



Reflections on Implementing Reasoning Ability in Junior High School Mathematics Classroom Teaching

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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

Reasoning ability is a hot topic in the field of education at home and abroad. Based on the meaning and training requirements of reasoning ability in the Mathematics Curriculum Standards for Compulsory Education (2022 Edition), this paper studies the current teaching status of classroom reasoning ability in junior high schools, and draws the following conclusions: 1. Teachers carry out teaching activities closely around the requirements of curriculum standards and textbook content; 2. Some teachers, especially veteran teachers have the thinking inertia of teaching; 3. Most students can only focus on what they are currently learning; 4. Students are inert in learning. Therefore, this paper gives the following four teaching suggestions: 1. Teachers engage in group lesson planning; 2. Teachers include a section in the exercise class where students explain the exercises; 3. The teacher expands the content of the textbook appropriately when teaching, and shows students the theorem-proving process; 4. Teachers conduct unit thematic teaching activities. The above four suggestions will help teachers to cultivate students' reasoning ability.

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1. INTRODUCTION

As one of the nine core qualities of junior high school stipulated in the *Mathematics Curriculum Standards for Compulsory Education (2022 Edition)*, reasoning ability plays an important role in junior high school teaching. *Mathematics Curriculum Standards for Compulsory Education (2022 Edition)* clearly states that teachers should further cultivate students' reasoning ability, and highlight the cultivation of reasoning ability in teaching suggestions for algebra and geometry [1]. The current mathematics curriculum standards all over the world regard reasoning ability as one of the important indicators to cultivate students' mathematical ability [2]. Therefore, the cultivation of reasoning ability is particularly important in junior high school classrooms. So, how should we implement reasoning ability in junior high school mathematics classroom teaching? To effectively improve the quality of teachers' classroom teaching, based on the meaning of reasoning ability, this paper analyzes the current situation of reasoning ability in junior high school classrooms and provides some teaching suggestions for teachers on this basis. These teaching suggestions will help teachers to implement reasoning ability in junior high school classrooms.

2. ANALYSIS OF REASONING ABILITY

2.1 Definition of Reasoning Ability

According to Mathematics Curriculum Standards for Compulsory Education (2022 Edition), reasoning ability refers to the ability to introduce other propositions or conclusions based on rules from some facts [1]. It can be seen that reasoning ability is the ability to get an unknown conclusion from some known conclusion.

Reasoning ability can be divided into two broad categories: sympathetic reasoning and deductive reasoning. Sympathetic reasoning, which includes inductive and analogical reasoning, is the ability to derive general conclusions from particular results. Deductive reasoning is the ability to use known conclusions to derive particular results.

2.2 The Training Requirements of Reasoning Ability

First, understand the importance of logical reasoning in forming mathematical concepts,

rules, and solving problems, and initially grasp the basic forms and rules of reasoning. This sentence means that students should understand the formation of mathematical concepts and rules must be rigorously reasoned and demonstrated. Students should understand the relevant knowledge of reasoning, such as the type and meaning of reasoning, and be able to use the corresponding reasoning knowledge to solve problems.

Second, for some simple problems, general conclusions can be inferred from special results. That is, students should have certain plausible reasoning abilities, and be able to use inductive and analogical reasoning methods, from special to general, summarize propositions, or summarize rules from various special conclusions. By doing this, students can understand the importance of induction and analogy in discovering rules and proposing conjectures.

Third, understand the structure and connection of the proposition, explore and express the argumentation process. That is, students should understand that knowledge does not exist independently, understand that knowledge is connected, and students should link what they have learned to form a knowledge network and be able to flexibly use multiple knowledge to solve comprehensive problems. In addition, in the process of problem-solving, students are expected to engage in logical reasoning or proof, as evidenced by the fact that they are expected to have standardized problem-solving steps and a complete reasoning process when solving a problem.

Fourth, understanding the rigor of mathematics. Students should understand that mathematics is a rigorous science.

3. CURRENT STATUS OF TEACHING AND LEARNING

3.1 Teachers Carry Out Teaching Activities Closely Around the Requirements of Curriculum Standards and Textbook Content

At present, the teaching design and teaching methods of junior high school teachers are closely related to the requirements of the new curriculum standard, and the teaching is carried

out with the textbook as the core. This method has both advantages and disadvantages. Following the curriculum standard and taking the textbook as the core conforms to the students' cognitive law, making the teaching process clear and logical, and allowing students to master a lot of knowledge efficiently. However, some teachers rely too much on textbooks. Teachers follow the traditional teaching methods, explain and teach mathematics knowledge in a regular way, and ignore the actual learning effect of students in mathematics learning [3].

3.2 Some Teachers, Especially Veteran Teachers, Have the Inertia of Teaching Thinking

It was found that teacher burnout today is generally at a moderate level and that the degree of burnout is positively correlated with the number of years teachers have been teaching [4]. It means that, in the current mathematics teaching, some teachers, especially those who have taken at least one round of students and veteran teachers are more or less slack and fall into a kind of empirical thinking circle. They tend to think that I have taken many students and there are many successful cases, so my teaching methods are no problem, the successful methods in the previous students can be brought to the next students. This part of the teachers do not pay attention to the update of knowledge and the differences between students but also ignore the innovation of teaching methods, can not step out of their comfort circle, can not keep pace with the times to adjust their teaching strategies, live off their past gains. Their teaching methods and knowledge are obsolete, and not suitable for the new era of students, resulting in poor teaching results [5].

3.3 Most Students Can Only Focus on What They are Currently Learning

Students in the junior high school stage always have such problems. Students who do well academically in the first and second years of school tend to fluctuate, more or less, in their grades in the third year. After investigation, it was found that compared with the first and second years of school, the third-year students' understanding of mathematical concepts is ambiguous and not deep enough to connect old knowledge and make connections with new knowledge in math learning [6]. The reason for this situation is that math learning in the third year is more comprehensive, the use no longer a

single point of knowledge, students in the face of knowledge integration of the topic (such as the moving point problem, the general drinking horse problem, etc.) often feel at a loss, and any part of the lack of knowledge or weakness will lead to failure in solving the problem.

3.4 Students are Inert in Learning

Students have inertia in the learning process and always discount the teacher's demands that are not practiced 100%. In the process of students' proving problems, there will be problems that are step-saving or unclear, and when the teacher asks the problem-solving ideas in detail, it is very common for the students can not answer the questions or the answer is very vague. In a survey on students' learning methods, it is pointed out that: the majority of students like the teaching method of "the teacher talks, I listen", and only 1.33% of students can insist on pre-study before class and review after class; more than half of the students spend only half an hour to study math in class; one-third of the students don't take notes, and few of them can use the notes or prepare a problem book after class, even if some students take notes or prepare a problem book [7]. It can be reflected from here that many students are learning with the mentality of "almost" or "know it but don't know why". They have a general understanding of a lot of knowledge but are not rigorous. In the usual practice, there may be no significant problems, but students rely on their intuition to solve the problem, resulting in the neglect of the stringency of mathematics.

4. TEACHING RECOMMENDATIONS

4.1 Teachers Engage in Group Lesson Planning

The proposal calls for schools to organize collective lesson planning activities, led by the head of the teaching and research group, with teachers in the group talking to each other about their lessons and honing their skills to find a teaching method that best meets the current development of the students. After finding an appropriate teaching method, the teachers in the group should unify and implement the teaching method.

One of the requirements for the development of reasoning skills is for students to acquire initial knowledge of the basic forms and rules of reasoning. This requirement requires students to

master the basics of logical reasoning and deductive reasoning and to be able to apply logical reasoning to solve real-life problems. Classroom teaching is the quickest and most effective way to enable students to master the basic forms and rules of reasoning and to be able to apply this knowledge flexibly to solve problems [8]. The current situation in education is that some teachers, especially veteran teachers, have the inertia of teaching thinking, and the teaching methods are backward, so they can not achieve good teaching results [5]. Therefore, the head of the teaching and research group should take the lead in organizing collective lesson preparation activities, and the teachers in the group should discuss and get the teaching methods that are most in line with the current development of students, to help students master the basic forms and rules of reasoning. Collective lesson planning puts more emphasis on seeking the true meaning of teaching based on cooperative inquiry among teachers, emphasizes the symbiotic sharing of excellent teaching resources and teaching experience, and stresses the cohesion of group wisdom to generate and create new teaching [9].

4.2 Teachers Include a Section in the Exercise Class Where Students Explain the Exercises

The proposal calls for teachers to give some of the time in exercise classes to students, with students narrating the detailed reasoning process and steps of the corresponding exercises under the teacher's moderation and guidance, and to set up students' mutual support, with gifted students explaining the topics to the less advanced ones.

One of the requirements for the cultivation of reasoning ability is that students explore and express the argumentation process. This requirement requires students to be able to clearly express their reasoning and argumentation process. Students' questions in the exercise class can help students deepen their understanding of the basic forms and rules of reasoning, and can also improve students' ability to express their reasoning and argumentation process. The current teaching situation is that students are inert in learning. They have a vague understanding of the relevant knowledge of reasoning and expression. Although they can solve problems, they cannot clearly express their reasoning and demonstration process, and teachers cannot

judge their true level [6]. At the same time, many former and freshmen students suggested that the time given by the teacher for thinking was too little, and the students could not understand in class, so they were naturally unwilling to learn after class. Most of the students prefer to have more time in class to interpret the example problems independently, think independently, and arrive at the answers after discussion among classmates, peers, and teachers [7]. Therefore, teachers should add the link of students' lectures to the exercise class, on the one hand, it is convenient for teachers to test the true level of students so that teachers can carry out targeted teaching; on the other hand, it can "force" students to deeply understand the relevant knowledge and ideas of reasoning, and share them with others in the classroom, to strengthen students' ability to explore and express the process of argumentation.

4.3 The Teacher Expands the Content of the Textbook Appropriately When Teaching, and Showing Students the Theorem Proving Process

The proposal calls for teachers to teach mathematical theorems and laws, based on the knowledge points of the textbook, guide students to summarize the corresponding theorems and laws, and then supplement the students with the process of proving the corresponding knowledge points.

The cultivation of reasoning ability requires students to understand the importance of logical reasoning in forming mathematical concepts, rules, and solving problems, and to understand the rigor of mathematics. The former requires students to understand the importance of induction, analogy, and deductive reasoning in the formation of mathematical concepts, rules, etc., and to understand the conclusions obtained by induction and analogy need to be demonstrated by deductive reasoning [10]; the latter requires students to realize that mathematics is a rigorous science. Mastering the basic forms and rules of logical reasoning is crucial to the development of students' core literacy in logical reasoning, and showing teachers the process of proving theorems and laws to students is a good way to make students understand the importance of deductive reasoning as well as to perceive the rigor of mathematics [11]. The current situation in education is that teachers rely too much on textbook content for teaching, ignoring the

cultivation of students' deductive reasoning. To give a simple example, the square difference formula. The requirement for this formula at the middle school level is that students can master it and use it to solve problems. Some teachers require students to memorize the formula mechanically, which is not effective. Instead, teachers show students the derivation of the formula, which can deepen students' understanding of the knowledge and promote the flexible use of the formula. Therefore, teachers should appropriately expand the content of textbooks in the teaching process, show students the proof process of theorems and rules, and help students understand that analogy, induction, and deductive reasoning together constitute logical reasoning, and logical reasoning plays a huge role in the formation of mathematical concepts and rules. At the same time, it can also make students realize the rigor of mathematics.

4.4 Teachers Conduct Unit Thematic Teaching Activities

The proposal calls for teachers to reorganize the related knowledge points that students have already learned into a unit topic in the course of teaching and to dedicate a special lesson to the unit topic to help students link up the knowledge points they have learned.

One of the requirements for the cultivation of reasoning ability is that students understand the structure and connection of propositions. This requirement requires students to understand that knowledge does not exist independently, that knowledge is related, and that students should connect the knowledge they have learned to form a knowledge network. Teachers can make students understand the structure of propositions and find the connection between knowledge points by carrying out unit thematic teaching activities. The current situation of education is that students can only focus on learning the current knowledge and cannot integrate knowledge. Therefore, teachers should carry out unit teaching, for example, the parallelism of line segments, triangles, parallelograms, and other content can be integrated to carry out the "proof of plane geometry" unit of thematic teaching. This can reintegrate the teaching content so that it is in line with the cognitive development of students so that students can establish a systematic, complete, and logical knowledge structure system [12].

5. CONCLUSION

Reasoning ability is one of the nine core qualities that junior high school students should possess according to the *Mathematics Curriculum Standards for Compulsory Education(2022 Edition)*. However, after investigation, the current status of implementing reasoning skills in the classroom is not satisfactory. As teachers, they can adopt strategies such as collective lesson preparation, adding students' lecture links in exercise classes, appropriately expanding the content of textbooks during teaching, showing students the proof process of theorem rules, and carrying out unit thematic teaching activities, to better implement and cultivate students' reasoning ability in classroom teaching, so that students can develop a scientific attitude and rational spirit of seeking truth from facts.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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