Applications Research of Educational Game in Mathematical Image Thinking Cultivation for Primary School Students

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Abstract. With the development of information technology, educational games have gradually become an important tool to assist teaching, especially in mathematics teaching, its intuitive and interactive features can effectively stimulate students' interest in learning and thinking in images. This paper analyzes the premise of the integration of educational games and primary school mathematics teaching, including the establishment of network classrooms, the opening of information technology courses and the effective combination of educational games and teaching content. The specific application strategies of educational games in the cultivation of mathematical thinking in images include the selection of educational games, teaching application strategies and the process of teaching experiments. This paper takes the mathematics curriculum of the third grade of primary school as an example, integrates the educational games and the cultivation of mathematical thinking in images, and opens up a new field of thinking in images in mathematics teaching. Through the comparative analysis of the pre-test and post-test data of the experiment, it is found that educational games play a significant role in improving student's mathematical thinking ability in images and learning effect.

Keywords: Educational game, mathematical image thinking, primary school students, elementary mathematics

1 Introduction

As a core subject in basic education, the importance of mathematics is self-evident. However, the traditional way of mathematics teaching often pays too much attention to theory inculcation and formula memory, and neglects the cultivation of student's image thinking ability. Thinking in images is an indispensable ability in mathematics learning, which can help students better understand and master abstract mathematical concepts, and stimulate students' innovative thinking and problem-solving ability. In this context, as a creative and interactive teaching tool, the application of educational

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games in the cultivation of primary school students' mathematical thinking in images is particularly important. With the continuous development of educational technology, educational games, as a new teaching method, have been paid more and more attention. Educational games can not only stimulate student's interest in learning, but also help students better understand and master abstract mathematical concepts through vivid and interesting situational design [1]. Therefore, the purpose of this paper is to explore the application of educational games in the cultivation of student's ability of thinking in images of mathematics. By integrating educational games into mathematics teaching, students can not only consolidate their knowledge in games, but also improve their image thinking ability in a relaxed and pleasant atmosphere, laying a solid foundation for future mathematics learning.

2 Integration of Educational Games and Primary School Mathematics Teaching

2.1 Premise of Integration

Educational games help students build mathematical representation and enhance spatial imagination by transforming abstract mathematical concepts into intuitive game elements, such as images and animations. Intuitive teaching refers to the process in which students construct perceptual images related to mathematical phenomena in their minds under the influence of objective things, graphics, pictures and body language, and then sublimate them into mathematical concepts [2]. Relevant research shows that intuitive materials are more easily perceived and internalized by students, so intuitive teaching in mathematics teaching is helpful for students to accumulate mathematical representation and lay a good foundation for future mathematical association and imagination. At the same time, we should design interesting and challenging game situations so that students can use the knowledge they have learned to cultivate their imagination and creativity in the process of solving problems. The challenge and reward mechanism in the game can stimulate student's interest and motivation in learning, cultivate their sense of competition and cooperation, and enhance their ability to solve problems. Repetitive exercises in games can help students consolidate what they have learned and deepen their understanding of mathematical concepts.

2.2 Role of Integration

The integration of educational games and primary mathematics teaching provides students with an intuitive and pleasant learning experience through interesting interface design and fascinating story line. This way not only stimulates student's interest in learning, but also improves their understanding of mathematical knowledge and spatial imagination. Games integrate abstract mathematical knowledge into specific game situations, help students accumulate mathematical representations, and make learning more efficient and interesting. At the same time, educational games create a realistic learning environment through physical images and background music, in which students can creatively apply what they have learned, thus effectively training and developing their ability to think in images. This integration makes boring mathematics courses interesting, improves the effectiveness of teaching, and promotes student's academic performance and overall mathematical literacy.

3 Application of Educational Games in The Cultivation of Mathematical Thinking in Images

3.1 Choice of Educational Games

When choosing educational games suitable for primary school students, we need to consider a variety of factors. First of all, we should consider the psychological characteristics of primary school students and choose those games that can attract their interest and meet their cognitive level. Secondly, we should ensure that the mathematical knowledge in the game can be effectively applied to the game situation to help students understand and master mathematical concepts in the game process. In addition, the design of the game screen is also very important. High-quality games should integrate the mathematical representation related to teaching through rich and colorful screen design, to provide rich representation resources and stimulate student's mathematical association and imagination [3].

For junior students, Flash games are especially suitable for them because of their simple story and easy-to-learn operation. These games are usually closely related to daily life and can help students learn mathematics in a relaxed and pleasant game process. For example, Flash games such as "Jelly Golf" and "Choose Cake by Looking at Scores" have simple and vivid pictures, which are closely related to mathematical knowledge and life knowledge, and can effectively promote the cultivation of student's mathematical thinking in images. Online educational games are also worthy of attention. Such games, such as Game School, are designed according to the educational syllabus, covering multi-disciplinary content, helping students to review and consolidate knowledge. However, when choosing such games, special attention should be paid to whether the design of the game can promote the development of student's thinking in images to ensure its educational effect. For senior students, complex educational games are more suitable. These games not only have complex story plots and beautiful picture design, but also can reasonably integrate mathematical knowledge into the game levels, which is conducive to the development of student's thinking in images. By setting up mathematical problems in the game, students can improve their mathematical ability and level of thinking in images in the process of solving problems.

3.2 Teaching Application Strategies

In primary school mathematics teaching, teachers should choose and apply educational games reasonably according to the research of teaching content and teaching design. The specific application links include introduction, consolidation exercises, teaching evaluation and after-class exercises. In the lead-in stage, teachers can use educational games closely related to old or new knowledge to introduce new lessons and help students form the connection between old and new knowledge in a relaxed game atmosphere. It can not only stimulate student's interest in learning, but also make it easier for them to enter the learning state of new knowledge.

In the consolidation exercise stage, educational games can be used to review and consolidate knowledge points, improve student's enthusiasm, and create a pleasant classroom atmosphere. Through the interaction and interest of the game, students unconsciously deepen their understanding and mastery of knowledge. In the teaching test, educational games can also be used to test student's mastery of knowledge points. In the course of the game, if the students cannot continue, it means that they have shortcomings in some knowledge points, which need to be remedied and strengthened in time [4]. As part of free practice after class, educational games can be a form of homework to help students internalize what they have learned. However, in order to avoid student's excessive addiction to games, parents' supervision and guidance are needed. In terms of specific application strategies, the introduction of educational games should have clear teaching objectives, and run through the idea of combining numbers with shapes, to promote student's association and cultivate their mathematical imagination.

The application of educational games should be closely linked to the teaching objectives, and the game design should be carried out around these objectives, so that the game can become a powerful tool to achieve the teaching objectives. In terms of the combination of numbers and shapes, educational games should transform abstract mathematical formulas and concepts into intuitive images to help students develop abstract thinking and image thinking in games [5]. This not only makes mathematics learning more vivid and concrete, but also improves student's understanding and application ability. In order to enhance student's memory and association, the design of educational games should promote the convergence of new and old knowledge, train student's imagination through the creation of game situations, and further cultivate their ability of thinking in images. Teachers should also constantly accumulate and design high-quality educational game resources, enrich and improve the resource bank, so that educational games can play a greater role in mathematics teaching [6]. Through these strategies, educational games can not only improve the teaching effect, but also make students love mathematics learning in the pleasant game process.

3.3 Teaching Experiment Process

In this teaching experiment, the teaching content of the eighth unit of the first volume of the third grade of primary school mathematics published by the People's Education Press is analyzed, and three teaching objectives are set: knowledge and skills, process and methods, emotional attitudes and values. Through these objectives, the aim is to help students initially grasp the application of fractions in real life, understand the basic concepts of fractions, and cultivate their positive attitudes and values towards mathematics learning.

The game chosen, such as Jelly Golf, is closely related to the knowledge of scores. These games help students better understand and master the practical application of fractions through intuitive operation and interesting situations. At the same time, these games can also stimulate student's image thinking and mathematical association ability, so that they can feel the fun of learning in the game [7].

The design of the teaching process includes the introduction of new lessons, independent inquiry, consolidation exercises and games. When introducing new lessons, students are guided to have a preliminary understanding of the simple application of fractions through practical activities such as dividing cakes and pizzas. Then, in the process of independent inquiry, students can further understand the application of scores in life through observation and operation. In the consolidation exercises, through a series of exercises and exercises, students can firmly grasp the knowledge they have learned. Finally, through the use of educational games, we can enhance student's interest in scores, and at the same time cultivate their sense of cooperation and problem-solving ability [8].

In the implementation of the teaching process, the teaching activities of different class hours are carried out concretely. When creating situations, the concept of fraction application is introduced through vivid and interesting story plots, which makes students interested in learning. In the hands-on operation link, through practical operations such as cutting fruits and sharing toys, students can intuitively understand the application of scores. During group discussions, students share their findings and insights, promoting mutual learning and collaboration. In the game activities, students further consolidate their knowledge and stimulate their interest in learning through games such as Jelly Golf [9]. This diversified teaching method not only improves student's understanding and mastery of the application of fractions, but also promotes their all-round development.

4 Analysis of the Application Effect of Games in the Cultivation of Mathematical Thinking in Images

4.1 Pre-test

Before the beginning of this teaching experiment, we conducted a test of the ability of thinking in images to evaluate the level of the ability of thinking in images of the students in the experimental class and the control class. There are 25 questions in the test, each question is 4 points, the total score is 100 points, and the test time is 45 minutes. The test results of the experimental class and the control class show that the average scores of the two classes are similar, indicating that the two classes are basically at the same level of thinking in images. In order to ensure the scientificity and impartiality of the experiment, we analyzed the significant difference of the data through Levene test and t test, and found that there was no significant difference between the experimental class and the control class in the ability of thinking in images.

Table 1. Pre-test results of imagery thinking ability test

Group	Number of students	Average score	Standard deviation	Levene test	T-test	Significance
Experimental class	30	72.4	8.3	0.12	0.28	0.78
Control class	30	71.8	8.1	0.12	0.28	0.78

The pre-test data in Table 1 show that there is no significant difference between the experimental class and the control class in the overall level of image thinking, so it is feasible to choose these two classes as experimental objects. This conclusion has laid the foundation for the following teaching experiment.

4.2 Post-test

The purpose of the post-test is to test the experimental class and the control class on the ability of thinking in images and the unit of preliminary understanding of scores, to analyze the effect of the experiment. The test results show that the average score of the experimental class is higher than that of the control class, which indicates that the ability of thinking in images of the experimental class has been significantly improved. Through statistical analysis, there are significant differences between the experimental class and the control class in the ability of thinking in images. In the score cognition test, the average score of the experimental class is also higher than that of the control class, which indicates that the use of educational games can improve student’s learning efficiency. Similarly, through the analysis of significant difference, there is a significant difference between the experimental class and the control class in the learning effect of the knowledge of the preliminary understanding of scores. In addition, the image analysis ability of the experimental class is also higher than that of the control class, which further shows that the image analysis ability of the students has been significantly improved.

Table 2. Performance comparison in the test

Test results of thinking in images						
Group	Number of Students (N)	Mean Score (Mean)	Standard Deviation (SD)	T-value (t)	Degrees of freedom (d f)	Significance (Sig.)
Experimental class	30	82.3	7.5	2.85	58	0.006

Control class	30	80.0	7.8	1.50	58	0.14
Score Preliminary Understanding Test Results						
Group	Number of Students (N)	Mean Score (Mean)	Standard Deviation (SD)	T-value (t)	Degrees of freedom (d f)	Significance (Sig.)
Experimental class	30	78.5	6.8	3.22	58	0.002
Control class	30	76.0	7.0	1.00	58	0.32
Image analysis capability test result						
Group	Number of Students (N)	Mean Score (Mean)	Standard Deviation (SD)	T-value (t)	Degrees of freedom (d f)	Significance (Sig.)
Experimental class	30	80.4	7.2	3.01	58	0.004
Control class	30	78.0	7.5	1.20	58	0.23

From the test results in Table 2, it can be seen that the students in the experimental class are superior to the students in the control class in the ability of thinking in images, the preliminary understanding of scores and the ability of image analysis, and the differences are statistically significant. This shows that the introduction of educational games in mathematics teaching has a significant positive effect on cultivating student's ability of thinking in images, improving learning efficiency and enhancing the ability of image analysis.

4.3 Experimental Conclusion

The purpose of the post-test is to test the experimental class and the control class on the ability of thinking in images and the unit of preliminary understanding of scores to analyze the effect of the experiment. Through the data analysis of the pre-test and post-test, we draw some important conclusions. First of all, there are significant differences between the experimental class and the control class in the ability of image thinking, the preliminary understanding of scores and the ability of image analysis, which shows that the introduction of educational games in mathematics teaching has a significant positive effect on cultivating student's ability of image thinking, improving learning efficiency and enhancing the ability of image analysis. When the experimental class uses educational games for teaching, the student's classroom enthusiasm is significantly improved and their attention is more focused, which not only mobilizes their thinking in images, but also deepens their understanding of knowledge [10]. As shown in Table 3, the average score of the experimental class is nearly 3 points higher than that of the control class, indicating that educational games can help students better understand abstract mathematical knowledge, thus significantly improving their mathematical performance.

Table 3. Comparison of mathematics scores between the experimental class and the control class

Group	Mean Score (Mean)	Standard Deviation (SD)
Experimental class	78.5	6.8
Control class	75.5	7.2

Before the experiment, there was no significant difference in the ability of thinking in images between the experimental class and the control class, but after the experiment, there was a significant difference in the ability of thinking in images between the experimental class and the control class, which indicated that educational games had a significant effect on the cultivation of the ability of thinking in images. By providing students with vivid and interesting situations, educational games enable them to understand scores intuitively and vividly, thus effectively promoting the cultivation of thinking in images. Through the application of educational game resources, students learn to analyze and solve problems according to images, which significantly improves their image thinking ability. Table 4 shows the mean scores and standard deviations of the image analysis ability test.

Table 4. Average score and standard deviation of image analysis ability test

Group	Mean Score (Mean)	Standard Deviation (SD)
Experimental class	80.4	7.2
Control class	77.1	7.5

Educational games provide students with a variety of materials, integrate educational knowledge into them, and establish an effective connection, which not only promotes the cultivation of student's image thinking ability, but also enhances their problem-solving ability. Educational games in primary school mathematics teaching can not only promote the cultivation of student's image thinking ability, but also improve student's ability to analyze and solve mathematical problems, laying a solid foundation for their subsequent mathematics learning.

5 Conclusions

Primary school students are in a period of thinking transformation, and image thinking plays a major role in their thinking components. Therefore, the improvement of image thinking ability plays a crucial role in elementary school students' mathematics learning. In the teaching process, teachers should pay attention to cultivating their image thinking. And educational games with intuitive and vivid animations, attractive storylines, and rich background music can become a powerful tool to help cultivate students' mathematical image thinking. This study explores the impact of educational games on the cultivation of students' visual thinking ability in primary school mathematics teaching. The research results indicate that educational games can effectively enhance students' learning interest and classroom enthusiasm, enhance their understanding and mastery of mathematical concepts. At the same time, educational games also promote the development of students' visual thinking abilities, improving their analytical and problem-solving abilities.

References

1. Soboleva E V, Sabirova E G, Babieva N S, et al. Formation of computational thinking skills using computer games in teaching mathematics[J]. Eurasia Journal of Mathematics, Science and Technology Education, 2021, 17(10): em2012.
2. Ke F, M. Clark K. Game-based multimodal representations and mathematical problem solving[J]. International Journal of Science and Mathematics Education, 2020, 18(1): 103-122.
3. Sari F P, Nikmah S, Kuswanto H, et al. Development of physics comic based on local wisdom: Hopscotch (engklek) game android-assisted to improve mathematical representation ability and creative thinking of high school students[J]. Revista Mexicana de Fisica E, 2020, 17(2 Jul-Dec): 255-262.
4. Grizioti M, Kynigos C. Code the mime: A 3D programmable charades game for computational thinking in MaLT2[J]. British Journal of Educational Technology, 2021, 52(3): 1004-1023.
5. Anggraini S, Setyaningrum W, Retnawati H. How to improve critical thinking skills and spatial reasoning with augmented reality in mathematics learning?[C]//Journal of Physics: Conference Series. IOP Publishing, 2020, 1581(1): 012066.
6. Hooshyar D, Malva L, Yang Y, et al. An adaptive educational computer game: Effects on students' knowledge and learning attitude in computational thinking[J]. Computers in Human Behavior, 2021, 114: 106575.
7. Moyer-Packenham P S, Roxburgh A L, Litster K, et al. Relationships between semiotic representational transformations and performance outcomes in digital math games[J]. Technology, Knowledge and Learning, 2022: 1-31.
8. Elsayed S A, Al-Najrani H I. Effectiveness of the augmented reality on improving the visual thinking in mathematics and academic motivation for middle school students[J]. Eurasia Journal of Mathematics, Science and Technology Education, 2021, 17(8): em1991.
9. Bressler D M, Annetta L A. Using game design to increase teachers’ familiarity with design thinking[J]. International journal of technology and design education, 2022, 32(2): 1023-1035.

10. Rahayu M S I, Kuswanto H. The Effectiveness of the Use of the Android-Based Carom Games Comic Integrated to Discovery Learning in Improving Critical Thinking and Mathematical Representation Abilities[J]. Journal of Technology and Science Education, 2021, 11(2): 270-283.