Research on Training Strategies of Quantity Sense of Primary School Students under the Background of New Curriculum Criteria

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Abstract. Mathematics is a subject based on numbers and quantities. The quantity sense will affect students’ understanding of mathematics. The new curriculum criteria in 2022 have increased the discussion and requirements on the sense of quantity. The author analyses the significance of the sense of quantity, and investigates the situation of primary school students’ sense of quantity through questionnaires and interviews. The results show that the students’ overall mastery of the quantity sense is poor, especially in the estimation of volume unit. In view of the above problems, the article puts forward the strategies of cultivating the sense of quantity of primary school students under the background of the new curriculum standards, mainly including integrating quantity sense elements, enriching quantity sense accumulation and developing quantity sense reasoning to provide reference for relevant researchers.

1 INTRODUCTION

Compared with the 2011 edition, the Compulsory Education Mathematics Curriculum Criteria (2022 Edition) add a new core concept “quantity sense” [1]. It makes the following description: quantity sense mainly refers to the intuitive perception of measurable attributes and size relationships of things. Know the meaning of measurement and understand the necessity of unifying measurement units. It will select appropriate units of measurement for the real situation and convert different units under the same measurement method; Preliminarily perceive the errors caused by the measurement unit tools and methods, and reasonably obtain or estimate the measurement results. Establishing a sense of quantity helps to develop the habit of understanding and solving problems with quantitative methods, and is the empirical basis for forming abstract ability and ability application consciousness. “Number” and “quantity” are like two sides of a coin, which are difficult to peel off. Mathematics learning requires not only the understanding and grasp of "number" to form a proper sense of number, but also a clear and accurate understanding of "quantity". Number sense is one of the ten core concepts proposed by the curriculum standard. This has been recognized by the majority of mathematics educators, and has been deeply studied by the majority of mathematics teachers in the practice of mathematics education. It may be strange to the sense of quantity. In the four fields of primary school mathematics: number and algebra, graphics and geometry, statistics and probability, synthesis and practice, there is no content in the field of "measurement" or "measurement". Therefore, "sense of quantity" is added to the 2022 new curriculum standard as the expression of core literacy [2].

Different requirements are made for students of different grades in Compulsory Education Mathematics Curriculum Criteria (2022 Edition). For students in grades 1-2, Compulsory Education Mathematics Curriculum Criteria (2022 Edition) require that a preliminary spatial concept and sense of quantity be formed in the process of graphic recognition and measurement. Understand the importance of unified units, properly select the length units of meters and centimetres to describe the length of common objects in life, and convert the units. Can estimate the length of some common objects around, and can measure the length of objects in life with tools. For students in grades 3-4, Compulsory Education Mathematics Curriculum Criteria (2022 Edition) require that the concept of space and the sense of quantity should be enhanced in the process of graphic recognition and measurement. In the process of solving the actual problems of the perimeter and area of the graphics, gradually accumulate the experience of operation, and form a sense of quantity and a preliminary geometric intuition. In the process of solving the actual problems of the perimeter and area of the graphics, gradually accumulate the experience of operation, and form a sense of quantity and a preliminary geometric intuition. The area teaching of graphics should enable students to intuitively perceive the concept of area in familiar situations, experience the process of selecting area units for measurement, understand the meaning of area and form a sense of quantity [3]. For students in grades 5-6, Compulsory Education Mathematics Curriculum Criteria (2022 Edition) require that students...
form a sense of quantity, spatial concept and geometric intuition. Learn about negative numbers in theme activities and project learning, apply mathematics and other discipline knowledge and methods to solve problems, accumulate experience in mathematical activities, and form a sense of number, quantity, model, application and innovation [4].

This paper will focus on the current situation of the development of the sense of quantity of primary school students and the training strategies under the background of the new curriculum standards.

2 CONNOTATION OF QUANTITY SENSE

“Sense of numbers” contains very rich content. Guo min put forward six elements of the sense of number the meaning of number, the expression of number, the relationship of number, the operation of number, the estimation of number and the solution of the problem of number. Among these elements, “quantity estimation” and “quantity problem solving” are both “quantity” estimation and problem solving [5]. Since number is abstracted from quantity, and the definition of “number sense” includes quantity and quantity relationship, many researchers do not distinguish between them. However, if the “sense of quantity” is classified as a part of the “sense of quantity”, it is easy for teachers and students to ignore the importance of the “sense of quantity” [6]. With the deepening of numerical abstraction and the improvement of calculation proficiency, students' understanding of quantity will be gradually away, and it is easy to ignore the quantitative meaning of the operation itself. However, the lack of this "sense of quantity" is not conducive to their future study and life. If the "sense of quantity" is taken as the main line in the development of students, it will make teachers' pay more attention to the practical significance of "number" in teaching, and also make students feel that mathematics is closely related to life, so as to cultivate the vision of looking at the world with mathematics. Through the comparison with the connotation of “sense of quantity” and the analysis of the content of measurement at home and abroad, the author believes that quantity sense refers to students’ perception of quantity comparison, calculation and estimation [7].

The direct perception of the size relationship of things is reflected in the following aspects. The appropriate unit of measurement will be selected for measurement. The premise of making a choice is to have a clear representation and perception of the size of the measurement unit [8]. Be able to use the unit representation, measurement experience and spatial imagination in the mind to reasonably judge or estimate the measurement results. This is not at the level of knowledge and skills, but at the level of thinking. This is the judgment made by the students based on the understanding of the area unit representation and the perception of the object. In daily life, we often need to estimate the area of the object. At this time, we need to make judgments with the help of measurement experience. The measurement result can be converted based on the change of the measurement unit. The cultivation of the sense of quantity is based on the observation, comparison, operation and accumulation of specific and typical measurement units. The final result is described and characterized by numbers, which makes the experience organized. This is an important way to develop students' mathematical thinking [9].

3 INVESTIGATION ON PRESENT SITUATION OF QUANTITY SENSE OF PRIMARY SCHOOL STUDENTS

3.1 Investigation Design

The research adopts the idea of “determining research questions - designing test papers - questionnaires for students based on the connotation and external design of concepts - analysing the data obtained from the test and field survey - Reflection and suggestions” [10].

This study mainly through the questionnaire survey to understand the current situation of students' sense of quantity, and at the same time, combined with the results of the questionnaire, interview students and teachers. There are many questionnaires about the sense of number in China, but there are few researches about the sense of quantity. The first definition of the sense of quantity in this study refers to an understanding of the relationship between names and numbers [11]. A nominal number is a number with units. A quantity expressed in numbers and units of measure. A number with only one unit of measurement is called a simple number. The number represented by more than one unit of measurement is called complex number. At the same time, on the basis of analysing and studying the number sense test papers for primary school students at home and abroad, this paper deeply analyses the requirements of our curriculum standards for quantity, and designs the test papers in combination with the test questions about quantity sense mentioned in the academic degree test [12].

<table>
<thead>
<tr>
<th>Number</th>
<th>Thing</th>
<th>Unit</th>
<th>Concrete unit</th>
<th>Correct answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Kitchen</td>
<td>Area</td>
<td>L, m³, kg, m²</td>
<td>m²</td>
</tr>
<tr>
<td>2</td>
<td>Washing machine</td>
<td>Volume</td>
<td>L, m³, kg, m²</td>
<td>m³</td>
</tr>
<tr>
<td>3</td>
<td>Heater</td>
<td>Capacity</td>
<td>L, m³, kg, m²</td>
<td>L</td>
</tr>
<tr>
<td>4</td>
<td>Apple</td>
<td>Weight</td>
<td>L, m³, kg, m²</td>
<td>kg</td>
</tr>
<tr>
<td>5</td>
<td>Coin</td>
<td>Thickness</td>
<td>g, mm, cm, cm²</td>
<td>mm</td>
</tr>
</tbody>
</table>

Table 1. Quantity sense questionnaire design. (self-made)
The constituent subject of the community with a shared future for mankind is mankind, which is a human community. In terms of the objects and subjects covered, it includes all mankind, and adopts the principle of no externality, that is, a world with only internality but no externality. In this regard, there is no larger community than it, making it an individual of a larger community, so it has only one internal relationship, that is, there is no external community outside it, and there is no relationship between self-community and other communities. In terms of space, in terms of the scope of current science and technology, it refers to the geographical area covered by the whole earth, specifically, the increasingly closely connected global village between countries. Marx believed that in a world that eliminated division of labour, private ownership and class, a new type of non-antagonistic social relationship would be formed between people, and the role and function of the community were more ethical than political. The community with a shared future for mankind reflects the Chinese people's sincere wish to build a common community for mankind.

The questionnaire is divided into three dimensions: the first part is the distinction between different units; the second part is to infer that the quantity expressed in a unit is consistent with the size of an actual object; the third part is to infer the size of a certain quantity without using measurement tools. The second part is divided into two categories, one is the selection of quantities expressed in the same unit, and the other is the selection of quantities expressed in different units. Some of the topics are designed to be converted into units. Reading China's curriculum standards, we can find that the main requirements of China's primary school curriculum standards are length (mm, cm, decimeter, meter, kilometer), area (square centimeter, square decimeter, square meter, square kilometer, hectare), volume (cubic centimeter, cubic decimeter, cubic meter), volume (mL, L), and mass (g, kg, ton). After adjustment, we determined that the quantity surveyed in the questionnaire is the quantity in the curriculum standard, including length, weight, area, volume and volume. The questionnaires are all multi-choice questions, with fifteen questions in total. The students are required to choose the most appropriate option. In particular, interviews were conducted for individual cases. Before the prediction of the test paper, the opinions of many experienced math teachers who have been teaching in primary schools for many years were consulted, and the questionnaire questions were adjusted and modified, with a certain degree of reliability. The design of the interview topics for teachers is as follows: which topics do you think are unreasonable and need to be improved? Do you think the choice of life background in each topic is appropriate and what needs to be adjusted? Do you think the option design of each topic is reasonable, and what needs to be adjusted?

### 3.2 Investigation Implementation

In this study, the author will take a questionnaire survey to conduct an in-depth study on the students' grasp of the sense of quantity. The whole questionnaire has gone through three stages: the first stage: the preparation of the initial questionnaire. Starting from March 2022, according to the research purpose and content of this paper, the relevant data at home and abroad were collected to design and prepare the initial questionnaire. Stage II: pre-investigation stage. In late April 2022, 50 questionnaires were distributed to class 3, grade 6, which the author was familiar with, and 48 valid questionnaires were collected. The questionnaires were modified according to the feedback results. In June 2022, the author conducted a formal investigation. The subjects of the survey are students in class 1 and class 2, grade 6 of the primary school. The students in class 2 have medium grades. There were 48 students in class 1, including 28 boys and 20 girls. There are 52 people in class 2. Among them, there were 26 boys and 26 girls. A total of 100 questionnaires were distributed and 100 valid questionnaires were recovered. The students did not whisper to each other. They answered the questionnaire carefully and carefully. The time was 15 minutes. After the test, interviews were conducted with individual students immediately after the test according to their answers. Although the questionnaire has the characteristics of anonymity and high efficiency, the questionnaire also has the disadvantages of cumbersome filling and avoiding essential questions, which affects the accuracy of information. It needs to be combined with interviews to understand the deep-seated information. We designed both student interviews and teacher interviews. The interviews with students are mainly focused on the degree of mastering the sense of quantity, and the interviews with teachers are mainly focused on the ways and methods of teaching the sense of quantity.
3.3 Investigation Result

A total of 100 questionnaires were distributed and 100 valid questionnaires, including 48 valid questionnaires for class 1, grade 6 and 52 valid questionnaires for class 2, grade 6. The questionnaire data is processed and counted by SPSS 17.0, and the results of overall analysis and corresponding statistical analysis are obtained by combining interviews. The reliability of the questionnaire is used. The coefficient is 0.825 and the reliability is good. It can be seen from the data that the overall scores of the two classes on the sense of quantity are general, with an average of about 20 points. This also reflects that the children's perception of the quantity is not ideal. At the same time, the standard deviation of the two classes is large, which indicates that the students' fluctuations are large and unstable, and there are differences in their perception of each quantity.

<table>
<thead>
<tr>
<th>Item</th>
<th>Class 1</th>
<th>Class 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid sample</td>
<td>48</td>
<td>52</td>
</tr>
<tr>
<td>Invalid sample</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mean value</td>
<td>9.55</td>
<td>10.37</td>
</tr>
<tr>
<td>Mode</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>2.62</td>
<td>1.53</td>
</tr>
<tr>
<td>Variance</td>
<td>5.24</td>
<td>2.34</td>
</tr>
<tr>
<td>Minimum value</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Maximum value</td>
<td>15</td>
<td>15</td>
</tr>
</tbody>
</table>

4 TRAINING STRATEGIES OF QUANTITY SENSE OF PRIMARY SCHOOL STUDENTS UNDER THE BACKGROUND OF NEW CURRICULUM CRITERIA

4.1 Integrate Quantity Sense Elements

Primary school mathematics textbooks usually arrange learning chapters in the form of units. The knowledge contents of the same unit are interrelated and form a relatively independent whole. We integrate the key elements such as the concept, unit, progress rate, tools and strategies of measurement, and open up the knowledge connection to grasp the internal structure as a whole, systematically think and design teaching activities, and integrate the cultivation of the sense of measurement into the unit teaching. The learning contents of the unit "area" include area and area unit, advance rate of area unit, area calculation of rectangle and square, and solving simple practical problems. It covers the key elements of measurement concept, measurement unit and advance rate, measurement and calculation of quantity, and estimation of quantity. In teaching, it is necessary to integrate these elements with the understanding of the concept of area as the core, with the development of measurement consciousness as the main line, and directly compare the intuitively perceived area and area from low to high. Primary school mathematics teachers should analyse the connotation of the sense of quantity, associate the sense of quantity with the individualized, all-round and sustainable development of the students' core quality, and efficiently permeate in the class, seize the educational opportunities for students to perceive the size, speed and quantity of objective things, give the sense of quantity cultivation effectiveness and regularity, and provide support for students to continuously improve the sense of quantity. Primary school math teachers should reasonably design homework in the process of implementing the principle of life-based teaching and creating micro classes. Based on “homework management”, they should guide students to go deep into life and strengthen their mathematical sense of quantity. They should be able to weigh and evaluate fruits and vegetables and enhance their perception of weight. Guide the students to perceive the speed and length when running with their partners, and perceive the size of space when visiting parks, museums and buses, so as to broaden the scope of cultivating students' mathematical sense of quantity [13].

4.2 Enrich Quantity Sense Accumulation

Experience is not only an important way to develop the sense of quantity, but also an important basis for accumulating appearances and establishing concepts [14]. In teaching, through multi-dimensional personal experience activities such as seeing, touching, measuring, drawing, comparing and speaking, the whole senses of eyes, hands, mouth and brain are linked, so that students can participate in the physical experience and gain rich perception of quantity. The combination of explicit movement and implicit thinking can gradually accumulate and precipitate in a hierarchical and orderly manner to form a clear image of quantity. The following experience activities can be designed during the teaching of the area. Make use of the familiar things around the students, let them observe with their eyes, touch with their hands, speak with their mouths and preliminarily understand the meaning of the area. Second, based on the students' existing life experience, fully observe and compare the “surface” of objects and irregular shapes to highlight the
essence and fully understand the concept of area. Based on the observation, operation and comparison of the dynamic changes of the graph, realize the motion invariance of the area and develop the concept of area conservation. Based on the close connection and easy confusion between the two concepts of length and area, students are asked to draw a circle of a graph and paint a picture to show the area of the graph. Through different operation activities, they can compare and distinguish to achieve a deeper understanding of the area. Through multi-level experience activities and multi-sensory collaborative participation, students gain a profound understanding of the area and reach an understanding of the meaning of the area. The life materials around the students have a clear appearance in the students' minds. With these familiar materials, the abstract quantity can be transformed into a visible and touchable experience, which can effectively help the students strengthen their sense of quantity. Cultivating the sense of quantity is inseparable from the support of concrete and intuitive form.

4.3 Develop Quantity Sense Reasoning

Problem solving teaching in our country attaches importance to guiding students to find quantitative relationship, which is a good opportunity to develop quantitative reasoning ability [15]. Many students just put together the numbers in the questions without paying attention to the quantitative meaning of the arithmetic formula, which will lead to the error of adding and subtracting different numbers. In the teaching materials of Singapore, the units of quantity (such as length, volume, currency unit, etc.) are involved in calculation, so students can know more clearly which quantities are being calculated. In the mathematics teaching of our country, the unit is not required to participate in the calculation process of the formula, but the unit is added to the final result, and the students tend to ignore the quantitative significance behind the number. This requires teachers to pay attention to the expression of quantitative relations in teaching, help students better develop their quantitative reasoning ability, and then promote the cultivation of quantity sense. Measurement is a very important skill, and its purpose is to obtain the most accurate value. The "sense of quantity" is more reflected in the more accurate perception of quantity without the help of tools. This requires teachers to organize students to estimate the number of people around them in various forms in teaching, including selecting appropriate estimation strategies to continuously improve the accuracy of estimation. For example, students can first try to estimate the distance from school to home, the area of the school playground, the weight of a bag of rice, and the number of green beans per kilogram, and then compare and verify with the measured data. In particular, these activities can help students understand the larger units of measurement and quantity and let students feel the quantity in person, not only the unit conversion at the paper and pen leve.

5 CONCLUSIONS

It is pointed out that the sense of quantity mainly refers to the intuitive perception of the measurable attribute and the size relationship of things in Compulsory Education Mathematics Curriculum Criteria (2022 Edition). Establishing a sense of quantity is helpful to develop the habit of understanding and solving problems with quantitative methods, and is the empirical basis for forming abstract ability and application consciousness. Teachers should give full play to the role of guidance and pay attention to the establishment process of students' sense of quantity. As each student has different basic knowledge and perception ability, teachers should teach students according to their aptitude. For students with poor foundation, they should pay more attention to their phased progress and improvement, so that each student can establish an appropriate sense of quantity.

References

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