



# **Research on the Cultivation Strategy of Junior Middle School Students ' Mathematical Innovation Consciousness 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**

With the implementation of mathematics curriculum reform in primary and secondary schools, the cultivation of mathematical innovation consciousness is becoming more and more important. Many scholars have conducted relevant research on the cultivation of junior middle school students ' mathematical innovation consciousness, however, few relevant findings have been summarized. Through the method of literature analysis, this paper retrieves keywords such as ' innovation consciousness ' in the CNKI database and obtains relevant literature. After intensive reading of 36 articles, this paper uses the method of taking notes with the intention of summarizing the research contents, research methods, and research results in previous studies, and draws the following conclusions: (1) The cultivation strategies of junior middle school students ' mathematical innovation consciousness are mainly studied from three aspects: before class, during class, and after class. Scholars study more from the perspective of class ; (2) The researchers mainly use two kinds of research methods: literature research method and case analysis method, and the research

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method is relatively single ; (3) The suggestions and strategies given by scholars are relatively broad and general. Most of them are put forward from the perspective of teachers, and there are gaps in the perspective of students. Therefore, in the future, it is essential for improving the research methods and conducting research from a broader perspective in order to find more reasonable and specific suggestions and strategies.

*Keywords: Innovation consciousness; Junior Middle School; mathematics.*

## 1. INTRODUCTION

Compulsory education mathematics curriculum standards (2022 edition) points out that mathematics curriculum should cultivate students ' core literacy so that students can observe the real world with mathematical vision, and one of the manifestations of mathematical vision is innovation consciousness. Innovation consciousness helps students form a scientific attitude and rational spirit of independent thinking and questioning. Therefore, it is essential for studying the cultivation strategy of junior middle school students ' mathematical innovation consciousness. At present, there are many types of research on the cultivation strategy of junior middle school students ' mathematical innovation consciousness, but there are few general studies on this topic. Therefore, this paper intends reviewing and sorting out the current research, systematically analyzing the research status of this topic, and providing a corresponding strategic reference for how to cultivate junior middle school students ' awareness of mathematical innovation. More importantly, by finding out its blank points, scholars are encouraged to further study.

The question studied in this paper is: What is the research status of the "cultivation strategy of junior middle school students ' mathematical innovation consciousness in China"? Specifically, it includes the following two aspects:

- (1) What aspects have scholars studied on the cultivation strategy of junior middle school students ' mathematical innovation consciousness? What are the main results? What are the main methods used?
- (2) Which areas are currently being studied more? Which aspects are less researched? What are the deficiencies? Are there any blank points?

## 2. METHODS

### 2.1 Data Source

This paper selects the literature in the CNKI (China National Knowledge Infrastructure) database as the sources of data. CNKI is the

most authoritative document retrieval tool in Chinese academic journals, which approximately contains all the contents of Chinese journals. This database can ensure persuasion and reliability.

### 2.2 Data Collection

Through the advanced search of CNKI, a total of 20 articles were retrieved by searching the three keywords of " innovation consciousness " " junior middle school mathematics " and " cultivation ". Through reading each article, 16 articles related to the topic were retained. In addition, 20 articles were selected according to relevance and publication time by searching the keyword " innovation consciousness ". Therefore, these 36 articles are analyzed in depth.

### 2.3 Data Collation

Through the intensive reading of the literature, the author uses the method of taking notes to summarize the research contents, research methods, and research results in previous studies.

## 3. RESULTS

### 3.1 Research Aspects and Categories

After reading 36 articles, we found that the research on the cultivation strategy of junior middle school students ' mathematical innovation consciousness in China mainly involves three aspects: how to cultivate innovation consciousness before class, during class, and after class. All strategies are roughly divided into 19 categories, namely : (1) Creating an innovative thinking environment and inspiring students to explore independently ; (2) Creating a relaxed learning atmosphere and building a harmonious teacher-student relationship; (3) Carrying out extra-curricular activities to cultivate students ' practical ability; (4) Encouraging students to question and guiding students to explore actively; (5) Using students ' interests and hobbies to cultivate the innovative ability; (6) Cultivating teachers ' innovation consciousness

and divergent thinking; (7) Cultivating students ' habit of active thinking; (8) Carefully creating problem situations; (9) Fully exploring the teaching material resources; (10) Taking notice of the cultivation of students ' non-intellectual factors; (11) Dividing students into groups and studying in groups ; (12) Taking notice of the history of mathematics teaching; (13) Innovating teaching methods, rationally using multimedia research, and developing teaching aids and learning aids; (14) Taking notice of the accumulation and flexible use of knowledge, cultivating students ' divergent thinking; (15) Contacting the reality of life to stimulate the willingness to innovate; (16) Creating an evaluation mechanism to enhance students ' innovative ability; (17) Updating the concept of education, deeply understanding the new

teaching ideas; (18) Improving and optimizing teaching methods; (19) Cultivating students ' subject consciousness and making students experience the process of exploration. The details of the number of occurrences of each type of strategy in all articles are shown in Table 1.

As can be seen from Table 1, "Creating a relaxed learning atmosphere and building a harmonious teacher-student relationship"" Carefully creating problem situations" "Carrying out extra-curricular activities to cultivate students ' practical ability" and "Encouraging students to question and guiding students to explore actively", these four strategies are the most mentioned by scholars.

**Table 1. Research aspects and categories on the cultivation strategy of junior middle school students ' mathematical innovation consciousness**

Research categories	Research aspects	Before class	During class	After class
Creating an innovative thinking environment and inspiring students to explore independently			6	
Creating a relaxed learning atmosphere and building a harmonious teacher-student relationship			18	
Carrying out extra-curricular activities to cultivate students ' practical ability				13
Encouraging students to question and guiding students to explore actively			12	
Using students ' interests and hobbies to cultivate the innovative ability			6	
Cultivating teachers ' innovation consciousness and divergent thinking		3		
Cultivating students ' habit of active thinking			5	
Carefully creating problem situations		14		
Fully exploring the teaching material resources		7		
Taking notice of the cultivation of students ' non-intellectual factors			3	
Dividing students into groups and studying in groups			3	
Taking notice of the history of mathematics teaching			2	
Innovating teaching methods, rationally using multimedia research, and developing teaching aids and learning aids		6		
Taking notice of the accumulation and flexible use of knowledge, cultivating students ' divergent thinking			5	
Contacting the reality of life to stimulate the willingness to innovate			8	
Creating an evaluation mechanism to enhance students ' innovative ability				1
Updating the concept of education, deeply understanding the new teaching ideas		7		
Improving and optimizing teaching methods			4	
Cultivating students ' subject consciousness and making students experience the process of exploration			5	

*Note: Numbers indicate the number of times the corresponding strategy appears in the article.*

**Table 2. Research methods**

Research method	Literature research	Case analysis
Frequency	34	35

*Note: Numbers indicate the number of times the corresponding method appears in the article*

### 3.2 The Method Adopted

By summarizing the research methods involved in 36 articles, it is found that most of the articles adopt the literature research method and case analysis method. The number of times that various methods appear in the article is summarized. The details are shown in Table 2.

### 3.3 Main Viewpoints of Predecessors

#### 3.3.1 How to cultivate mathematical innovation consciousness before class

How to cultivate junior middle school students' awareness of mathematical innovation before class, there are mainly 5 strategies, which are: (1) Cultivating teachers' innovation consciousness and divergent thinking; (2) Carefully creating problem situations; (3) Fully exploring the teaching material resources; (4) Innovating teaching methods, rationally using multimedia research, and developing teaching aids and learning aids; (5) Updating the concept of education, deeply understanding the new teaching ideas.

Tang pointed out that teachers should change traditional ideas and form advanced innovation consciousness. On this basis, teachers should subtly cultivate students' innovation consciousness. Each student has an innovative ability, and the cultivation of teachers is the key factor in the development of students' innovative abilities [1]. Yu, Huang, Yan, and others pointed out that a good teaching situation can effectively stimulate students' thinking sparks, which is of great help to cultivate students' innovative abilities. Teachers should pay attention to the creation of teaching situations, guide students to deepen their understanding of knowledge in the process of using what they have learned and enhance the flexibility of thinking [2-4].

Zhou, Qin, and others hold that the new textbook under the new curriculum reform attaches great importance to new sources of knowledge, knowledge tends to be more intuitive and interesting, and students learn because they are interested and their thinking follows their interests. Teachers should fully tap the teaching

material resources and cultivate students' innovation consciousness [5,6]. Yao, Chen, and others believed that compared with traditional educational methods, multimedia technology can create vivid and realistic teaching situations and make mathematical knowledge vivid and interesting. Teachers should make full use of multimedia means to teach, attract students' attention, and improve students' classroom participation [7,8]. Yu, Wu, and others said that as the guide of students, teachers should first update the educational concept in teaching work, separate from examination-oriented education, deeply understand new teaching ideas, innovate classroom teaching mode, and attach great importance to students' innovation consciousness in teaching [9,10].

#### 3.3.2 How to cultivate mathematical innovation consciousness during class

How to cultivate junior middle school students' awareness of mathematical innovation during class, there are mainly 12 strategies, namely: (1) Creating an innovative thinking environment and inspiring students to explore independently; (2) Creating a relaxed learning atmosphere and building a harmonious teacher-student relationship; (3) Encouraging students to question and guiding students to explore actively; (4) Using students' interests and hobbies to cultivate the innovative ability; (5) Cultivating students' habit of active thinking; (6) Taking notice of the cultivation of students' non-intellectual factors; (7) Dividing students into groups and studying in groups; (8) Taking notice of the history of mathematics teaching; (9) Taking notice of the accumulation and flexible use of knowledge, cultivating students' divergent thinking; (10) Contacting the reality of life to stimulate the willingness to innovate; (11) Improving and optimizing teaching methods; (12) Cultivating students' subject consciousness and making students experience the process of exploration.

Ji, Ma, and others believed that mathematics is everywhere in life. Teachers should be good at creating an atmosphere conducive to cultivating students' innovative ability, infiltrating into all

aspects so that students can accept the cultivation of innovative thinking in a subtle way [11,12]. Wang, Qin, Jiang, and others pointed out that in a relaxed learning environment, students will be more active to express their own ideas. In teaching, teachers should establish a democratic and equal teacher-student relationship, create a relaxed and harmonious classroom atmosphere, and guide and encourage students to make bold attempts and actively participate in learning [13-15]. Ma, Yi, Zhou, and others hold that in the teaching process, teachers should constantly encourage students to question, form questioning thinking, and constantly deepen their understanding of knowledge in questioning, communicate in questioning, improve in communication, and innovate in improvement [16-18].

Wang, Qiao, and others pointed out that interest is the best teacher. Teachers should fully consider students' interests and hobbies, and use this as a starting point to encourage students to actively use the knowledge they have learned, imagine, guess, and verify independently, so as to promote students' independent innovation [19,20]. Wang, Sun, and others pointed out that in addition to teaching knowledge in the classroom, teachers should also plan independent thinking time for students, guide students to deeply understand the knowledge they have learned in the process of independent thinking, generate more novel ideas, and also promote students to develop a good habit of seeking new and thinking [21,22]. Zhang et al. pointed out that good non-intellectual factors have positive effects on students' growth in many aspects, such as guidance, maintenance, and adjustment. Therefore, in the teaching process, teachers should pay attention to students' emotional experience and self-pursuit tendency, mobilize students' non-intellectual factors, enable students to have learning motivation, and thus be able to devote themselves to learning activities [23].

Yao et al. (2013) believed that team spirit is conducive to the cohesion of class members. Teachers can design some problems that need students to cooperate with each other in teaching. While cultivating students' team spirit, it also provides a good platform for the cultivation of innovation consciousness [24]. Chen and others pointed out that the study of the history of mathematics is helpful for students to understand the role of mathematics in the development of human civilization, to feel the rigorous attitude

and perseverance of mathematicians, to understand the formation process of mathematical knowledge, and to stimulate students' national pride and carry forward the responsibility of the excellent traditional culture of the motherland [8]. Wang, Zhou, and others pointed out that teachers should guide students to use knowledge points flexibly, use divergent thinking and logical thinking to think and solve problems from multiple perspectives and promote the development of students' innovative thinking abilities [19,25].

Tian, Nan, and others (2019) pointed out that the combination of mathematics learning and life practice is the inevitable trend of curriculum reform. Teachers need to focus on bringing mathematics to life, introducing mathematical problems in life into the classroom, let students realize the practical significance of mathematics, so as to improve their enthusiasm for learning mathematics and innovation consciousness [26,27]. Zhou, Liu, and others pointed out that scientific teaching methods can cultivate students' innovation consciousness more efficiently. Teachers should make full use of various teaching tools and means to help students better understand and master mathematical knowledge according to the key and difficult contents of classroom teaching [18,28]. Shi, Ma, Liu, and others pointed out that teachers should help students clarify their roles, guide students to learn and explore independently, let students experience the exploration process personally, and improve their innovative literacy [29,12,30].

### **3.3.3 How to cultivate mathematical innovation consciousness after class**

How to cultivate junior middle school students' mathematical innovation consciousness after class, there are 2 main strategies: (1) Carrying out extra-curricular activities to cultivate students' practical ability; (2) Creating an evaluation mechanism to enhance students' innovative ability.

Zhu, Pei, Cao, and others pointed out that in the process of junior middle school mathematics teaching, in order to enhance the sense of innovation, it is necessary to combine thinking with practice. Students deepen their understanding of the knowledge they have learned in the process of participating in practical activities so that the knowledge they have learned can be used for themselves, improve

their practical ability, and improve their sense of innovation [30-32]. Chen pointed out that when evaluating students, teachers should pay more attention to the changes in students' thinking in the learning process, give full play to the incentive role of evaluation, and stimulate students' innovative thinking and learning enthusiasm [33-36].

## 4. DISCUSSION

### 4.1 Discussion on Relevant Aspects and Categories

Through the collation of statistics, it can be seen that the previous research on the cultivation strategy of junior middle school students' mathematical innovation consciousness mainly focused on three aspects: before class, during class, and after class, and a total of 19 strategies are proposed. The research mainly focuses on how to cultivate students' awareness of mathematical innovation during class. It can be seen that the research on strategies during class is relatively concentrated and is the focus of current research. There are 12 types of strategies for cultivating innovation consciousness during class, and the research is more comprehensive; however, there are few studies on how to cultivate students' innovation consciousness before and after class. Before class, only five strategies are proposed: carefully creating problem situations, fully exploring the teaching material resources, updating the concept of education, deeply understanding the new teaching ideas, innovating teaching methods, rationally using multimedia research, and developing teaching aids and learning aids, and cultivating teachers' innovation consciousness and divergent thinking. After class, only two strategies are proposed: carrying out extra-curricular activities to cultivate students' practical ability, and creating an evaluation mechanism to enhance students' innovative ability. It can be seen that there is a lack of research on how to cultivate students' innovation consciousness before and after class, and further research is needed.

### 4.2 Discussion on Research Methods

For research methods, most of the 36 articles use the literature research method and case analysis method. The research methods are relatively simple, mostly based on speculation and drawing on previous experience, and lack

certain persuasiveness. Later research can use the questionnaire method and interview method, through real data collection and analysis, objectively put forward strategies to ensure the reliability and persuasiveness of the results. The experimental method can also be used to verify the effectiveness of the relevant strategies proposed by the predecessors in cultivating students' innovation consciousness through the comparison between the experimental group and the control group.

### 4.3 Discussion on the Main Strategies

In view of how to cultivate junior middle school students' awareness of mathematical innovation, the researchers mainly mentioned 19 strategies. During class, the strategies commonly mentioned are creating a relaxed learning atmosphere and building a harmonious teacher-student relationship, encouraging students to question and guiding students to explore actively, it can be seen that these two strategies are generally recognized by current scholars; before class, the strategy commonly mentioned is carefully creating problem situations, it can be seen that this strategy is generally recognized by current scholars; after class, the strategy commonly mentioned is carrying out extra-curricular activities to cultivate students' practical ability, it can be seen that this strategy is generally recognized by current scholars. There are relatively few previous studies on the other 15 strategies, and further research is needed to verify the effectiveness of these strategies.

## 5. CONCLUSION

In this paper, through the analysis of the results of previous studies, the following conclusions are obtained:

- (1) By sorting out 36 articles, this paper finds that the previous research on the cultivation strategy of junior middle school students' mathematical innovation consciousness mainly focuses on three aspects: pre-class, in-class, and after-class, and there is more research on the in-class aspect.
- (2) By analyzing the previous views, it is concluded that the current common views are mainly creating a relaxed learning atmosphere and building a harmonious teacher-student relationship, encouraging students to question and guiding students to explore actively, carefully creating

problem situations, carrying out extra-curricular activities to cultivate students' practical ability.

- (3) Most of the previous studies used the literature research method and case analysis method. The application of the questionnaire method, interview method, and experimental method is blank. It can be seen that the research methods used in previous studies are relatively single, so more research methods can be used in future research to ensure the reliability of the results.
- (4) All kinds of strategies are studied by researchers from the reference of other people's literature or their own experience, lacking certain persuasiveness. Therefore, in the future, it is necessary to further study the cultivation strategy of junior middle school mathematical innovation consciousness from multiple perspectives, put forward more effective strategies, and further verify its effectiveness for other strategies proposed by predecessors.
- (5) At present, most of the research on "innovation consciousness" is put forward from the perspective of teachers, while the measures from the perspective of students are relatively few. In the future, we should study from a wider perspective and give more reasonable strategies.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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