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Implementation Status and Research of Primary School Mathematics Games in Lower Grade Mathematics Teaching

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Abstract: *With the continuous improvement of educational methods, the gamification teaching method in mathematics education in the lower grades of primary school has received increasing attention. This paper will use a questionnaire survey to analyze and study the current application status of primary school mathematics games in lower grade teaching. Through the research, it is found that due to the single form of mathematics game teaching, poor classroom organization, and failure to achieve teaching goals, there are certain difficulties in the actual application of mathematics game teaching. Gamified teaching should be innovative and improved according to specific teaching content and student needs, so as to better cope with the challenges in mathematics game teaching, and improve students' learning effectiveness and the quality of education and teaching.*

Keywords: *Game-based Teaching; Primary School Mathematics; Lower Grades*

1. Introduction

With the gradual advancement of the new curriculum reform in primary schools in China, the development of primary school mathematics teaching is facing new opportunities and challenges. This study actively explores how to apply mathematics games to the practice of primary school mathematics classroom teaching, enrich and expand the value of mathematics games in primary school mathematics teaching, further enhance students' interest in learning mathematics, and improve students' core mathematical literacy.

2. Core Concept Definition

2.1 Mathematical Games

The term "mathematical games" in the Encyclopedia Britannica refers to entertainment activities conducted through mathematical knowledge. Mathematical games embody mathematical logic and principles. Additionally, mathematical games are rule-based and must adhere to corresponding mathematical laws and concepts. Through participating in game activities, the value of mathematical games is fully reflected, making it ultimately an educational game activity.

2.2 Game-based Teaching

Game-based teaching originates from the idea of combining education with entertainment, representing a new type of teaching activity. Games and teaching are inseparable. Teachers combine interesting games with teaching content, enabling students to learn efficiently in a relaxed and enjoyable atmosphere. This teaching method not only meets the psychological development characteristics of students in lower grades but also stimulates students' interest in learning and improves their classroom focus, among other aspects.[1]

2.3 Lower Grades of Primary School

Based on the characteristics of children's psychological development and cognitive laws, the new curriculum standards divide the compulsory education stage of primary schools into three stages: lower grades, middle grades, and upper grades. The lower grades referred to in this study are the first and

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second grades of primary school. This stage is the specific operational stage of cognitive development according to Piaget's cognitive development stages. Students at this stage are lively and have a strong interest in exploration but unstable attention. Their thinking is dominated by concrete and imagery thinking. They enjoy playing games but have poor self-control. Students are in a critical period of forming habits of life and learning, but they are highly dependent.

3. Theoretical Basis

3.1 Theory of Multiple Intelligences

The theory of multiple intelligences was proposed by American developmental psychologist Gardner from Harvard University. He believes that human intelligence is the ability to solve problems that can only be demonstrated in specific contexts. Gardner pointed out that there are at least eight intelligences in humans, including linguistic intelligence, logical-mathematical intelligence, spatial intelligence, musical intelligence, bodily-kinesthetic intelligence, interpersonal intelligence, intrapersonal intelligence, and naturalist intelligence. These eight intelligences exist in different combinations in each person, making each person have unique characteristics. For students in lower grades, their intellectual development is unique, with both strengths and weaknesses. Game-based teaching takes into account the intellectual structure of different students and the development of different aspects of the same student's intelligence, promotes the development of students' mathematical logical thinking, stimulates students' interest in learning, and also cultivates students' abilities in interpersonal communication, cooperation, and communication.

3.2 Constructivism Learning Theory

The constructivism learning theory originates from the theory of children's cognitive development, which was first proposed by Piaget, a Swiss psychologist. Piaget emphasized that each person's cognitive development is different, and individuals have different understandings of the same thing. However, in the process of participating in internalizing knowledge and mastering skills, learners often need a cooperative community of learning to complete it. Therefore, in daily teaching, teachers and students as well as students need to cooperate and play their roles. Teachers should design game-based teaching activities based on students' existing experiences, guiding students to master knowledge through exploring games, thereby achieving meaningful construction.

4. Survey and Analysis of the Current Application Status of Mathematical Games in Lower Primary School Teaching

4.1 Overview of the Survey Situation

4.1.1 Survey Objects

This study mainly selected primary school students and mathematics teachers from two primary schools in the urban area of H city for investigation. These two schools adhere to a student-centered educational philosophy and focus on providing education and teaching in an environment that integrates education with entertainment. To ensure the comprehensiveness of the samples, the teaching experience of the teachers was distributed, and a total of 30 samples were collected. Additionally, first and second-grade students from these two primary schools were randomly selected, with the cooperation of teachers and parents, and a total of 100 samples were collected. In order to gain a deeper understanding of the current implementation of mathematical game teaching by primary school mathematics teachers, two open-ended questions were included in the teacher questionnaire. Both the teacher and student questionnaires were conducted online.

4.1.2 Survey Content

With the purpose and objects of the survey determined, the questionnaire was divided into two parts: student questionnaire and teacher questionnaire. The design of the teacher questionnaire mainly involved the following five aspects: 1) the current attitude of teachers towards mathematical game teaching; 2) the current status of mathematical game teaching design in primary schools; 3) the current status of mathematical game teaching implementation in primary schools; 4) the current effectiveness of mathematical game teaching implementation in primary schools; 5) the challenges faced by teachers

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in mathematical game teaching and any good suggestions for overcoming difficulties. A total of 21 questions were designed, including 19 multiple-choice questions and 2 open-ended questions. The student questionnaire design included four aspects: 1) the current attitude of students towards mathematical game teaching; 2) the design of mathematical game teaching in primary schools; 3) the implementation of mathematical game teaching in primary schools; 4) the effectiveness of the implementation of mathematical game teaching in primary schools. Considering that the survey targets students in lower grades, with different cognitive development levels, existing cultural levels, and comprehension abilities, the number and wording of the questions were designed to be as clear and understandable as possible. Therefore, a total of 12 multiple-choice questions were designed.[2]

4.2 Current Application Status of Mathematical Games in Lower Primary School Teaching

Both teacher and student questionnaires were based on attitudes towards mathematical game teaching, the current design and implementation status of mathematical game teaching, and the effectiveness of mathematical game teaching implementation. Therefore, the current application status of mathematical games in lower primary school teaching is also elaborated from the following four aspects.

4.2.1 Attitude Towards Mathematical Game Teaching

According to statistics, over 93.33% of teachers believe that game teaching is needed in mathematics classes, indicating a large proportion, while 6.66% of teachers remain neutral or are more influenced by traditional teaching models and believe that game teaching is not needed. However, most teachers acknowledge the method of mathematical game teaching. Regarding the question "Do you want the teacher to play mathematical games often in class?" 74.00% of students explicitly expressed their desire for teachers to play mathematical games often, while 26.00% of students chose not to play. This indicates the degree to which students like mathematical games. For them, presenting boring and complex mathematical knowledge in the form of mathematical games is very interesting and highly attractive.[3]

4.2.2 Implementation Effectiveness of Mathematical Games in Primary School

Students are highly interested in learning: The study found that for the majority of students, using game-based teaching can significantly increase their interest and enthusiasm for learning mathematics, thereby promoting the effective implementation of mathematics teaching. In primary school mathematics education, the purpose of proposing game-based teaching is to meet the high interest of students and to make them more actively and positively participate in mathematics learning. This teaching method not only promotes the increase of students' interest but more importantly, it also stimulates their curiosity and desire for knowledge in mathematics, thus enabling them to more deeply understand and apply the mathematics knowledge they have learned. Therefore, in actual teaching, game-based teaching can be an effective teaching method to improve student learning effectiveness and interest.

Difficulties in achieving teaching objectives: In the teacher questionnaire, 16.67% of teachers stated that they had successfully achieved the preset teaching objectives after using game-based teaching; 60.00% of teachers stated that they had basically achieved the teaching objectives after using game-based teaching; and 23.33% of teachers stated that they had not achieved the teaching objectives. The data shows that teachers still have some problems in understanding and applying game-based teaching, with fewer than one-fifth of teachers able to fully achieve the preset teaching objectives. This indicates that how to achieve the goal of combining education with entertainment and improve teaching efficiency through game-based teaching is still a problem that needs to be studied and explored.

5. Problems with the Application of Mathematical Games in Lower Primary School Teaching

With the deepening promotion of the "Compulsory Education Mathematics Curriculum Standards (2022 Edition)", researchers have begun to focus on the effectiveness of game teaching in primary school mathematics classrooms. This study combines the results of questionnaire surveys and mathematical game teaching cases observed during internships to identify the following main problems in the implementation of mathematical game teaching in lower primary grades: single form of game teaching, overly chaotic classroom order, and inability to achieve mathematical classroom teaching objectives. Through teaching cases, we can present these problems more intuitively, thereby analyzing them more deeply.

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5.1 Single Form of Mathematical Game Teaching

During the internship observation of a teacher's teaching of the "Multiplication Table of 8" in the Sujiu Grade Two Book, the teacher used the "train driving" game to consolidate the content learned in the previous lesson during the review and introduction stage. However, after teaching the students the multiplication table of 8, the teacher used a simple "word game" to consolidate the content of this lesson in the practice and consolidation stage. Due to the relatively single form of the game and lack of richness, students became bored, found it difficult to maintain their enthusiasm for learning, and could not keep up with the teacher's pace. Therefore, teachers should pay attention to the diversity of game teaching, appropriately make the game "lively", and design various forms of game teaching, including card games, maze games, and group competitions, to make game teaching more diversified and interesting. Only in this way can students better understand and master mathematical knowledge.[4]

5.2 Poor Classroom Organization during Game Teaching

Good classroom order is an important guarantee for achieving educational and teaching tasks and teaching objectives, as it helps maintain classroom stability, stimulate students' learning potential, and improve the efficiency of teaching work. In the classroom recording of the teaching of "Recognizing Shapes", the teacher prepared cuboids, cubes, cylinders, and spheres for each student, and asked them to build according to their imagination and creativity. The discussion was very heated, but although all students were eager to build blocks, they did not discuss the shapes of the blocks, but argued with each other, focusing on grabbing blocks. Those students who were not interested in building blocks sat aside, drawing or playing other things, and the classroom order was very chaotic. This case is about recognizing shapes in the first grade mathematics book of Sujiu, and the purpose of teaching is for students to deepen their understanding of cubic shapes through hands-on operation and accurately identify types of shapes through block-building games, which is beneficial to achieve the teaching objectives. However, the first-grade students were not focused, and once the blocks were distributed, the students were out of control. If the teacher cannot effectively control and guide the students, the classroom will become chaotic, and the students will not learn anything, and the value of the game cannot be fully realized.

5.3 Failure to Achieve Mathematical Classroom Teaching Objectives through Game Teaching

Teaching objectives are tasks completed jointly by teachers and students, as well as standards for measuring the actions of teachers and students, with important motivating and guiding roles. However, for mathematical game teaching, the formulation of teaching objectives lacks scientificity and may often be just superficial words. However, in the process of mathematical game teaching, achieving teaching objectives also faces some challenges. For example, in the fifth unit "Recognizing RMB" of the second semester of the first grade mathematics textbook of the Bu Compilation, the teacher hopes that students will understand the basic knowledge and value of RMB and learn to use RMB in daily life. To this end, the teacher designed a series of activities, including asking students to go to the supermarket to buy learning supplies or snacks they like and bring some change to the classroom for shopping games. However, although these activities seem lively, they actually deviate from the teaching objectives. The teaching objective is for students to recognize RMB, understand the value of RMB, experience the value of RMB, and the process of equivalent exchange, so as to learn to use RMB in daily life. Therefore, in order to better achieve these objectives, teachers need to redesign activities to ensure that students can deepen their understanding of the value and usage of RMB, rather than just buying items and playing games.

6. Research on Strategies for Mathematical Games in Lower Primary School Teaching

6.1 Enriching Game Forms Based on Textbook Knowledge

In the primary school stage, using different forms of mathematical game teaching can improve teaching effectiveness. Common forms of mathematical games include role-playing, hands-on, and competitive games. Teachers should delve into these forms and design more diverse game forms based on actual teaching situations.

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6.1.1 Role-playing Games

Teaching Content: Recognizing currency, basic addition and subtraction

Game Example: Little Shopkeeper

Teachers divide students into groups, with each group playing the role of a shopkeeper. The teacher gives each group a certain amount of money and lets them engage in activities such as shopping and giving change. Before the game starts, the teacher can explain the currency to help students understand different denominations of currency and the ways they can be combined. During the game, students need to perform addition and subtraction operations to calculate the shopping amount and change for customers. This game allows students to learn calculations through games and also helps develop their teamwork and communication skills.[5]

6.1.2 Hands-on Games

Teaching Content: Recognizing numbers 0-20, recognizing geometric shapes

Game Example: Geometric Shape Puzzle

Teachers can let students use geometric puzzles or mathematical building blocks to form different geometric shapes, such as squares, triangles, rectangles, etc. This game allows students to learn about the shapes, properties, and names of geometric shapes through hands-on activities, improving their hand-eye coordination and imagination.

6.1.3 Competitive Games

Teaching Content: Multiplication and division within tables, addition and subtraction of two or three-digit numbers

Game Example: Calculation Competition

Teachers can organize a calculation competition, where students must complete a certain number of calculation problems, such as multiplication tables, within a specified time. The competition can be divided into multiple stages, each with different difficulty levels, gradually improving students' calculation abilities and confidence. This game can stimulate students' interest in learning and competition, improving their hands-on ability and calculation speed.

Overall, these games combine mathematical teaching content with game elements, increasing students' interest and participation. They are suitable for both in-class teaching and as after-school activities, enhancing students' mathematical literacy and hands-on abilities.

6.2 Strengthening Classroom Management to Maintain Classroom Order

6.2.1 Establishing Standard Classroom Order

In mathematical game teaching, teachers need to develop detailed teaching plans before class and strictly adhere to them. Teachers also need to establish appropriate classroom discipline based on teaching content and student age characteristics, continuously emphasizing it in class. For example, before the game, detailed explanations of the game rules can be given to ensure that students understand the game objectives and rules, avoiding confusion due to unclear game rules. Additionally, teachers can establish corresponding reward and punishment mechanisms to ensure that students know how to behave in class.

6.2.2 Paying Attention to Student Personalities and Differences

In mathematical game teaching, teachers need to pay attention to student personalities and differences, as each student's learning style and interests are different. To meet students' needs and abilities, teachers can allow them to choose according to their preferences and abilities. Furthermore, teachers can design different game rules and tasks based on students' actual situations to meet different students' needs and ability levels.

6.2.3 Actively Participating in Game Teaching

In mathematical game teaching, teachers should actively participate in games, playing games with students and discussing games with them. Teachers can role-play in games, leading students to complete game tasks and guiding them to think and solve problems. After the game, teachers can summarize the gains and experiences of the game with students, better stimulating their interest and

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motivation in learning.

6.3 Conducting Game Teaching Around Teaching Objectives

6.3.1 Connecting Game Design with Teaching Objectives

In the process of designing games, it is necessary to combine them with teaching objectives to determine the theme, rules, and tasks of the game. The content of the game should directly or indirectly help students achieve teaching objectives. For example, for students who need to master addition and subtraction, games can be designed for students to complete related calculation problems in the game; for students who need to understand geometric shapes, games can be designed for students to do geometric shape puzzles, etc.

6.3.2 Learning Process and Learning Results in Games

Game teaching should focus on the learning process and results. In games, teachers need to guide students to think and help them form correct cognition and thinking patterns to achieve teaching objectives. Additionally, teachers need to pay attention to students' performance and learning outcomes in games, providing timely feedback and guidance.

6.3.3 Evaluation and Improvement in Games

Game teaching needs continuous evaluation and improvement. In game teaching, teachers need to collect feedback and opinions from students, understand their learning situations and game experiences, and make improvements and adjustments to the game in a timely manner. At the same time, teachers also need to evaluate the effectiveness of game teaching, optimize and improve the game to enhance teaching effectiveness.

7. Summary

With the continuous development of the education sector, the concept of "game" teaching has gradually gained recognition from many scholars. Integrating mathematical knowledge with games can create a relaxed and pleasant learning atmosphere for students. It can also help deepen students' understanding of mathematical knowledge, further stimulate their interest in learning mathematics, and cultivate their ability to discover, analyze, propose, and solve problems. The author of this article will continue to conduct in-depth research on mathematical game teaching in future educational practices, improve the level of mathematical game teaching for teachers, and promote the comprehensive development of students.

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