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Developing a New Teaching Model to Promote the Development of Second Graders' Metacognitive Monitoring

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Abstract

This paper is an empirical one."Learning to think" is the motivation system for students to "learn mathematics well", is a kind of inner stable cognitive psychological quality, and is the "engine" for the cultivation of innovative consciousness. Guiding students to learn to think plays an important role in mathematics teaching. However, students often do not understand the connection between mathematical knowledge and real life, and do not understand how to use mathematical knowledge to solve problems. In order to let students learn to think, the researchers designed a teaching model composed of "FROM-WHAT-WITH-HOW-CHANGE-HAVE" based on the concept of metacognitive monitoring. This is a new teaching method that uses a set of closely connected problems chains to guide students in solving problems and feel the charm of mathematical knowledge. At the same time, Thirty second grade students from a primary school in Yulin, Guangxi, were selected as the research object. The lesson "designing the best route to visit the zoo" was taken as an example to inspire second grade students to think and answer through the teaching experiment. Through experiments, students' problem-solving and reflective abilities have been greatly improved. It shows that guiding students to think through real questions can improve students learning ability. In the process of mathematics learning, we must focus on real problems and guide students to think deeply.

Keywords: *metacognitive monitoring; problem chain; real problem; teaching model*

1. INTRODUCTION

Metacognitive monitoring helps to regulate learners' own learning behaviour and learning process(Isaacson & Fujita, 2006; Syukri et al., 2020). In order to combine students' interests with mathematics learning, metacognitive monitoring accepts the questions raised by mathematics teachers within the cognitive range of students (Djamahar et al., 2019; Williamson, 2015). It is necessary for teachers to reorganize and integrate teaching materials on the basis of mastering students' metacognitive monitoring ability(Djamahar et al., 2019; Isaacson & Fujita, 2006). From the perspective of real life to think about the hidden life, and students' interests related to mathematical problems. In addition, since students' metacognitive

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monitoring consciousness is weak or they cannot realize whether their learning behaviour has problems. Teachers need to put forward reasonable questions and develop students' ability to further discover and ask questions.

The concept of metacognition originally came from a paper published by American psychologist Flawell in the 1970s and metacognitive monitoring, as the core of metacognition, refers to the process in which the cognitive subject regards his own ongoing cognitive activities as conscious objects, and constantly monitors and regulates them(Djamahar et al., 2019; Pesout & Nietfeld, 2021; ter Beek et al., 2019). Learning is a typical cognitive activity. In this process, metacognitive monitoring plays a very important role in the development of higher-order thinking abilities of learners and obtaining satisfactory academic performance (Kusumaningsih et al., 2018; Sanjaya et al., 2019; Suzanne, 2015; Yao & Manouchehri, 2019). At the same time, deep learning emphasizes the authenticity and effectiveness of learning problems. The most important purpose of education is to let students learn to learn. The improvement of metacognitive monitoring learning strategies is one of the key factors to promote students' learning effects. In this context, exploring metacognitive monitoring to promote students to learn to think is not only of great value in theory, but also of great significance in improving students' mathematics learning ability(ter Beek et al., 2019).

Through the review of conventional teaching, we find that in terms of the way of knowledge acquisition, if teachers can set interesting questions to stimulate students' initiative and make students willing to take the initiative to participate in classroom learning, it will help improve students' cognitive ability and strengthen their learning motivation. Question-based teaching can develop students' exploratory thinking and divergent thinking in the process of discovering and putting forward problems, and develop students' critical thinking and analytical thinking in the process of analysing and solving problems. In this way, on the one hand, students can review the knowledge and methods they have learned, and at the same time, new knowledge is generated in the process of applying existing knowledge. More importantly, questions play a role in connecting knowledge contents thinking and methods. Mathematics classroom introduction should pay attention to the perspective from creating problem situation focusing on "join" the relation between knowledge form "key point" problem solving strategy of development process of "invasion" of the process of knowledge background, and "origin" of the process of induction and abstract knowledge deformation, computation and reasoning "divergent point" of the process, thus maximizing the occurrence of effective teaching.（Cheng Xinzhan. Five focal points of problem situation Introduction design in Mathematics Classroom [J]. Teaching and Management,2020(10):31-33.）

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Based on the role of metacognitive monitoring and teaching problems, how to build a teaching model around metacognitive monitoring to promote the development of students' cognitive ability? This is the problem to be solved in this paper. So this paper is to set up a teaching model composed of "from-what-with-how-change-have" around metacognitive monitoring. The value of research is reflected in those students can decompose learning objects at different levels through this learning mode, understand the source, nature, connection, application, change and internalization of knowledge and finally improve the development of students cognitive ability.

2. LITERATURE REVIEW

a. The relationship between problem chain and mathematics teaching

Problem and problem chain are the link between mathematical knowledge and the real world in the process of mathematics learning. How to improve the effectiveness of the problem, make students full of curiosity and desire for knowledge of mathematics, is a problem that every mathematics teacher must face and seriously consider(Aliyah et al., 2020; Fessakis et al., 2018). At the same time, problems are the basic means for teachers to spread students' imagination, promote the development of students' thinking and enhance students' initiative to participate in the meaning, and also the core of improving the efficiency of mathematics teaching(Çekmez, 2020; Pachemska et al., 2014). Mathematics classroom teaching is inseparable from questions. On the one hand, the teacher asks the students; on the other hand, the students are inspired to ask the teacher questions. Before students put forward a question, students often need teachers to activate students' thinking. Therefore, teachers need to grasp the effectiveness and accuracy of questioning, around solving real problems to promote students' mathematical learning ability. And can solve a series of related problems in a certain period of time to learn mathematical knowledge, mathematical skills. Figure 1 shows the relationship between students and teachers in modern teaching, including development, cooperation, tolerance and equality. Creating a conversational classroom based on these relationships is the foundation of effective teaching. That is to say, in the process of learning, students and teachers is both partners and the relationship of mutual tolerance is not only the equal communication and dialogue, can also in the process of learning to learn each other's advantages, so as to achieve the bidirectional progress and growth of the students and teachers, so the education full of vigour and vitality.

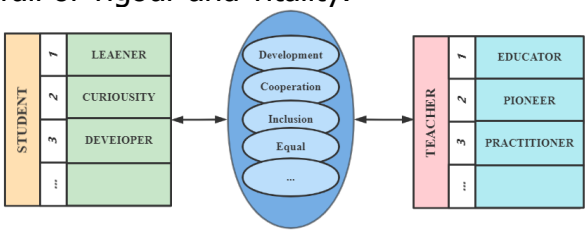

Figure 1. Student-teacher relationship(Claessens et al., 2016; Kim, 2018)

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b. Strategies for carrying out teaching activities around real problems

On the one hand, the application of mathematics in life is very extensive, in many aspects of life there are the shadow of mathematics. Such as the use of mathematical knowledge and methods to analyse economic problems in life or use mathematical logic to make correct inferences and choices about problems in life; Apply mathematical probability to sports. On the other hand, the sources of mathematical problems include life, society, discipline itself, science and other fields. By thinking and questioning some phenomena, they can be abstracted into problems that can be expressed by verbal information or character symbols. When a specific problem is found, it is necessary to carry out mathematical analysis and transformation of the problem, so as to transform the real problem into a mathematical problem expressed in mathematical language. Then through a series of mathematical knowledge and mathematical methods, mathematical modelling of the proposed problem, with a mathematical model for detailed analysis and explanation of the problem. Through mathematical language to get the results of the abstract summary of processing, so that the answer to the problem. Finally, apply and promote the mathematical answers, apply the mathematical results to the previously discovered problems, and check the results after application. If the mathematical results can solve real problems, it shows that the mathematical model has achieved good results (Figure 2).The real problem situation stimulates the students' true feelings and makes the students have the growth of "heart" in the real problem situation, and the creation of the real problem situation promotes the development of students' core ability. (Tao Wendi, Wu Chunlan. Application of Real Problem Situation in Elementary School Mathematics "Synthesis and Practice" -- Taking Parking Planner as an example [J]. New Curriculum Teaching (electronic version),2021(20):143-145.]

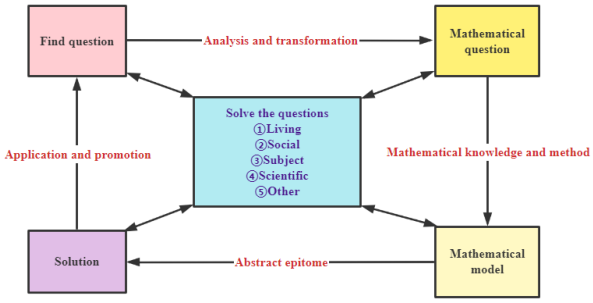

Figure 2. Strategies for solving problems with mathematical knowledge(Star et al., 2015)

c. Why do you need real mathematical problems

In the past mathematics teaching, teachers often design mathematical problems from the perspective of experiencers, but for most students, their life experience and learning content are limited and mathematical problem is more abstract, there are difficulties in understanding and expression for primary school students. On the one hand, the design of mathematical problems should focus on students' acceptable ability, give full consideration

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to students' recent development area, and help students to gain more mathematical knowledge through problem guidance or group cooperation. On the other hand, students' interests should also be taken into account in question design. For example, the problem is to compare the area of two 6-inch pizzas with that of a 12-inch pizza. For students, when teachers show pictures of pizza, they are often attracted by the composition or color of the pizza, and their attention will also focus on irrelevant issues such as whether ketchup is added or what kind of fruit or vegetable is added. In order to specifically teach students to find and think about problems, it is necessary to design reasonable and real questions, which can not only arouse students' interest in learning, but also allow students to obtain opportunities for expression and growth.In practical teaching, teachers should not only guide students to understand basic knowledge but also master basic skills, but also lead them to fully experience the process of knowledge occurrence, development and expansion and application. In the process, they should gradually enrich their knowledge, deepen their understanding and improve their thinking level. Improving and developing students' thinking ability not only helps them to apply the knowledge they have learned more flexibly to analyze and solve practical problems, but also helps them to acquire more powerful independent learning ability, thus providing real support for follow-up study. Improve mathematical thinking based on real problems. [1] Bai Xue Feng. Primary Mathematics Education,2021(Z2):30-31.]

With the rapid development of the global society, today's learners will face a more competitive job market, which not only requires learners to be able to use knowledge as a tool, but also requires them to be able to handle the vague and complex problems in the real world with knowledge. Ability. Real problems are becoming more and more important for mathematics teaching. The real problems include: 1) In order to meet the needs of the real world, the products created by students will really be used by people. For example: Design and build a roof garden for the school. After leading the students to the scenic spots, they are required to write a travel guide, and the excellent works will be distributed to the tourists as a travel guide. 2) Projects focusing on real life themes (preferably directly related to student life) For example: Children living by the sea can see the current status of marine pollution most directly, and students study how to protect marine life and improve the living environment around the community. Natural environment. 3). A project that simulates a real scene (even if it is a fictitious). For example: If you work in the schedule of the Winter Olympics Organizing Committee, how can you arrange the game time so that more people all over the world can watch the live broadcast?

If teachers can set up appropriate questions when learning or applying

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knowledge, these questions cannot only consolidate the knowledge they have learned, but also cultivate students' ability to find and ask questions in life, and make students realize that metacognitive monitoring is on themselves These problems are real and effective for students, and they are actually helpful to improve their learning ability.

d. Innovation

Integrating elements such as metacognitive monitoring and problem chain, this paper designs a teaching model with metacognitive monitoring as the core and problem chain driven. This is a new teaching model that has been scientifically revised under the guidance of experts. This model guides students in solving problems through different levels of problems, and allows students to feel the charm of mathematics in solving practical problems in discussion and thinking. The researchers took "designing the best route to visit the zoo" as an example to inspire second-year students to think and answer. During the experiment, the students showed active participation and the discussion atmosphere was very active. Through experiments, students' problem-solving and reflective abilities have been greatly improved.

3. RESEARCH METHODOLOGY

The teaching model of this paper is proposed by consulting material experts and professors on the basis of combing metacognitive monitoring to regulate learners' learning behaviour. Its ultimate purpose is to guide students to understand the essence of knowledge around the problem chain and solve real problems with mathematical knowledge. The design of problem chain requires researchers to take metacognitive monitoring as the core, and to consider six core learning elements from the perspective of learners, including the source of knowledge, the nature of knowledge, the connection between knowledge, the application of knowledge, the change of knowledge and the promotion of knowledge internalization. Therefore, the researcher designed the teaching model in Figure 1. In the question chain composed of "from-what-with-how-change-have", the next question needs to be based on the completion of the previous question, so as to realize the deep processing and internalization of learners' knowledge, and each question is interrelated and forms an organic whole.

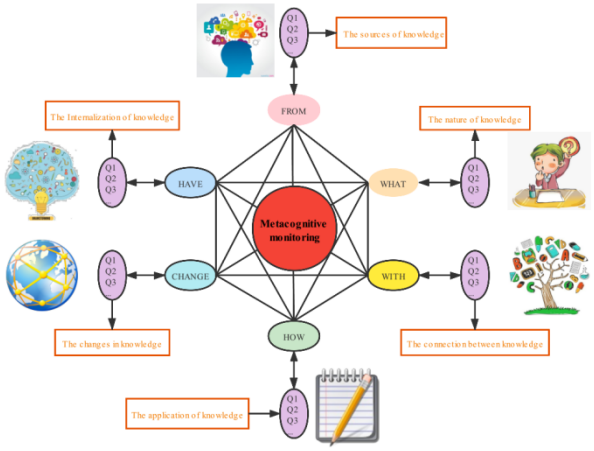

Figure 3. Teaching model led by metacognitive monitoring

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In this model, metacognitive monitoring is the core, and the problem chain composed of "FROM-WHAT-WITH-HOW-CHANGE-HAVE" is oriented, and students' learning activities are promoted through reasonable guidance by teachers. Using this model can help teachers in mathematics classrooms start from the students' cognitive characteristics and learning rules, subject characteristics and the nature of knowledge, and focus on embodying the level and continuity of mathematics teaching.

As a common teaching method in high school mathematics teaching, "problem chain" can guide students to form mathematical thinking, understand the learning content and establish the connection between different knowledge contents through reasonable setting of questions.（Liu Ming. Analysis of three Key Points in the Design of High School Mathematics "Problem Chain" [J]. College Entrance Examination,2021(29):121-122.）

The experimental object is a demonstration primary school in Yulin, Guangxi. Because there is little difference in the level of students in this school, 30 second-grade students are randomly selected to form an experimental class. Through the situation analysis, it can be found that they have learned the knowledge of addition, acquired the basic ability of painting and expression, and visited the zoo before learning this course. Combined with their life experience, this experiment is more realistic. The teaching process of metacognitive monitoring using figure 3 dominant teaching model for experimental object in teaching, in order to evaluate the efficacy of the teaching mode and teaching, this paper first presents a table 1 as the reference, and then distributed to each experienced expert evaluation to evaluate, and to the evaluation results using SPSS statistical software to analyze the results, Finally, experts put forward suggestions to improve the teaching model according to the teaching effect and evaluation results.

Table 1. The Evaluation indicators

Evaluation	Validation Level	Interpretation
1.6-2.7	Invalid	Total revision
2.8-3.6	Less valid	Less feasible
3.7-4.3	Valid Enough	Fair Enough
4.4-4.8	Valid	Perfect

4. RESULT

In order to let students understand why they learn mathematics knowledge, the role or help of mathematics knowledge in real life, the researcher chose the "design the best route to visit the zoo" project, which aims to test students ability to solve complex problems in real problem situations,

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including: The ability to deal with problems, the ability to collect and organize information, the ability to cooperate and communicate with peers and to reflect on them, and the ability to creatively solve problems. The problem chain of this design is shown in Figure 4.

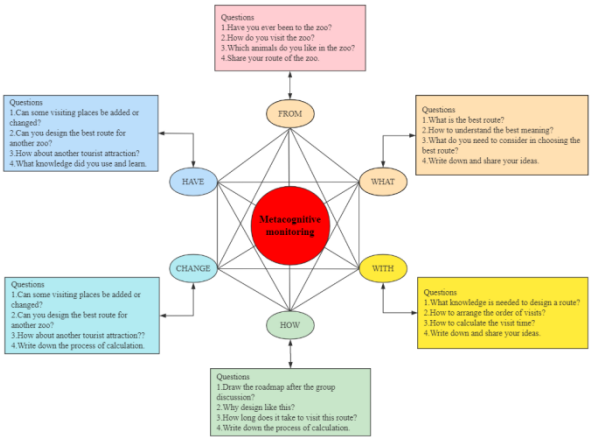

Figure 4. Questions used to guide teaching

The teaching model takes metacognitive monitoring as the core and takes the problem chain formed by "from-what-with-how-change-have" as the guidance to promote students' learning activities through teachers' reasonable guidance. The six elements of the teaching model are described below.

From

FROM refers to the source of knowledge. Why do mathematical problems arise? How were mathematical problems discovered? This is a question that will arise in the learning process of many students. In the long history of mankind, with the emergence of various problems, from simple to complex, from single to multiple, from known quantities to unknown quantities, the discovery and application of mathematical knowledge runs through the entire process. In order to allow students to develop new solutions based on new situations or tasks within a limited time, it is the starting point for activating new knowledge. The experience of visiting the zoo triggers thinking about the "best route", and this question is based on the perspective of all students. It is necessary to consider many aspects of knowledge to give a reasonable explanation, so as to design the most satisfactory route. Best route.

What

WHAT refers to what is the nature of the knowledge to be learned, what are its basic elements, what is the relationship between elements and elements, and between elements and the whole? In psychology, in order to facilitate memory, some things to be remembered are classified or processed into a small whole, which is called a block. The problem is broken down into elements one by one in a split way, and new knowledge is understood from a single element, which is conducive to discovering the composition and relationship of knowledge. When the learner recognizes the composition of knowledge, it not only helps to deepen the knowledge of knowledge, but also simplifies the memory capacity, which can improve the efficiency of learning. In this link, the concept of the best route is split to guide students to think about the best meaning and the conditions or necessary information needed to meet

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the best route. In this process, students are required to use paper and note down the ideas in their brains in time to facilitate follow-up inspections and timely communication with other students.

With

WITH refers to the comparison and exploration of new knowledge and knowledge that has been learned or experienced, providing a fixed point for new concepts in the learner's cognitive structure, and building a bridge to connect new and old knowledge. Piaget believes that learning enables new materials and materials that have been learned, new knowledge and previously learned knowledge to be represented in the answers to real problems in the form of schema, assimilation, adaptation and balance. Generally speaking, there is always a special connection between various kinds of knowledge. For example, the calculation rules of mathematics can be directly applied to the calculations of disciplines such as physics and chemistry. Only by understanding the information needed to design the route and considering the method of calculating the route time can you better explain the rationality of your own design to others, which is recognized by most students. In this way, by recognizing the connections between knowledge, it can not only strengthen the learner's understanding of various knowledge, but also promote the development of thinking.

How

HOW refers to the application of knowledge, which is a key step to test the teaching effect. It checks students' learning effect through problem-solving and classroom feedback. How to use the knowledge to solve practical problems? Are there constraints to the problem solving process? Do you need additional knowledge? How do you test the answer to the question? These questions are very important for the application of knowledge and are also the key steps in transforming external knowledge into students' own knowledge. If there are many questions in this step, and the method to solve the problem is not clear, it indicates that the students have a low grasp of knowledge, or they cannot understand the real meaning of the problem. Therefore, the guidance of teachers is particularly important. At this time, teachers need to understand students' cognitive ability and help them learn to adjust their learning methods. In this process, students are taught to consciously develop their metacognitive monitoring ability and improve the learning effect.

Change

CHANGE is to change a certain part of the material or the problem, and solve the problem from a different angle or different method. And try to integrate mathematical ideas and methods on the basis of preliminary application, and continue to strengthen the understanding of concepts, methods, and the essence of knowledge. Adding changes to the

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problem can cultivate students' innovative spirit. Innovation refers to the problem of obtaining new results through the combination of knowledge and knowledge, knowledge and problems, and problems and problems. The new problem can be different from others, or it can be an improvement on the basis of one's own ability. It stands out from the crowd. The key to innovative learning is to cultivate students' problem awareness. Only when students have questions, can they think and innovate. Using the changed questions in the classroom can guide students to think about problems from multiple sides, multiple angles, and multiple channels, allowing students to explore and argue more, which can effectively train students to think creatively, greatly stimulate students' interest, and cultivate Students' ability to innovate.

Have

"HAVE" means acquisition and reflection of learning. It summarizes and reviews classroom teaching links, knowledge understanding, remaining problems and other aspects, draws new schemata for the existing knowledge system, and improves the logic and systematicness of thinking. A complete teaching process should include the link of reflection. Reflection is a process in which students think independently and reproduce and extract the knowledge and methods they have learned. It can train students' mathematical thinking and improve their mathematical application ability. In this process, we should not only teach students to reflect on the knowledge, methods and new materials used in exercises, but also the connections between questions. But also teach students to reflect on their own problem solving ideas is correct, encounter difficulties to analyse the problem in the end where, there is no better method to solve the problem. Only by this constant reflection can we transform the new knowledge into our own and skilfully use it.

After completing the above preliminary design, invite experts to evaluate and suggest modifications (Table 1). Both material experts and educational experts have rich teaching experience in the field of mathematics teaching. Their suggestions make the design of teaching model more scientific and reasonable, and also provide meaningful direction for the implementation of practical teaching links.

In the course of teaching, the teacher first plays the propaganda video of the zoo to attract students attention; Present in time to the zoo, then draw out "have enough time, the optimal design of the specific problems, on the basis of need teachers to guide students to think about factors such as the number of venues, visiting time in the form of group work and organize the students to find useful information in the map, raises student's reading ability and the ability to access to information, again through the student representative to report, We sorted out the useful information in the map together to familiarize all the students with "what's in the map" and selected

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the popular venues by voting, which enhanced the sense of participation of students. At the same time, information technology is integrated into the classroom and put on the big screen, which not only saves time, but also makes the statistical process and results visible. This process is helpful to cultivate students the consciousness of the data analysis, students in the process of voting, truly feel every after clear tasks and methods, teachers give students enough time to discuss, division of labour, planning, inspection, adjustment and other learning activities, students experience a complete process of planning route, harvest the learning experience of planning route.

After the teaching, experts will evaluate the teaching effect, and the evaluation results are shown in Table 2:

Table 2. Results of expert evaluation

Validator	Aspect measured	Evaluation	Interpretation
Material experts	The rationality of the problem	4.5	Good
	The interconnectedness of problems	4.6	Good
	The connection between problem and thinking	4.4	Good
	Whether metacognitive monitoring is mobilized	4.3	Fair Enough
	material	4.6	Good
Education expert	Languege	4.5	Good
	Enforceability	4.4	Good
	Effectiveness of interaction	4.5	Good
	Student expression and choice	4.3	Fair Enough
	Continuous learning and exploratory	4.7	Good

It can be seen that experts have a high evaluation on the teaching effect, and the results are all good or very good, which highlights that the effectiveness of the teaching model has been recognized.

5. DISCUSSION

Based on the concept of metacognitiv e monitoring, this paper designs a teachi ng model composed of six elements. Bas ed on metacognitive as the core and pro blem chain as the main line, it improves s tudents' ability to think and learn.It is believed that this helps to develop students thinking and association ability by asking students a few closely related questions. After conducting the experiments, the researchers found that the role of metacognitive monitoring in the six questions has become very important. At what stage, the source of the problem needs to be explained. This is not only one of the foundations of learning, but also a way to discover from real life. When students understand where the problems comes from, they can find more interesting things through their own thinking. The problem, to create more space for future study and life. Regarding what it is, it is more to

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analyse the problem from different aspects. What elements do it consist of? Is there an equivalent statement? What knowledge is needed to solve it? When students learn this, they will have different views on the problem, and then try to put forward their own ideas. For He, I tend to build a knowledge graph between different knowledge and establish an effective connection between existing knowledge and unknown knowledge. Through this approach, students can experience the impact of existing knowledge (or methods) on current learning Help reduce the cognitive load of the learning process. Regarding how, it is the process of applying knowledge to problem-solving. At this stage, not only the students' knowledge reserves are tested, but also their thinking and practical abilities. Students' learning effects can be evaluated objectively by other learners. If most people agree with a certain conclusion, it means that the problem has been solved satisfactorily, which is also an encouragement and recognition for students. Regarding the change, what is tested is the knowledge transfer and creativity of students, and the reasonable dissemination of the learned knowledge to other scenes, using similar knowledge to solve the same or different types of knowledge is a common method in scientific exploration. For mathematics learning, it is also very important to change the problem. In this process, it helps to cultivate students' higher-order thinking, such as critical thinking. Finally, if the students cannot summarize the knowledge and doubts they have learned, the effect of learning will be weakened. Therefore, it is considered necessary to review and reflect on the learning process. What have I learned? Are there any questions that have not been resolved? Teachers can guide students to present the knowledge they have learned in the form of mind maps or tables. Through the "FROM-WHAT-WITH-HOW-CHANGE-HAVE" learning mode, students can build their own knowledge system in the next step under the guidance of the teacher, and gain the ability to further study. In other words, this learning model promotes students' learning and has proved to be of practical value.Compared with previous studies, the following similarities and differences can be obtained： Math classes are often organized around problem solving, with a focus on problem chains. We believe that the problem chain has three links: presupposition, exploration and summary. Presupposition, customized also, to build a platform for students to create; Exploration, dynamic generation, adapt to the situation, adapt to local conditions, it has situational dependence and dynamic change; To sum up, the last of the chain of problems - li road, to achieve the guidance of students' mathematical thinking method. Presupposition is the condition, exploration is the key, summary is fundamental.(Teng Yihe, Yang Min, Hong Yanni. Fujian Education,2021(4 1):30-33. (in Chinese)).With the help of mind mapping, the relationship between number, quantity and form is constructed.

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Each mathematical figure will have basic features and a set of formulas and theorems from which students will derive equal relationships between the data of the various elements of the figure. Students make connections between these basic elements of thinking, identify applicable mathematical theorems or formulas, and construct equal relationships between each other and arrive at correct solutions. And vice versa, as long as students find the graphics basic.(Zhang Li. Cultivating Primary School Students' Mathematical Thinking with mind Mapping [J]. Chinese Education Journal,2021(12):101.)

The teaching model in this paper focuses more on the consistency and systematicness of mathematical thinking and process. It emphasizes the teaching links which are closely connected based on the real problem chain and take metacognitive monitoring as the core, problem chain as the main line. At the same time, it is also combined with mind mapping for teaching to promote the development of students' thinking.

6. CONCLUSSION

This study were designed about a teaching model composed of "FROM-WHAT-WITH-HOW-CHANGE-HAVE" with metacognitive monitoring as the core. Starting from the real problem situation, students fully communicated and discussed, and their thinking was collided. Improved the ability of mathematics subjects and cultivated the ability of communication and expression. In the results, experts evaluate the teaching effect (Table 2) and get good feedback, which reflects that the model has achieved good experimental results. The various components of this model are closely linked and interlocked. On the one hand, the instructional design from these six questions reflects the continuity and systemicity of teaching, which is helpful for the smooth development of classroom teaching, while on the other hand, these six questions follow the growth route and cognition of knowledge the psychological development route is conducive to moving from shallow learning to deep learning, promotes the development of students thinking and enables students to obtain real and effective knowledge.

Due to the limitations of experiments, objects and experiment time, the teaching model designed in this article can also set up different questions, such as from other life scenes related to students or raise a comprehensive question, so as to carry out further research.

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