get faster progress and growth, so in order to improve students' operation ability and lay a good foundation for future in-depth study of mathematical knowledge, we should pay attention to the cultivation of students' operation habits [39]. Yu pointed out that students' over-reliance on electronic products has led to a degradation of their operation ability [20]. Wang pointed out that students' dependence is particularly strong, and whether the calculation results are correct or not depends entirely on the teacher's marking. If the calculation results are wrong, some students do not have the habit of correcting themselves, waiting for the teacher to explain and give the correct answer. Dependence on teachers or calculators is a factor that affects students' operation ability [5]. Yan pointed out that students rely too much on calculators and lack

operation skills, resulting in poor operation ability [21]. Through investigation, Fang found that students have the habits of not carefully examining questions, copying wrong or missing operation symbols or intermediate processes in the operation process, irregular writing of problem-solving format, and misleading themselves due to untidy volume surface, which will affect the operation results. After obtaining the results of the operation, students often neglect to test the results, resulting in wrong conclusions [23]. Through the observation of students' daily learning, Yang found that most students did not develop good operation habits. Bad habits mainly include irregular answers, poor use of draft papers, lack of detailed examination of questions, and lack of post-operational testing and reflection. These habits will affect the rationality, accuracy, proficiency and simplicity of the operation [34]. Zhang pointed out that students only look at the answer without looking at the process will affect their mathematical operation ability [10]. Wen pointed out that students' bad learning habits will also affect students' mathematical operations. Students' bad operation habits are mainly reflected in the following aspects: writing is not standardized, some students do not have the habit of checking while doing questions, do not know that the symbols or numbers are copied wrong in the process of doing questions, some students do not have the habit of thinking carefully after seeing the questions, and some students do not have the habit of reflecting on and summarizing the methods and skills of solving problems after solving problems [11]. Zhao pointed out that the problem that students do not have good learning habits is also an important factor leading to the decline of students' mathematical operation ability from the perspective of core literacy [24]. Liu pointed out that the unclear examination questions, writing is not serious, the answer format is not standardized, the use of calculators or mental calculations instead of written calculations, the use of draft paper is not standardized, the lack of self-monitoring of the operation process and the evaluation of the results will affect the students' mathematical operation ability [12]. Liu pointed out that relying on calculators, random checking calculations, sloppy writing, and scrawled handwriting will affect students' mathematical operation ability [41]. Through interviews with some teachers, Ruan found that the introduction of calculators had different degrees of negative impact on students' mathematical operation ability, which greatly hindered the improvement of junior high

school students' mathematical operation ability [14]. Liu, Zheng, and others pointed out that student's failure to make correct attribution is also one of the factors affecting mathematical operation ability [26,16,40,5,10,11,9,12].

4. DISCUSSION

4.1 Discussion on the Influencing Factors

Previous studies have mostly studied the influencing factors of junior high school students' mathematical operation ability from both objective and subjective perspectives. Objective factors refer to the factors that have nothing to do with the students themselves, including social, school and family environment, teachers and so on. Compared with the social, school and family environment, the influence factors of teachers are studied more widely. The influencing factors of teachers mainly include teachers' teaching level, teachers' teaching methods, teachers' teaching attitude, teachers' educational concept, teachers' interpretation of curriculum standards, teachers' teaching habits and so on. Researchers have mentioned more about teachers' teaching levels and teaching methods. The influencing factors of the subjective aspect refer to the influencing factors related to the students themselves. From the statistical data, it can be seen that the influencing factors of the mathematical operation ability of junior high school students are more concentrated in the previous studies. It mainly includes five aspects: knowledge and skills, ability and thinking, interest, emotion and attitude, and habit. Among them, the researchers mentioned more knowledge and skills, emotions and attitudes, and habits. In addition, the mathematics foundation of junior high school students, students' learning style, cognition of operation ability and number sense are also factors affecting junior high school students' mathematical operation ability. Future research can study the factors that affect the improvement of junior high school students' mathematical operation ability from the aspects of ability and thinking. The previous research categories have been more extensive, but not detailed enough. Future researchers can study the factors that affect the improvement of junior high school students' mathematical operation ability in more detail.

4.2 Discussion on Research Methods

The previous research methods mainly involve eight methods: experience summary method,

literature method, questionnaire survey method, interview method, test volume method, experimental method, statistical analysis method and observation method. Most of the authors of the study are middle school teachers. According to their own teaching experience, they draw the influencing factors of middle school students' mathematical operation ability through theoretical speculation. Part of the research is a dissertation. The researchers understand the research status of related topics through the literature method, design questionnaires and interview outlines, go deep into middle schools to do surveys, and use statistical analysis to analyze the collected data to obtain the influencing factors of junior high school students' mathematical operation ability. Based on this, the teaching design is carried out, and the experimental method is used to verify the teaching effect. Among the eight research methods, the experience summary method, literature method, questionnaire survey method, interview method and statistical analysis method are used the most. The predecessors seldom use the experimental method and the observation method to study the factors that affect the improvement of junior high school students' mathematical operation ability. However, the two empirical research methods of experimental method and the observation method can better assist the research in this field. Therefore, it is necessary for future researchers to use experimental methods and observation methods to study the factors that affect the improvement of junior high school students' mathematical operation ability.

5. CONCLUSION

This paper reviews and collates the previous research, and draws the following conclusions:

- (1) Research on the influencing factors of junior high school students' mathematical operation ability, predecessors have made great achievements. The predecessors have explored the influencing factors of junior high school students' mathematical operation ability through the experience summary method, literature method, questionnaire survey method and interview method, and then sorted out and analyzed the collected data through statistical analysis method.
- (2) The influencing factors obtained by predecessors mainly include objective and

subjective aspects. Objective aspects include school, social and family environment and teachers. Subjective aspects include knowledge and skills, ability and thinking, interest, emotion and attitude, and habits.

- (3) The influencing factors obtained by the predecessors are more extensive, but lack detail and specificity.
- (4) Few researchers have verified the authenticity of the influencing factors.
- (5) In future research, researchers can study the factors that affect the improvement of junior high school students' mathematical operation ability in a more detailed and specific way. For the influencing factors, their authenticity can be verified by empirical research methods such as experimental methods.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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