



Implementation of Model Concept of Core Literacy in Mathematics in China

Siyu Liu^a and Zezhong Yang^{a*}

^a *School of Mathematics and Statistics, Shandong Normal University, Jinan, Shandong, China.*

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

Compulsory Education Mathematics Curriculum Standards (2022 edition) puts forward the core literacy of the model concept. There are now many studies that concentrate on the model concept, but there are seldom any thorough generalized studies on this topic. The following results are reached by adopting the method of literature analysis to synthesize the pertinent research literature on the model idea in China: (1) The current research on the model concept at the compulsory education level has a very broad scope and includes in-depth investigations on the model concept's status, significance, the classroom design, and penetration strategies of model concept. (2) Most studies are conducted in terms of curricular content and subjects, and they focus on a limited number of fixed themes, such as quadratic equations, quadratic inequalities, and functions. To demonstrate how to fully understand the model concept, researchers offer practical examples and instructional designs. (3) But in terms of curricular styles, there aren't many studies on the model concept. To strengthen the research content, encourage in-depth study by academics and front-line instructors, and increase the effectiveness of the model concept's penetration, it is required to extend the research direction and the entry point.

Keywords: *Core literacy; model concept; penetration strategies.*

*Corresponding author: Email: zhongzee@163.com;

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1. INTRODUCTION

Compulsory Education Mathematics Curriculum Standards (2022 edition) [1] is proposed to be based on the development of students' core literacy. The model concept mainly refers to a clear understanding of using mathematical models to solve practical problems. It also aids in the execution of interdisciplinary thematic learning and the perception of the universality of mathematical applications. There are numerous studies on the model concept and model ideas, mostly focusing on the state of model concept and model penetration strategies (Model penetration means that teachers can transfer the significance and strategies of model application to students in daily teaching, and students can develop the habit and literacy of applying mathematical models to solve problems.), however, there are only a few comprehensive generalized studies on this subject. Therefore, to explore the current status of model concept and the practicality of penetration strategies, this paper aims at making a thorough summary and overview of prior studies, systematically analyze the current status of model conceptions, the significance of model conceptions in junior high school mathematics teaching, and the strategies for developing model conceptions, and identify the research gap. This study can not only assist researchers in providing ideas and directions for further research, but more importantly, it can provide teaching strategies for front-line primary and secondary school teachers, highlighting the flaws and uncovered gaps in them and encouraging deeper research.

The main research questions in this paper include the following three aspects:

- (1) What is the current status of the model concept in student learning and teacher teaching?
- (2) How to penetrate the model concept in junior high school teaching?
- (3) What are the deficiency and gaps in the current research on the model concept?

2. METHODS

2.1 Sources of Information

In this paper, only Chinese materials are studied, and all the materials are from the China National Knowledge Infrastructure (CNKI) database. CNKI is a sizable full-text database that includes, combines, and disseminates all forms of Chinese

literature, including journals, doctorate theses, conference proceedings, newspapers, patents, yearbooks, etc. It is the most authoritative literature search tool for national academic journals and includes all the contents of journals in China, including various subject areas. Therefore, the study's credibility and dependability may be assured by the literature review based on China's National Knowledge Infrastructure. The literature selected for this study includes both journals and dissertations.

2.2 Data Collection

We searched the database of China Knowledge Network with the keywords of "model concept" and "model idea", and retrieved 1010 documents. Taking "junior high school mathematics" and "core literacy" (Core literacy is formed and developed gradually in the process of learning mathematics, at different levels of development for different levels, and is the basic basis for setting curriculum goals. The core literacy to be cultivated in the mathematics curriculum include the following three aspects: to be able to observe the real world with a mathematical perspective, to think about the real world with mathematical thinking, and to express the real world in mathematical language. The model concept is one of the main manifestations of core literacy at the middle school level.) as the main themes, the search continued in the results, and a total of 107 documents were retrieved. The 107 documents were read and examined one by one when the search was finished. Since this review mainly focuses on the core literacy content of the model concept in junior high school, relevant literature in primary school is deleted and 68 pieces of literature are selected as data, including 57 journal literature and 11 academic dissertations. The following research is conducted based on this literature.

2.3 Data Collation

The author organized the findings of earlier studies using the note-taking technique after initially scanning the chosen literature. In the process of reading the literature, the author made an overview of the research methods, research questions, research results, and conclusions in each piece of literature. After reading all the literature thoroughly, it was initially determined that the current research mainly focused on the current situation of the model concept, the significance of the model concept in junior high school mathematics teaching, and strategies for developing the model concept.

3. RESULTS

3.1 Current Status of Teaching Model Concept

3.1.1 Lack of emphasis on the model concept by teachers or students

Lei et al. [2] discovered that junior high school students had problems such as students did not pay enough attention to knowledge and were easily influenced by thinking stereotypes in the model concept. Through investigating students' knowledge of models, model ideas and existing teaching mode cognition, and the ability to apply model ideas, Li [3] discovered that students' understanding and application of models were both rather weak, there were significant variances in students' ways of recognizing the model concept, and model ideas' significance in mathematics differed from school to school. Through students' questionnaires, tests, and interviews with teachers, Miao [4] found that however model ideas were rarely discussed by teachers in the classroom and most teachers built contexts in the classroom, middle school mathematics teachers might recognize that the model concept and contextual instruction are vital for students' mathematical learning and future development. After a survey, it was discovered by Hu [5] that few students could raise their understanding of mathematics to the level of ideas, that they were unfamiliar with model ideas (almost half of them), that teachers focused more on problem-solving than on the development of student's critical thinking and questioning skills, and that they were only recently beginning to pay attention to the introduction of realistic situations. However, the use of modeling concepts in classroom instruction was still inadequate due to realistic pressures.

3.1.2 Lack of clear understanding of model ideas

The current state of teaching the mathematical model concept in the classroom, according to Xu [6], was as follows: first, only examples were explained without the process of building models and model ideas, second, they were unaware of how to build model ideas, third, model construction was superficial, and model ideas were not established. Through questionnaires and interviews, it was found that students and teachers did not have a thorough understanding of model ideas, teachers lacked research on the

integration of model ideas into mathematics teaching, and there was a lack of introduction and application of model ideas in actual teaching [7].

3.1.3 Weak ability to apply the model concept

Li [8] surveyed the state of teaching model ideas in junior high school mathematics through questionnaires and interviews with ninth-grade students and in-service mathematics teachers from a public junior high school in Jinan, Shandong Province, China, and we discovered that most students enjoyed math and can see how useful math was in learning math, that most students can see how mathematical model ideas reflected the connection between math and reality, and that learning model ideas was beneficial to learn an academic subject, more than half of the teachers frequently discussed model ideas and conducted lessons specifically on model ideas, but students' ability to apply modeling ideas was low, especially to real-world problems, which were difficult for students to solve by building mathematical models. The current state of the students' and teachers' model concept was looked into using questionnaires and interviews by Wang [9]. More than half of the students reported that they could not translate natural language into mathematical language, indicating that some students had not developed model ideas. Young teachers also reported having less knowledge of model ideas than middle-aged and older teachers did, and teachers generally believed that the textbooks reflected model ideas and provided useful examples, but the teachers did not carefully examine the teaching materials from the perspective of incorporating model ideas into the classroom. Liao [10] used questionnaires to determine how well the eighth-grade students at the school understood the four concepts of mathematical model ideas, mathematical models in life, the application of mathematical models in classroom learning, and the application in life. The student's lack of knowledge of mathematical model ideas and their lack of understanding and application of mathematical models suggested that they did not have a sufficiently deep understanding of mathematics. Wang [11] discovered that junior high school mathematics has issues with the teaching of model ideas due to model ideas teaching adhering to tradition, the teaching system not being flexible enough, it being difficult for students to understand, and the teaching of model ideas being more dispersed, the model concept not being closely connected

to the actual practice and lack of concrete practice.

3.1.4 Bias in the motivation of the learning model

Fang [12] pointed out that in the integration of model ideas into junior high school mathematics teaching, students have a too one-sided understanding of mathematical model ideas, think it is only used for daily problem solving and the application of mathematical modeling ideas is too passive. Wang [13] investigated and analyzed the current situation of teaching mathematical models in junior high schools using questionnaires and interviews, it was found that teachers generally had a deeper knowledge of mathematical models and had their teaching thinking and teaching methods for teaching mathematical models, but students more often thought that the role of mathematical models was to cope with exams, and only a small number of students were interested in learning models. Junior high school student's interest in learning mathematics and motivation for learning was investigated using questionnaires and interviews by Huo [14]. Most students understand mathematical model ideas, primarily through teachers' teaching processes, and most of them were satisfied with teachers' teaching methods and approaches. They also believe that mathematical model ideas were useful and can be applied to solve problems in practical problem-solving.

3.2 The Significance of the Model Concept in Teaching Mathematics in Junior High School

It was concluded through the literature method and the analysis of example problems combined with the front-line teaching experience that the mathematical model was both a teaching content and a learning style for students. The cultivation of application awareness should be a key component of mathematical model teaching, it was noted that the mathematical model can foster students' generalization ability and application abilities [15]. Han [16] explained the necessity of applying mathematical modeling in junior middle school mathematics teaching through the literature analysis, and junior high school students can gradually acquire the techniques for applying mathematical knowledge to situations, and create the groundwork for understanding and using mathematical models in high school and beyond through the specialized

teaching in this area. Ou [17] believed that cultivating core literacy in junior high school can cultivate students' independent learning ability and improve the effectiveness of classroom teaching. Through the analysis of sample problems, taking the teaching fragment of "graphical information problems" as an example, Zhang [18] believed that graphical problems were the visual manifestation of model thinking, and open-ended problems were good for penetrating model thinking, which was suitable for piercing model thinking and was favorable to the establishment of modeling consciousness. Students can more easily understand the mathematical problems contained in the actual problem and simplify the problem. Through case study analysis, Liu [19] concluded that by using mathematical models in junior high school mathematics instruction, teachers may raise the level of instruction, maximize the teaching environment, and support teachers' abilities. Fang [20] believed that by learning model ideas in junior high school mathematics teaching, students can flexibly use their learned knowledge to solve problems, develop students abstract generalization and innovation ability, and the solution of mathematical models was also an awakening of the past knowledge, which helped students analyze and solve problems. Model ideas were the most frequently used in mathematical activities, according to Zhuang [21], and they helped to increase the effectiveness of mathematical problem-solving. They were also an effective way to enhance the caliber of junior high school mathematics instruction and students' mathematical learning, allowing students' mathematical activities to be more organized. The experience and outcomes of mathematical activities can be transferred to real-world situations, as well as to the study and problem-solving of other topics, through the use of the model concept. Cui [22] believed that model ideas in teaching middle school mathematics geometry can simplify the process of problem-solving, improve the speed of problem-solving, and make problems more intuitive and concrete. Xie [23] thought the penetration of model ideas in junior high school mathematics teaching can stimulate students' interest in learning, cultivate their thinking ability and develop their awareness of applying what they have learned. Wang [24] believed that the infiltration of model thinking in junior high school mathematics teaching can make up for the lack of focus on junior high school students' application of mathematics, stimulate their desire to learn, encourage the updating of mathematics

teachers' professional knowledge, cultivate students' mathematical thinking, increase their interest in learning, improve their application capabilities, form a good attitude towards learning, enrich mathematics teaching ideas, and improve teachers' teaching level. Hua [25] thought that model teaching was crucial for the teaching of geometry because it can support the gradual development of student's cognitive abilities, assist teachers in quickly identifying and resolving issues that arose in junior high school mathematics geometry lessons, and satisfy the needs of junior high school mathematics geometry subjects' theoretical development.

3.3 Strategies for the Development of the Model Concept

Different scholars have presented different perspectives on the integration of the model concept into daily teaching and learning, and the integration strategies are mainly distributed in the following areas.

3.3.1 Strategies based on specific knowledge points

Li [26] demonstrated how to develop students' model concept under the core literacy and outlined the process of addressing the "hidden circle" problem through the analysis of the Chinese examination questions, using the "hidden circle" problem as the entry point. Deng et al. [27] analyzed the content of unitary first-order equations and students' existing knowledge, experience, and thinking level. Based on the model thought of constructivism theory, they proposed the strategy of the penetration of model concept thought into the teaching of the unitary first-order equation. Combining the example of "inequalities and inequality groups", Liang [28] contended that for students to fully grasp the concept of mathematical models, they must first construct a situation, abstract and generalize the resulting mathematical problems, establish mathematical models, comprehend the concept of models, and then learned to apply the concept of models to solve real-world problems. Through the literature method and the analysis of example problems, Zhang [29] concluded that students must become the subject of construction in the classroom, he took the example of explaining the example quadratic equation to illustrate how to use mathematical models to solve problems, and took the example of a quadratic function to explore mathematical materials and construct a living mathematical model.

3.3.2 The cultivation strategy proposed in many aspects

Li [30] illustrated three aspects of promoting the development of students' model concept from model cognition, revision, and migration. Through the analysis of literature, Bu [31] emphasized the significance of reading informational skills, and the cultivation of students' thinking and summarizing abilities, and provided five phases for designing the teaching process: reading analysis, problem hypothesis, model penetration, model decomposition and solution. Through the literature analysis, example problem analysis, and first-line teaching experience, An et al. [32] were able to understand mathematical models from the three perspectives of equation, function, and geometry. They proposed to build mathematical models to solve measurement problems and image information issues by using exercises from textbooks as examples. By giving examples of the classroom teaching process, the practice of developing students' model concept was illustrated by Yu [33] in terms of both mathematical model methods and mathematical model ideas. Huo [14] primarily proposed teaching strategies from three perspectives in light of the actual situation of the mathematical model concept learned in the classroom: teaching preparation, teaching implementation, and teaching evaluation. Teaching preparation strategies for mathematical model concept included deep processing strategies of teaching materials and teaching design strategies, teaching implementation strategies of mathematical model ideas including organizational teaching strategies and content teaching strategies, teaching evaluation strategies of mathematical model ideas including classroom interaction strategies, and teaching feedback strategies.

3.3.3 Principles of cultivation

Wang [34] summarized the fundamental ideas of developing students' understanding of mathematical models using case studies and highlighted specific tactics for doing so in concept teaching, scenario teaching, autonomous investigation, and extension. Yang [35] believed that the integration of modeling ideas in junior high school mathematics teaching should follow the principles of mathematization, appropriateness, process, and progressiveness, and the three aspects of preparation before class, teaching implementation, and teaching

evaluation were elaborated to specify how to integrate modeling ideas in mathematics teaching. Wang et al. [36] gave the principles followed by model ideas through cases: the mathematization principle, the process principle, the zone of proximal development principle, and the principle of relevance, and elaborated the strategies of infiltrating model ideas from two aspects of preparation and implementation of teaching materials. Through the results of the investigation and the analysis of the teaching materials, Li [3] summed up the guidelines for adopting model ideas as follows: focus on a range of teaching formats, accept students as the major body, and be able to reflect the entire construction process. Using the two-way degree analysis method of connecting experience and theory, the guidelines for junior high school mathematics model methods were summed up by Luo [37] as follows: teaching in accordance with the material, step-by-step, acceptability, encouragement, consolidation, creativity, linking theory to practice, teachers' careful planning before class, students as the main body in class, increasing students' awareness of application, increasing students' ability to examine problems and read diagrams, good at induction and summarizing, strengthening scholastic literacies, and strengthening scholastic literacy. Based on the findings of the survey and the theoretical guidance, the principles of model thinking infiltration in junior high school were proposed by Li [8]: the principle of student subject, the principle of attaching importance to the process, the principle of gradual progress, the principle of contextualization, the principle of linking theory to practice, the principle of consolidation and the principle of mathematization, and on this basis, the main methods of teaching model thinking were proposed. Teachers should constantly improve their own quality, prepare textbooks and learning situations, and carefully design teaching activities, with students as the main body.

3.3.4 Training strategies explained from the perspective of textbook or curriculum standards

Through the analysis of the textbook, and sorting out the model content in the middle school mathematics textbook of Su Education, Sun [38] found that the distribution of model content focused on the content of "number and algebra", the requirements of the standard and the teaching objectives, and there was a need to optimize the design of problem situations, contact with real-life situations, explore the value

of graphs, pay attention to the application of data analysis, and clarify the characteristics of statistical models in teaching. Thought comparing the evolution of the concept, content, and form of comprehensive and practical content in the three editions of curriculum standards. Fan et al. [39] believed that teachers should have a firm grasp of mathematical models in order to solve mathematical problems, assist students in learning across disciplines, create realistic situations, explain mathematical concepts to students, gradually awaken students' existing model awareness, created post-lesson discussion questions that encouraged students to think critically, and encouraged students to apply mathematical models. Teachers should not substitute but only supplement.

3.3.5 Focus on situational teaching

Situational teaching means that teachers introduce situations with life examples, guide students to observe and analyze life examples, rely on students' mathematical knowledge and inquiry experience to solve problems, and let students experience the mathematization process from real problems to mathematical models. Through a case study, Xu [40] came to the conclusion that teachers should focus on the examination and understanding of the problem, start with the textbook, delve deeply into the content of the model concept, and also pay attention to the problems in real-world scenarios. They should also help students improve their arithmetic skills and get ready for computationally intensive mathematical modeling training. Li [41] thought that in order to help students develop models with the aid of their mathematical knowledge and solve everyday problems using the mathematical model concept to improve their capabilities of the model, teachers were encouraged to offer scenarios with examples from life. Liu [19] through the case analysis, it was thought that they should create real-world situations, concentrate on the fusion of theoretical knowledge and practical knowledge, direct students to observe and analyze real-world examples, inspire students, carefully plan the classroom, understand the rhythm of teaching, and use the right techniques to direct students to construct models. According to Wang [24], the integration of model ideas into mathematics instruction at the junior high school level should take into account some current issues, be based on the content of teaching materials, and direct junior high school students to use model ideas to solve real-world problems. It is believed by Jin

[42] that we should create problem situations with real life, develop a mathematical model with students' inquiry activities, and promote a mathematical model with question expansion. According to Liu [43], in order to develop students' model concept, teachers should design vivid and precise teaching situations that are relevant to the lesson's content and the cognitive rules of their students, let them actively participate in the creation and development of their knowledge, have them apply the model concept to real-world issues, prompt them to express their uncertainties when they do so, and constantly encourage them to compare and contrast various knowledge. According to Wang [44], the penetration of model concept should be based on concrete examples, start from real life, deepen students' understanding of mathematical models by introducing life prototypes, start from students' experience, rely on students' mathematical knowledge and exploration experiences, among other things, and start from reality. In the practice phase of building models, students must experience the mathematical process from real-world issues to mathematical models. Liao [10] proposed the teaching method of penetrating model ideas in junior high school mathematics teaching based on the constructivist theory and Polya's problem-solving theory, combined with the investigation of the penetration of mathematical model ideas, i.e., create a situation to perceive model ideas, guide inquiry to experience model ideas, connect with reality to apply model ideas, and expand the practice and test the model ideas. Yao [7] thought that the integration of model thinking into junior high school mathematics teaching should pay attention to the background of the problem to be close to students' life, not be detached from the actual so that students can experience the whole process of abstracting from actual problems into mathematical problems. Zou [45] put forward the teacher should focus on guiding the learning process, training students in the methods of mathematical models, and creating application opportunities to enhance student's experience of the mathematical model. Li [46] believed that the penetration of mathematical model ideas should be based on contextual tasks, creating problem situations and life situations, with mathematical activities as the main line and life applications as the goal. Through the literature method and the analysis of cases, Xie [23] concluded that the teaching of middle school mathematics based on modeling ideas should create situations similar to life and carry out inquiry activities.

3.3.6 Classroom structure

Classroom structure here mainly refers to before, during and after class. Han [16] pointed out that the application of model thinking in junior high school mathematics teaching should be well designed before class, enhance students' awareness of the application, assign practical tasks in conjunction with reality, enhance students' ability to examine problems and read diagrams, and strengthen students' understanding of the nature of models. Through case studies, it is proposed by Xue [47] that the cultivation of model thinking in junior high school mathematics based on core literacy should be based on textbooks, group lesson preparation, improving lesson preparation, focusing on learning before teaching, allowing students to learn to think in pre-study, and strengthening targeted counseling after class. According to Shi [48], educators should combine regular instruction with the development of core literacy, plan classes by incorporating content that develops into logical systems, allow students to describe real-world situations in mathematical language, and help students with application skills.

3.3.7 Student-oriented

Through the case study, it was pointed out by Zou [49] that it was necessary to strengthen the understanding of mathematical models, let students participate in the process of mathematical modeling, and teachers should dare to let go of the students and let them really participate in the modeling process. Teachers, according to Li [50], should help students find mathematical laws, select appropriate ways for helping students strive to construct mathematical models, summarize, refine model concepts through time, and learn how to check and amend models. Du [51] used the second volume of the eighth-grade Human Education Edition, as an illustration, to show how the infiltration of mathematical models should start from life or social issues, adhere to the principle of student-oriented, increase the mining of teaching materials, and actively create situational teaching environments. Qian [52] pointed out that teachers should clarify the transition from mathematical modeling to modeling ideas, focus on students' perceptions, learn to find opportunities to point out, and design a relatively fixed and long-term mathematical model process for students. According to Hu [5], teachers should improve their own learning, engage in

thematic research of model ideas, conduct a thorough examination of the textbook, and be knowledgeable about the model concept that was contained inside the textbook. Second, the evaluation of pupils should be varied and not solely based on their test results. Teachers should allow students to participate in the process of knowledge production in the classroom and focus on the growth of students' mathematical ideas as well as problem-solving techniques.

3.3.8 Focus on individual student differences

Shi [53] pointed out that for the cultivation of mathematical modeling in junior high school, students should pay attention to the accumulation of knowledge, teachers should pay attention to the improvement of their teaching quality, simplify complex problems and consider students' individual differences. Ou [17] believed that the cultivation of model thinking under core literacy should be an innovative classroom model, student-oriented, differentiated teaching, and cultivating the ability to grasp the essence of the problem. Hu [54] was of the opinion that for the cultivation of mathematical model thinking in junior high school students, students should have a strong foundation in mathematics and that teachers should take into account the differences between their students and use a variety of teaching techniques to enrich junior high school mathematics lessons. Zhuang [21] believed that in daily teaching activities, attention should be paid to protecting students' individuality, cultivating students' divergent thinking, and making good use of multimedia teaching equipment to cultivate students' divergent thinking. According to Wang [13], when teaching middle school mathematics models, teachers should cultivate students as much as possible in accordance with their abilities, set up a reasonable number of fine-grained problems between lesson preparation sessions, pay attention to the in-depth development of teaching materials, and rationalize the setup of the classroom.

3.3.9 Focus on the influence of basic knowledge on the model concept

Liu [55] specifically outlined the teaching methods of mathematical modeling in junior middle school through case studies, including: from difficulties to simplification, problem transformation, and model classification, based on knowledge, to deepen understanding of

knowledge and improve problem-solving skills while learning modeling concepts. The integration of model ideas in junior high school mathematics instruction, according to Ou [56], should concentrate on explaining pertinent model theory knowledge to students, doing a good job of screening and explaining example problems, and teachers should organize students to strengthen training to motivate students to turn what they have learned into ability.

4. DISCUSSION

After analyzing and organizing the literature, the current research mainly focuses on the current situation of the model concept, the significance of the model concept in junior high school mathematics teaching, and the strategies for developing the model concept.

4.1 Discussion on the Current Status of the Model Concept

Through the literature reading and the above analysis, it is to discuss the current model concept in teachers' teaching and students' learning, and point out the hot spots and gaps in the current research.

The development of the model concept among junior high school students and teachers is poor, and the majority of students believe that learning the model concept is necessary to correctly answer mathematical problems [57-59]. This leads to students' strong utilitarianism in learning the model concept and prevents them from effectively internalizing them. Most students are also unable to apply the model concept flexibly to solve problems in their daily learning, and teachers seldom take the initiative to learn the model concept into teaching methods and cases, and the teaching methods about model concepts are relatively single [60,61].

The majority of literature reflects the current situation of the model concept from two parts: students' learning and teachers' teaching, so it can be seen that the research on the current situation of educators and educated people is more concentrated and is the hot spot of current research. However, there are fewer studies on the types of the model concept permeating classrooms and teaching materials, and only a few researchers have compared the changes in some versions of teaching materials, there are still gaps in theoretical research [62-64].

4.2 Discussion on the Meaning of Model Concept Penetration

Based on the above literature reading and analysis, this part summarizes the significance of penetration of model concept for teachers and students.

The majority of literature provides an overview of the model concept's importance for teaching junior high school mathematics in terms of student learning capacity, classroom instruction, and the teacher level. The model concept can assist students to improve their capacity for independent learning, generalization, and application, as well as their mastery of the strategies and techniques for applying their knowledge of mathematics to problems. It can also enhance the effectiveness of classroom instruction [65,66].

However, compared to finding the significance of the model concept from the perspective of students' ability, there are relatively few studies from the perspective of teachers' level, and only a few papers mention the benefits of model concept penetration for teachers' professional development, which is not conducive to teachers' awareness of the long-term impact of penetrating model concept on their own development, which may lead to teachers' lack of motivation in actual teaching.

4.3 Discussion on Cultivation Strategies

Based on the current state of model concept penetration, the literature suggests development options for models. Some literature begins with the junior high mathematics curriculum and describes how the model concept should be incorporated into each topic separately; other literature begins with particular subjects and provides teaching cases; some scholars have also proposed the model concept penetration principles for junior high school teaching, etc.

Not only that, but from the above studies, we can see that there are actually some gaps in the previous studies. The majority of literature begins with the more popular model concept penetration topics, such as quadratic equations, quadratic inequalities, and functions; it then discusses the methods of model concept penetration and provides teaching cases; however, the remaining topics are less studied and cannot be covered in

full; The majority of literature begins with specific mathematical examples to elaborate model idea infiltration techniques or the mathematical content categories (number and algebra, graphics and geometry, statistics and probability, and synthesis and practice); Lesson kinds like new lessons, review lessons, and problem-solving lessons and so on are rarely used as entry points in the mathematical literature [67-69]. Therefore, it is also necessary to expand the scope of future research to make this study more systematic and comprehensive.

5. CONCLUSION

This paper reviews and organizes 68 articles of literature dealing with the model concept at the middle school level and draws the following conclusions:

- (1) The current research on the model concept at the compulsory education level is wide-ranging, and there are detailed studies on the current situation of model concept, their significance, classroom construction, and penetration strategies, but after the above analysis, it is obtained that the current penetration of model concept is not satisfactory, and there are few studies mentioning the benefits of penetration of model concept for teachers' professional development from the perspective of teachers' level.
- (2) Most of the studies used the literature analysis method or case study method, and relatively few questionnaires, interviews, and experimental methods were used, and the research methods were relatively single, so the studies were theoretical but not practical enough and lacked certain persuasive power.
- (3) Most of the studies started from course contents and topics and focused on a few fixed topics, and the researchers gave specific cases and instructional designs to explain in detail how to penetrate the model concept.
- (4) However, relatively few studies have been conducted on the modeling concept from the aspect of curriculum type, and further research is needed.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Ministry of Education of the People's Republic of China. Compulsory education mathematics curriculum standards (2022 edition). Beijing: Beijing Normal University Press. 2022: 5-10.
2. Lei YH, Lu HL. Analysis of strategies for developing students' mathematical modeling literacy in junior high school mathematics teaching. *Mathematical Learning and Research*. 2022;(06):113-115.
3. Li LJ. A practical study on the integration of mathematical modeling ideas into middle school mathematics. Luoyang Normal College; 2021.
4. Miao XQ. Research on teaching middle school mathematics context based on the model idea. Henan Normal University; 2019.
5. Hu QQ. Research on the idea of modeling and its teaching in junior high school mathematics. Wenzhou University; 2016.
6. Xu RH. The establishment of mathematical modeling ideas in classroom teaching under core literacy. *Tianjin Education*. 2021; 24: 26-27.
7. Yao HY. Research on the integration of model ideas into middle school mathematics teaching. Ludong University; 2017.
8. Li Q. Research on the current situation and teaching strategies of the infiltration of mathematical modeling ideas in junior high school. Shandong Normal University; 2022.
9. Wang L. Research on the integration of modeling ideas into the teaching of middle school mathematics. Yili Normal University; 2021.
10. Liao YQ. Research on the teaching design of infiltrating model ideas in junior high school mathematics teaching. Chongqing Normal University; 2021.
11. Wang M. Strategies for the penetration of model ideas in junior high school mathematics in classroom teaching. *Scholastic*, 2019;12(05): 32-33.
12. Fang XQ. Exploring the ways of integrating model ideas into middle school mathematics teaching. *Exam Weekly*. 2019; A0: 59-60.
13. Wang X. Analysis of the current situation of the infiltration of mathematical modeling ideas in junior high school and the study of strategies. Yan'an University; 2021.
14. Huo XL. Research on teaching strategies of middle school classrooms based on the idea of mathematical modeling in core literacy. Shaanxi University of Technology; 2018.
15. Lin SB. Application consciousness: A pointer to mathematical modeling--reflections on mathematical modeling in junior high school mathematics teaching. *Mathematics Teaching Newsletter*, 2021; 32: 58-59.
16. Han ZP. The application of modeling ideas in junior high school mathematics teaching. *Qinghai Education*. 2021;Z2:73-75.
17. Ou GX. Cultivation of model thinking in middle school mathematics based on core literacy. *Exam Weekly*. 2019;33:85.
18. Zhang Y. Mathematical models, making problems simpler--an example of the penetration of function models in middle school mathematics teaching. *Mathematics Teaching Newsletter*. 2018;29:44-45.
19. Liu HY. Exploring the flexible application of mathematical models in junior high school mathematics teaching. *Mathematical World (Upper)*. 2018;08):91.
20. Fang HL. The penetration of mathematical modeling ideas in junior high school mathematics teaching. *Exam Weekly*. 2017;93:76.
21. Zhuang, WG. Effective strategies for cultivating modeling ideas in middle school mathematics activities. *Exam Weekly*. 2017; 21:97-98.
22. Cui CC. Modeling ideas to build an efficient classroom teaching of middle school mathematics geometry. The newest edition of the book. The newest edition of the book". 2021;08:27.
23. Xie MQ. Exploring the practice of teaching middle school mathematics based on model thinking. *Reading, Writing and Arithmetic*. 2021;19:71-72.
24. Wang L. Exploring the strategy of model idea penetration in junior high school mathematics teaching. *New Course Research*. 2021;15:133-134.
25. Hua LF. A brief discussion on the ways of using models in teaching geometry in junior high school. *Exam Weekly*. 2018;62: 66.
26. Li L. The construction of a "hidden circle" model to find the most value of a line segment from the perspective of core literacy. The study of secondary school mathematics (South China Normal University Edition). 2022;18:36-38.
27. Deng SS, Sang HF. Reflections on the teaching and learning of infiltrating model

- ideas in elementary school mathematics quadratic equations. *Mathematical Learning and Research*. 2020;13:105-106.
28. Liang JQ. The infiltration of model ideas in junior high school mathematics teaching--taking the teaching of "inequalities and inequality groups" as an example. *Mathematics Teaching Newsletter*. 2018; 29:24-25.
 29. Zhang JJ. The infiltration of subject core literacy in the use of mathematical models in junior high school. *Test and Research*. 2019;18:174.
 30. Li, HB. The practice and thinking of "model building" in junior high school mathematics. *Mathematics Teaching Newsletter*, 2022; 05:28-29.
 31. Bu JH. The penetration of mathematical modeling ideas in junior high school mathematics teaching. *Mathematics and Science World (Middle School Edition)*. 2022;01:78-80.
 32. An ZH, Liu JY. Constructing mathematical models to solve real-world problems--An example of problem-solving topics in middle school mathematics. *Examination Research*. 2021;17(06):25-29.
 33. Yu QH. Strengthening mathematical modeling to enhance core literacy. *Secondary School Mathematics*. 2020;20: 85-86.
 34. Wang LJ. Cultivating students' awareness of mathematical modeling under core literacy. *Education*. 2020;16:37-39.
 35. Yang GH. An introduction to the strategy of incorporating model ideas in middle school mathematics teaching. *Tian Tian Ai Science (Frontiers in Education)*. 2022;08: 37-39.
 36. Wang DY, Gu XD. An introduction to the research on teaching the idea of modeling in junior high school mathematics. *Shanxi Youth*. 2018;08:69-70.
 37. Luo X. Exploring the teaching of mathematical modeling in junior high school. *Huazhong Normal University*; 2019.
 38. Sun K. Analysis of the mathematical modeling content in the middle school mathematics textbook of Suke version. *Research on Teaching in Primary and Secondary School Classrooms*. 2022;08: 21-23.
 39. Fan LZ, Liu XL, Xing YY, et al. Model concept and application awareness: The key to developing "synthesis and practice" in junior high school mathematics: A case study of seventh-grade teaching [J]. *Liaoning Education*. 2022; 15:5-10.
 40. Xu YM. Exploring strategies for developing middle school students' core literacy in mathematical modeling. *Exam Weekly*. 2019;30:104.
 41. Li WX. The use of mathematical modeling method in the middle school mathematics classroom. *Mathematical World (Upper)*. 2018;09:9.
 42. Jin K. Quality intention - the penetration of model ideas in junior high school mathematics. *Test and Research*. 2018;30: 38-39.
 43. Liu ZF. Reflections on the infiltration of model ideas in junior high school mathematics teaching. *New Course (in)*. 2018;06:108.
 44. Wang YM. Using modeling ideas, effectively constructing mathematical models in junior high school. *Mathematics Teaching Newsletter*. 2018;11:51-52.
 45. Zou QH. A few attempts to penetrate modeling ideas in middle school mathematics teaching. *Examination Weekly*. 2016;71:61.
 46. Li JQ. Strategies for infiltrating modeling ideas in middle school mathematics in the context of core literacy. *Mathematical World (Upper)*. 2019;08:34-35.
 47. Xue HG. Cultivation of model thinking in junior high school mathematics based on core literacy. *Advanced Placement*. 2019; 06:237.
 48. Shi NC. Cultivation and teaching of academic core literacy - taking the cultivation of core literacy in mathematics as an example. *Primary and secondary school management*. 2017;01:35-37.
 49. Zou CF. Practice and reflection on middle school mathematics based on modeling ideas. *Middle School Mathematics*. 2020; 12:88-89.
 50. Li G. Strategies for integrating modeling ideas into middle school mathematics teaching. *Parenting*. 2020;21:29-30.
 51. Du W. The infiltration of mathematical modeling ideas in junior high school mathematics teaching - Taking the second volume of the eighth grade Human Education Edition as an example. *Mathematical World (Upper)*. 2019;11:28.
 52. Qian HL. Model thinking: a mathematical concept with rich meaning--thinking based on middle school mathematics. *Mathematics Teaching Newsletter*. 2017;11: 49-50.

53. Shi Q. Research on the cultivation of model thinking in middle school mathematics based on core literacy. *New Wisdom*. 2019;22:137.
54. Hu P. Cultivation of model thinking in middle school mathematics based on core literacy. *China Teacher*. 2018;S1:114.
55. Liu ZS. Analysis of strategies for teaching mathematical modeling in junior high school. *Famous Teachers Online*. 2019;29: 35-36.
56. Ou QH. Strategies for integrating modeling ideas in junior high school mathematics teaching. *Famous Teachers Online*. 2021; 18:66-67.
57. Geng SL. Perceiving the process of mathematical modeling and developing core mathematical literacy--an example of shortest path problem application. *Qinghai Education*. 2022;05:46-48.
58. Zhang R. Exploring strategies for building an efficient classroom in middle school mathematics from the perspective of core literacy. *Intelligence*. 2022;05:124-126.
59. Chen BZ, Chen HZ. Exploring the development of mathematical modeling ability in junior high school. *Fujian Basic Education Research*. 2022;01: 55-57.
60. Wu H. Strategies for building an efficient classroom in middle school mathematics from the perspective of core literacy. *Journal of Knowledge Seeking*. 2019;51: 32-33.
61. Shen L. Mathematical modeling: From methods to ideas--and thoughts on the landing of core literacy in middle school mathematics. *Mathematics Teaching Newsletter*. 2019;32:37-38.
62. Wang DB. An introduction to the use of model ideas in middle school math problem-solving. *Science Enthusiast (Educational Teaching)*. 2021;04:35-37.
63. Dong X. Analysis of strategies for penetrating model ideas in junior high school mathematics classroom teaching. *New Curriculum Teaching (Electronic Edition)*. 2020;15:39.
64. Wang GY. Research on the infiltration of modeling ideas in the teaching of junior high school mathematics functions--Taking "primary function" as an example. *Mathematics Teaching Newsletter*. 2020; 17:67-68.
65. Zhang HB. How to make core literacy take root - the implementation of mathematical modeling. *Mathematics Teaching Newsletter*. 2019;26:50-52.
66. Zhao XM. The penetration of model ideas in teaching middle school mathematics. *Huazhong Normal University*; 2018.
67. Ge XH. Analysis of mathematical modeling teaching in junior high school in the context of the new curriculum. *Science Public (Science Education)*. 2016;01:25+40.
68. Zhong JJ. Example of the application of model ideas in junior high school mathematics. *Middle School Mathematics Research (South China Normal University Edition)*. 2013;14:6-8.
69. Shi JH. How to integrate model ideas into junior high school mathematics teaching. *Mathematical and Rational Problem-Solving Research*. 2021;35:4-5.

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