

Attach Importance to Mathematical Symbolic Language and Improve Students' Symbolic Consciousness by Using Teaching Methods

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Abstract: Mathematics is a highly abstract subject. As a mathematical ability, the ability to use the language of mathematical symbols is the fundamental skill in learning mathematics, and it plays a significant part in student's subsequent algebra studies. From practical teaching experiences and prior studies, the thesis concludes current problems with the language of mathematical symbols in class teaching, which include: (1). Teachers cannot express with the language of mathematical symbols; (2). Teachers cannot standardize the language of mathematical symbols, (3). Teachers cannot utilize the language of mathematical symbols to develop students' symbol senses. Accordingly, the author recommends three methods to improve teachers' capacity of using the language of mathematical symbols so that students' symbol senses can be enhanced.

1. Introduction

“Mathematics teaching is the teaching of mathematical language”, professor Stolyar proposed. Mathematics teachers should emphasize the value of mathematical language and the necessity of educating students the ability to express mathematical language, according to the objectives of primary mathematics curricula in China. In mathematics education, all types of mathematical language are of extreme importance, among which symbolic language is abstract^[1], so it is very vital for teachers to master the meaning and application of the language of mathematical symbols in practical teaching.

2. Core concept definition

2.1 mathematical notation

Mathematical symbol is the special text of mathematics, which is used in mathematics to express mathematical concepts, mathematical relations and so on^[2]. Mathematical symbols do not come naturally, they are formed through long-term research and accumulation. Based on the characteristics of mathematics discipline, in order to reflect the simplicity and refinement of

mathematics, the complicated theorems and inferences can be concisely expressed by using mathematical symbols. For example, in basic mathematical operations, "+" is defined for addition, "-" for subtraction, "×" for multiplication, "÷" for division, etc. Broadly, mathematical symbol refers to can stimulate the senses, produce mathematical objective existence in the mind, is the mathematics literature, mathematics communication and mathematics teaching to express, transfer, enlightenment, mathematical information of all carrier or stimuli, it not only includes text symbols, medium mathematical symbols, chart symbols created abstract symbols, also include objects, models, physical pictures used to convey mathematical meaning of natural physical symbols^[3]. For example, the Venn diagram used to represent the set relationship, the mathematical sticks used to recognize numbers, and the tangram used for recognizing geometric figures can be called generalized mathematical symbols.^[4]

2.2 Mathematical symbol language

Mathematical symbol language is an important part of mathematical language. Having a certain ability of mathematical symbol language understanding is a necessary basic ability for people's lifelong learning and continued development. Therefore, in mathematical learning, the understanding of mathematical symbol language is particularly important.^[5]Mathematical symbol language takes mathematical symbols as the basic element, using mathematical symbols to describe mathematical phenomena and describe quantitative relations. In the teaching process, teachers can use appropriate symbolic language to facilitate students to understand and understand the mathematical knowledge and content. Mathematical symbolic language has a fixed form of expression. Different from natural language, it pays attention to simplicity, science and rigor. When representing the relationship between numbers, the existence form of mathematical symbol language is the fusion of a variety of mathematical symbols, including numbers, letters, operational symbols and relationship symbols.

3. Characteristics of the mathematical symbolic language

In terms of mathematical symbol language in primary school, it has the following characteristics:

3.1 Convenience of writing

Mathematical symbolic language is usually expressed in the simple form of an abbreviation, numbers, Latin or Greek. Compared with the Chinese expression, the mathematical symbolic language is much more concise. Once the meaning of each symbol, the theorem or nature expressed in symbolic language will be more acceptable. Especially in the middle and senior grades, teachers and students use symbolic language more frequently, which also shows that students have recognized the convenience brought by concise symbols.

3.2 The refinement of the expression

Using mathematical symbols can not only improve the speed of the operation, but also can clearly present each step, so as to further deepen the students' understanding of the arithmetic theory. For example, in daily life, words like "numbers within 20" often appear, but it does not explicitly indicate whether the "20" itself is included. If expressed in the mathematical symbolic language, it can be clearly expressed as " <20 ", which is very clearly expressed that the numbers in this range do not contain "20", which is more refined and accurate than natural language.

3.3 Intuitive expression

There are also some special marks in the mathematical symbols. These marks are not involved in logical reasoning, not in the expression of quantitative relationships, and their meaning is easy to understand. But these marks are abstracted from the geometric intuition, and they are intuitive. Such mathematical symbolic language links graphics and mathematical knowledge in life. In the framework of primary school mathematical graphics and geometry knowledge, the symbol " \perp " is generally used to indicate the vertical relationship between the two, and the symbol " \triangle " is used to represent the triangle and so on. These geometric shapes like names are used to vividly represent the abstract meaning of mathematical symbols.

3.4 Normalization of content and form

For example, the length unit "meter" is represented by the letter symbol "m", and the volume unit "rise" is represented by the symbol "L". The symbols used in these content are conventional and cannot be changed. Although sometimes sharing the same symbol can occur, it can be clearly distinguished in a specific situation. For example, in Equation 72-11, it means a minus sign, and the lowest temperature in Harbin in winter is " -15°C ", which means "minus".

To sum up, mathematical symbol language has the advantages of convenient writing, simplified expression, intuitive graphics, fixed content and form, and specification. These advantages make mathematical symbolic language play an irreplaceable role in mathematics learning.

4. The problems with the language of mathematical symbols in class teaching

It requires high professional competence for teachers to use the language of mathematical symbols in class teaching, but studies find that many problems still exist in practical teaching:

4.1 Teachers cannot express with the language of mathematical symbols

Due to the poor theoretical knowledge of symbolic language, some teachers cannot express with symbolic language and replace mathematical languages with ordinary language, resulting in language deficit in class. Although mathematical language bear on ordinary language, the latter cannot be a substitute for the former, and they must be distinguished strictly. However, in teaching experiences, the author has noticed that when reviewing Four Arithmetic Operations, some teachers would say "the minuend - the subtrahend = the difference" instead of expressing with corresponding symbols.

4.2 Teachers cannot standardize the language of mathematical symbols

On account of the standardization of mathematical symbols, educators, as the role models of students, are supposed to standardize the usage of the language of mathematical symbols with particular attention, because even just a small difference may lead to unexpected mistakes. In contrast, teachers often commit the problem in practical teaching. For example, when teaching the chapter, *Classification of Angles*, some teachers specify the mathematical symbols such as the acute angle, the obtuse angle and the right angle as follows: while we are distinguishing between the acute angle and the obtuse angle, we usually state the angle greater than 90 degrees as an obtuse angle and the angle less than 90 degrees as an acute Angle. This is a problem that most teachers often encounter when teaching the classification of angles. Some teachers directly refer to acute angles as "small angles" and obtuse angles as "big angles" for the sake of better understanding by

students. Sometimes, when guiding students, teachers will say: "Your right angle drawing is not straight at all", and the use of mathematical symbol language is not standardized and accurate.

4.3 Teachers cannot utilize the language of mathematical symbols to develop students' symbol senses

The illustration of "symbol sense" in *Compulsory Education Mathematics Curriculum Standards (2011 edition)* cannot operate by teachers, which means it needs further refining. As an abstract and implicit psychological tendency, "symbol sense" sees a shortage of external behavior indicators which are relatively objective. In consequence, in symbolic teaching at present, teachers lack concrete and workable measures while teaching methods are not systematic. To be specific, teachers ignore the functions of symbolic language, the meaning of symbols and the education of constructing students' experience, as a result, they usually require students to memorize mathematical concepts and theorems by recitation and master the types and methods of mathematical problems through a large number of practices.^[6]

5. The methods to improve primary mathematical teachers' ability of the language of mathematical symbols

As the key to class teaching, only if teachers develop the awareness of optimizing the use of the language of mathematical symbols, can they enhance their professional qualities of teaching language through continuous training and self-improvement. With initiative accumulation and cultivation of the mathematical symbol sense, teachers need apply it actively to class teaching and discuss frequently with extraordinary teachers. At the same time, they should cultivate students' mathematical core literacy with the language of mathematical symbols according to the characteristics of teaching contents.

5.1 Accumulate, cultivate and apply symbol sense actively

Inadequate accumulation results in the inability to apply symbolic language. Teachers should fully realize the role of the language of mathematical symbols. Only when they understand its importance and influence, will they actively accumulate, cultivate and enhance the use of symbol sense, hence students' learning effect can be promoted. To achieve this, teachers need understand the language of mathematical symbols in textbooks and its characteristics by researching textbooks. Moreover, teachers should observe and learn how excellent teachers apply the language of mathematical symbols. For instance, teachers can refer to teaching language in teaching plans of veteran teachers of mathematics, carefully study their expressions, and internalize the experience after analyzing personal situation.

5.2 Prepare, practice and summarize after class carefully

In the preparation of classes, teachers should compile detailed teaching plans based on students' situations, teaching materials, teaching contents and teaching objectives, etc., in which every words must be written down and modified again and again. Young mathematics teachers with inadequate teaching experience especially have to note down every sentence and repeatedly review and examine the language of mathematical symbols. Based on the teaching plans, teachers are supposed to train their teaching language through various methods in addition to class teaching.

Teachers must constantly accumulate, analyze and summarize their shortcomings in class teaching^[2]. For example, after class, teachers can inspect whether his language of mathematical

symbols is standard and whether the students can understand his expression. Besides, teachers can invite other educators who are proficient at the language of mathematical symbols to attend their classes and make a request for recording their problems with their symbolic language in class to correct them next time.

5.3 Foster model thought with symbol sense

It is beneficial for students to use symbolic language to explain the quantitative relationship of mathematical problems in real contexts, when they try to understand the implication of mathematical problems and find the methods and corresponding mathematical models to solve problems.

When teaching “*Calculation of the Area of a Triangle*”, teachers lead in the new lesson with a context first, and then invite students to think up related mathematical questions, among which one is: “Could you explain how to figure out the area of the triangles?” The teacher takes advantage of the question: “Can you try to convert triangles into figures you have learned to deduce the formula for calculating the area of the triangle?” After exploration, cooperation and communication by students themselves, some convert triangles into squares, rectangles or parallelograms, and derive the calculation formula: the area of the triangles = the base \times the height $\div 2$, represented by symbols as $S=ah\div 2$. In this way, teachers can guide students to use symbolic language to represent the triangles’ area formula, which helps students to understand arithmetic clearly, internalize mathematical knowledge, and strengthen symbol sense. At last, students are required to use the formula to solve some simple practical questions, and take basic, variant and challenging exercises, etc. Consequently, with the help of “symbols”, abstract thoughts turn into intuitive images. Therefore, students can have a deep understanding of the mathematical models and the mathematical idea of “mathematics bears on symbolic language”, which improves their ability to solve problems.

Teachers should not conduct a class for teaching mathematical symbols especially. The language of mathematics symbols is a form of mathematical thinking and also a carrier of mathematical knowledge, mathematical models, and mathematical thinking methods for students. It is worthy to ponder and explore how to take full advantage of its intermediary role as a carrier.^[7]

Overall, the language of mathematical symbols, as a part of the primary teaching language, plays an essential role in the development of students’ awareness of mathematical symbols. Teachers should take the initiative to accumulate, cultivate and apply symbol sense, and prepare lessons carefully, practice more in practical teaching and learn from predecessors and finally grasp the connotation of the language of mathematical symbols so that the problems, that many primary mathematics teachers cannot use and standardize and the language of mathematical symbols and take advantage of it to enhance students’ symbolic sense can be resolved.

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