Research on Teaching Design of the Topic "Number and Algebra" in Primary School Mathematics Based on Error Transformation Education

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Abstract: The "Error Transformation Education" philosophy of renowned primary school teacher Hua Yinglong is based on students' life experiences. It transforms students' mistakes into teaching resources, guiding them to explore learning and cultivate mathematical thinking. Combining this philosophy, the teaching design of the lesson "Population Census" is created, using students' mistakes as the starting point for inquiry-based learning. The goal is to help students deeply understand the broad application of mathematics in life and enhance their understanding and application of mathematical knowledge.

Keywords: Error Transformation Education; Primary School Mathematics; Teaching Design

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1.Introduction

The "Mathematics Curriculum Standards for Compulsory Education (2022 Edition)" (referred to as the 2022 Mathematics Curriculum Standard) in China states: students should be able to express the real world using mathematical language, understand the meaning and value of data, and use the results of data analysis to explain and predict uncertain phenomena, forming reasonable judgments and decisions[1]. Therefore, the mathematics curriculum should not only teach students how to read and write numbers but also focus on the practical application of mathematical language. Mathematics is not confined to the classroom but exists in daily life. In the classroom, we should enhance students' ability to link knowledge with real-life situations and foster mathematical thinking. Hua Yinglong's "Error Transformation Education" philosophy also takes students' life experiences as its foundation. It guides students to naturally enter inquiry learning through life and teaching events, paying attention to and studying mistakes. This not only corrects errors but also integrates mathematical cultural classics seamlessly into the teaching activities, leading students to explore the social significance of mathematical themes in real life[2]. It can be said that the "Error Transformation Education" philosophy aligns with the requirements of the 2022 Mathematics Curriculum Standard and can implement its objectives. In primary school mathematics teaching, under suitable classroom environments, encouraging students to actively discover mistakes can maximize their engagement and initiative, giving them the space to independently explore mistakes. Analyzing the causes of mistakes in discussions can enhance memory and help students clearly understand the mistakes and their reasons, allowing them to correctly express their understanding using mathematical language.

Based on this, this research is grounded in Hua Yinglong's "Error Transformation Education" theory and uses the lesson "Population Census" in the fourth-grade textbook as a case study to design teaching strategies. The goal is to explore how to apply the principles of "Error Transformation Education" in designing a teaching model for the field of numbers and algebra in primary school mathematics.

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2.The Significance of Applying Error Transformation Education in Teaching "Population Census"

2.1 Protecting Students' Self-Esteem and Stimulating Learning Enthusiasm

"Error Transformation Education" is based on students' existing experiences. It guides them to expose their thinking process, discover misconceptions in their learning, and encourages them to actively explore and analyze the reasons behind their mistakes. This helps identify unfamiliar knowledge points, which can be further strengthened to improve understanding and promote knowledge transfer and application. The 2022 Mathematics Curriculum Standard suggests that students should attempt to discover and propose mathematical problems from daily life, explore, analyze, and solve these problems, and experience the accomplishment of overcoming difficulties and solving problems under the encouragement and guidance of others[1]. Therefore, as teachers, we should implement teaching activities that promote students' development, stimulate active thinking, and encourage students to discover and pose problems, analyzing and solving problems using various methods.In the lesson "Population Census," mistakes are not immediately criticized. Instead, the teacher analyzes the answers from both strengths and weaknesses, first recognizing and praising students' strengths and encouraging them to discover their mistakes on their own. Next, the teacher analyzes the causes of the mistakes to protect the students' self-esteem, further enhancing their motivation to correct their errors. This process involves group collaboration and inquiry, guiding students to identify their errors, improve their self-efficacy, and enhance their enthusiasm and initiative for learning.

2.2 Strengthening the Connection Between Learning and Life, Improving Teaching Quality and Efficiency

Error Transformation Education emphasizes the relationship between mathematics and real life. By introducing mathematical problems rooted in everyday life, it connects mathematical knowledge with real-world situations, which helps to stimulate students' interest and attract their attention. It makes it easier to identify students' knowledge gaps and uses mistakes as teaching resources to guide students to correctly express and communicate using mathematical language. This enhances students' ability to connect mathematics with real-life applications and improves their practical skills. Teachers should actively explore the underlying causes of students' mistakes, creating a harmonious bond with students, which will allow teaching to enter a positive cycle[3].

3.Teaching Design Analysis for "Population Census" Using Mistake Education

The 2022 Mathematics Curriculum Standard for the second stage includes the requirement to recognize numbers greater than ten thousand and understand the decimal system[1]. In the study of numbers and algebra, sensitivity to numbers is crucial for learning mathematics. As teachers, we need to guide students to abstract numbers from real-life situations, allowing them to read and write numbers in specific contexts. This unit builds on students' understanding of numbers up to ten thousand, extending their knowledge to recognize numbers in the billions and their real-life significance. Students are also expected to read, write, and compare large numbers. Error Transformation Education connects to everyday life by transforming errors that occur in daily life into learning and growth opportunities, enabling students to recognize mistakes, identify their causes, and ultimately correct them, thereby updating their cognitive structures and avoiding similar errors in the future. Combining Error Transformation Education with "Population Census" allows students to better understand China's current situation and the practical meaning of numbers. It also promotes the development of number sense by revisiting smaller numbers and further exploring larger ones.

3.1 Connecting Teaching to Real Life and Cultivating Number Sense

The lesson "Population Census" takes place after the students have learned to count and recognize larger numbers. Most students are familiar with the number sequence and can understand the relationships between adjacent units, For example, 100,000 is 10 times 10,000, 1,000,000 is 10 times 100,000, and 100,000,000 is also 10 times 10,000,000. The digit "5" in the 100,000s place represents 5 units of 100,000, which is 500,000. Similarly, the

digit "5" in the 1,000,000s place represents 5 units of 1,000,000, which is 5,000,000. The teacher introduces the topic using the results of China's seventh population census, which generates student interest. Most students may guess the number to be in the billions but lack understanding of the specific digits. The teacher then displays the census result of 1,411,778,724, relating the number to China's actual population and inviting students to attempt reading the number. Some students count the digits before reading them aloud, resulting in the following sequence: fourteen billion one hundred million one hundred seventy-seven thousand eight hundred seventy-four. Some students make mistakes, reading it too slowly or incorrectly, such as failing to first divide the number into units and levels. These mistakes are used as a starting point for further exploration.

3.2 Transforming Mistakes into Teaching Resources and Designing the Teaching Process

First, transform the misreading error into a teaching resource by inviting other students to evaluate the misreading student's performance. Analyze their strengths and weaknesses, concluding that their place value was correct—the error was ten million one hundred seventy-seven thousand. Praise and acknowledge this student for their effort to protect their self-esteem. Second, further inquire about how to read the number and why the incorrect approach is invalid. Provide students with space and time for independent exploration todiscovering that the "1" in the ten-millions place represents 1 ten-million(10,000,000); the "1" in the millions place represents 1 million (1,000,000); the "7" in the hundred-thousands place represents 7 hundred-thousands (700,000); and the "7" in the ten-thousands place represents 7 ten-thousands(70,000). Combined, this totals 11.77 million. Numbers in the ten-thousand place can be read like those in the ones place, followed by adding "ten thousand." Through their own reasoning, students deepen their understanding and gain a more profound grasp of what the digits represent. Next, students were asked to read the sixth national census result presented in the textbook: 1370536875. Applying their recent learning, they quickly broke it down: the "7" represents 7 ten-million(70000000); the "5" represents 5 hundred-thousands(500,000); and the "3" represents 3 ten-thousands(30,000). Combined, this equals 705.3 million, where the zero must be read aloud and cannot be omitted. Immediately after, the teacher presents the population figures for Beijing, Anhui, and Hong Kong. Students can independently summarize the following rules: For numbers within ten thousand: First group the digits. The four digits form one group. Read the digit in the ones place for the ten-thousand level, then add "ten thousand." The digit in the ones place is read normally. For numbers above ten thousand, again start by grouping them. The digit in the hundred millions is read as it is, followed by "hundred million." Additionally, zeros at the end of each group are not read, and regardless of how many zeros appear in other places, only one zero is read.

After mastering reading, students should attempt writing Guangdong's population: 104,303,132. Random questioning reveals errors like 14303132 or 10433132. While praising clear digit placement, have classmates analyze mistakes—typically stemming from prematurely writing the units digit or incorrect zero placement. Allow ample time for discussion to address these errors. Ultimately, guide students to write the correct format and draw conclusions: First, before writing, group the digits by place value and circle the hundreds of millions and millions to remind yourself. Second, write the hundreds of millions place first, then the millions place, and finally the ones place. Lastly, if a digit position has no counting units, write a zero in that position.

3.3 Reinforcing Through Practice and Strengthening Memory

Utilizing Error Transformation Education accelerates students' knowledge acquisition, fosters intrinsic motivation for independent inquiry, and enables them to identify and analyze errors through discussion. Rather than directly imparting learning methods, this approach provides students with time and space for free exploration and debate. It's far superior to simply revealing answers. Allowing students to learn from mistakes, transforming errors into correctness, and cultivating the character to transcend and confront errors—it is precisely the existence of error transformation that enables students to further engage in independent thinking and proactive learning, thereby fostering innovative thinking and a truth-seeking character[4].

Following error transformation, further consolidation exercises are essential. Apply the conclusions reached through inquiry to practice problems, where they are tested and reinforced, ultimately enhancing problem-solving abilities. Specifically, multi-tiered exercises can be designed, progressing from foundational to advanced levels. Basic exercises focus on reading and writing numbers, presenting large figures for students to practice segmented reading and writing. For example, in the post-lesson practice, the 2012 population statistic for Canada is approximately 33,490,000. Students first segment the number before reading it correctly. Subsequently, students are given the figure of approximately 28,690,000 for Saudi Arabia and asked to write the corresponding number. These foundational exercises reinforce students' mastery of place value reading and writing methods while deepening their understanding of place values and counting units.

Advanced exercises integrate real-life scenarios, creating problems related to census data and statistics. For example, present a population distribution table for different districts in a city, containing large numbers in the hundreds of millions, tens of millions, and millions. Have students answer questions based on the table, such as "Which district has the largest population and how many?" or "What is the total population of the two districts?" These exercises not only require students to accurately read and write large numbers but also involve basic data analysis. This enhances their ability to apply mathematical knowledge to solve real-world problems while further solidifying their understanding of large numbers.

Additionally, extension activities can be designed to encourage students to independently collect large-number data from daily life, such as local population figures or economic totals. Students then share and discuss these data points in class, practicing reading, writing, and analyzing their collected information. Such extension activities strengthen the connection between mathematics and real life while allowing students to continuously improve their perception and application of large numbers through practice. This approach truly achieves the goals of practice-based consolidation and memory reinforcement, deepening and extending Error Transformation Education within the exercise phase.

4.Conclusion

Mr. Hua Yinglong's "Error Transformation Education" has unique value for primary school mathematics learning. The lesson plan design of "Census" based on this educational approach integrates mathematical knowledge into real life and transforms errors into teaching resources. Students not only develop a positive attitude towards analyzing and correcting errors, growing and progressing through mistakes, but also deeply understand the widespread application of mathematics in daily life. This approach enhances students' comprehension and application of mathematical knowledge while improving their inquiry skills and mathematical thinking. In conclusion, Error Transformation Education provides new ideas and methods for teaching mathematics and algebra in primary schools, holding significant practical and application value.

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