

Gamification in Primary School Mathematics Teaching

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Abstract. This essay explains the current situation of primary school mathematical teaching and the effectiveness of applying Gamification in mathematical primary classrooms. The primary school stage is an important issue that the whole society cares about in childhood education. Among them, as a mathematics subject that will be widely used in future development, its learning method is even more critical. However, as traditional mathematics classes cannot consider individual differentiation, they cannot let students reach their potential. It will lead to a wrong understanding of mathematical theory from students. Therefore, it needs to incorporate some new pedagogy. Gamification, as a novel and innovative teaching method, can increase students' motivation and interest in a subject, which can be used in primary school mathematics classes. However, it has not been widely used in primary school mathematics. This study will combine the analysis of gamification by a large number of researchers to explore its advantages and disadvantages for primary school mathematics teaching, as well as the current status of a small number of gamification mathematics teaching, the difficulties it uses, and the strategies that can be used. Finally, combined with a lot of research and analysis, Gamification is feasible in the application of elementary school mathematics. Even if it contains some defects, it can be used in combination with other pedagogies to make up for the defects.

Keywords: Gamification, Learning, Motivation, Reflection, Challenges.

1. Introduction

Modern primary school classes are mostly taught by traditional lecturers, so individual differences and different enthusiasm of students are not considered [1], which is especially obvious in mathematics courses. Mathematics classes are based on a large amount of theoretical math knowledge, but the individual differences between students and experiences might sometimes lead to their wrong understanding of the same theoretical knowledge. Some researchers [2] have found that the current traditional education model, that is, teaching in the form of lectures can only give students a single knowledge, which prevents them from thinking about the possibility of more development, because most students are "backing" knowledge. Instead of really "understanding". At the same time, this will also consume students' independent learning ability. As a result, they would give wrong answers on the standardized tests and thus be labeled as "poor learners.". Therefore, a large number of researchers have begun to study the impact of innovative teaching methods on elementary school mathematics.

At present, according to the definition of researchers, Gamification is [3], which can improve students' motivation and encourage students to self-learning. According to the data, students' interest in mathematics and motivation for self-learning is lacking [4], so Gamification is a very good application in this situation. However, at present, Gamification is still in a state of being researched, and it has not been widely and systematically used in mathematics classrooms. Therefore, whether Gamification can be well used in elementary school mathematics is still lacking an answer.

Therefore, this study is to mainly analyze the effectiveness of using Gamification in primary mathematical classrooms. It will analyze the current situation of gamification and the advantages it brings. It also shows the need for more experimental support for gamification, and how to take measures in the classroom to make up for the shortcomings of gamification. This study is mainly to find a more suitable way for students to learn for the primary school mathematics class, thereby improving the learning efficiency of primary school students.

2. Current Use of Gamification in Primary School Mathematics Teaching

2.1. Integrating Gamification into the Use of Math Lessons

First of all, Gamification plays a very good role in current education. According to the research [5, 6], Gamification is to integrate some game functions into teaching, including expanding students' thinking, constructing framework and aesthetics, and integrating game mechanics. The elements of Gamification include reward mechanisms, rules and instructions, stories, challenges, decision-making, and a sense of mastery to improve students' motivation. Digital games are becoming more and more popular with the development of the times. For example, the now-famous "Sudoku" game integrates the sequence of numbers 1-9 into the design of the game. In addition to allowing players to learn more about the sequence of numbers, it also exercises learners' logical thinking ability. Although the "Sudoku" game is more interesting than professional teaching, many researchers have designed the application of gamification in mathematics teaching. At present, for mathematics teaching, Gamification can guide students to learn mathematical formulas by making mathematical models interesting or making them into stories. For example, Christopher Staecker [7] devised a way for students to learn about "adjacency" in mathematics by building a friendly robot using lines and dots and calling the opposite corners of the robot's figure neighbors. Although the design of this game involves junior high school concepts such as functions, the construction of polygonal graphics and the concept of "adjacent" are also applicable to elementary school students. For the teaching of elementary school mathematics, educators can use "board games", that is, let students answer each other's mathematics questions for the opportunity to move chess pieces, which also allows students to exercise their mathematical ability. These mathematical problems can be very basic, and become the design of exercising understanding of knowledge, such as matching polygons with their names, or solving primary school mathematical knowledge such as the solution of linear equations in one variable. For the teaching of primary school age, many researchers have shown that Gamification is very useful in teaching mathematics in elementary school. Researchers [8] evaluated the use of gamification in third-grade mathematics education. They used Ocatalysis proposed by Yu Kai-Chou constructs to measure third graders' experience as gamers. They found that third graders actively collaborated throughout the process, developing multiple skills and abilities. The reason why Gamification is very useful to elementary school students is mainly because of its fun. In the case that the logical thinking of elementary school students has not been particularly developed, the use of interesting classroom methods can attract them more.

2.2. Changes Brought by Gamification in the Mathematics Class in Primary School

Traditional mathematics classrooms are taught in the form of direct lectures. Through the teacher's lecture, the student's answers, and finally through continuous homework and exercises, as well as the final exam to test the student's ability. There is no way to determine whether each student understands the math content in this way. Lectures only focus on the dissemination of knowledge, but cannot ensure that each student can understand the same mathematical concept due to individual differences. According to the data [4] of declining class attendance, students are not interested in traditional classes and it cannot arouse their motivation to learn. In addition, students cannot learn independently. Their activities for learning may all come from homework assigned by the teacher, and they are even less motivated to study mathematics on their own. This is why gamification teaching can be applied to mathematics teaching in elementary school.

Gamified teaching stimulates the interest of elementary-age children and allows them to enjoy the feelings of success and failure. A rewards system allows them to learn how to compete with others and increase their motivation to learn because they crave rewards. Gamification can enable students not only to learn mathematics knowledge, but also to exercise their teamwork ability, management ability, and communication ability. At present, traditional mathematics teaching only focuses on theoretical teaching, without considering the training of students' various skills, but these skills are crucial to students' future. Gamification not only teaches primary school students' mathematical skills

but also cultivates their critical thinking and understanding of failure and success. [9] Throughout the process, students try to solve the challenges they face, reflect on mistakes they make, and engage in critical thinking to solve problems [10]. Failure in the game doesn't frustrate them, because they aren't punished for it. Therefore, when they encounter failure in the game, they will not be discouraged but will regard failure as part of success, and keep trying. Gamification teaching in this area also taught them how to accept failure. Gamification education leads to their emotional development but also leads to their emotional control. Critical thinking is a very important social skill. In gamified education, students will want to solve a problem or face a challenge. Therefore, in the face of failure, they will continue to systematically think and reflect to find out what the problem is, and the whole process is to exercise their critical thinking. In any case, doing this requires immediate teacher feedback and opinion-based.

3. The Challenges for Using Gamification in Primary School Mathematics Class

3.1. Lack of Intrinsic Motivation

A big challenge in using Gamification in elementary school mathematics teaching is that the reward mechanism in Gamification can only increase students' external motivation. This refers to the fact that students are motivated by their desire for rewards, or their desire to score points, rather than their genuine desire to learn mathematics. Over time, once the novelty of the reward wears off, students will no longer be motivated to learn math as it decreases their intrinsic motivation [11]. This will be even more serious for primary school students. In elementary school, students are at the basic level of cultivating their interests and hobbies, but they have no real motivation and love to promote intrinsic motivation in their hearts. Gamification can give them a short-term craving to learn math as they crave grading and rewards. However, the novelty of elementary school wears off very quickly. As they no longer crave rewards, their interest in mathematics will decrease because they have no intrinsic motivation. Intrinsic motivation mostly comes from emotions. For example, if winning or losing this game makes them feel proud and proud, then they will gradually fall in love with this game, and thus long for this kind of emotion to happen again, not just for the reward. But such emotions are difficult because people are complex. Different people have emotions about different events, so this is a factor out of the educator's control. In addition, students' emotions towards games can also be negative, which will hit their intrinsic motivation even more. For example, some students are unwilling to participate in games, or they are afraid to communicate with others, so it is difficult for primary school students to step out of their comfort zone. Therefore, forcing all students to participate in the game will make some students rebellious, and thus more resistant to learning mathematics. Most difficult of all, engaging all students in play is a must for educators. If some students are not allowed to participate in the game and let them do other things, this does not solve the difficulty of considering individual differences, and it will widen the individual differences because different activities bring different feelings.

3.2. Difficulties in Controlling Students' Behavior

In Gamification, the fun of the game is very strong. Although it can motivate students to learn, the order of the classroom can also be difficult to control. For primary school students, their communication skills and cooperation skills are not well developed. Therefore, for them, classroom disputes are common. Any dispute will easily disrupt the order of the game and affect the students' emotions, thereby reducing their intrinsic motivation and making them feel negative. For mathematics class, Gamification will be a very creative teaching method, so it will be more attractive to students, but at the same time, students may be overly active, resulting in a reduction in the quality of the class. Even if teachers can guide students by setting game rules and giving certain instructions to stabilize classroom order, the number of instructions is still difficult to decide. Too much instruction can make

students feel overwhelmed and feel locked in and not allowed to develop freely, but a small amount of instruction runs the risk of the classroom becoming very cluttered. The setting of rules may even make some students feel rebellious, and thus become more disgusted with the game, thus losing the motivation to learn mathematics.

3.3. Lack of Efficiency in Learning

If the classroom is too focused on game strategies, such as cooperative strategies and psychological game strategies, it will make the classroom deviate from the focus, so that students will not be very focused on learning mathematics. For elementary school students, if they are constantly competing with each other, enjoying failures and successes and emotional fluctuations, this may allow them to develop a lot of skills, but at the same time, it will deviate from the focus of learning mathematics knowledge.

In addition, the game atmosphere is difficult to create, especially in mathematics. The storytelling pedagogical approach in Gamification is very important. By establishing a story background and framework, students can be integrated into the game. However, perhaps it is easy to construct a story background related to humanities, but it is a little difficult to construct a background related to mathematics because it is difficult for students to connect emotionally. For example, if the students live in a kingdom called "One-time Equation" as a story frame, this cannot make the students' emotional connection directly, because the students' personal life is not directly related to "One-time" relation. It is also difficult to connect game elements to non-game elements. Students may learn linear equations in one variable in the game, but it is difficult to convert the knowledge learned from the game into a theoretical model of linear equations in one variable in reality. Therefore, Gamification may be more suitable for reviewing knowledge rather than learning new knowledge.

4. Suggestions for Teachers to Optimize Gamification in Mathematical Teaching

4.1. Creating Constant Challenges and Giving Feedback

Continuous challenges can increase students' intrinsic motivation, because it makes them feel satisfied and enhance their challenge psychology, and they have more expectations for future tasks. This is the same principle as playing video games. Only when there are challenges in the game or a plot line can the players feel excited and motivated to play the game. Once the students feel the emotion of pride or the emotion of satisfaction, they will be genuinely interested. Only emotions can make a student learn for a long time, which is especially important for elementary school students, an age group that has not established any big goals and perseverance. The characteristic of mathematics is that it requires constant thinking, so if the game is not challenging, students will get bored and will not want to think anymore. To ensure the balance of the challenge, teachers need to have a certain degree of professionalism, which includes the understanding of knowledge and understanding of students. Teachers can set grade hierarchies, taking into account the different range of abilities of each student. After challenging the easy tiers, students can upgrade to challenge harder tiers, and if students fail to challenge, they can continue to challenge their tiers. In this way, it is ensured that the challenge is always there, and the extrinsic motivation of the students is increased (please note that extrinsic motivation does not mean bad, but only extrinsic motivation is bad). But this also has some disadvantages. The class setting may cause students to compare themselves, thus affecting their negative emotions and intrinsic motivation. Moreover,[12] the challenge of the game should not be too high, and it needs to be within a controllable range, because the emotions of primary school students are easily affected, and excessive failure and negative emotions will make them feel negative, thus losing intrinsic motivation.

A single reward is not enough, such as badges, or scores, etc., but if it can be combined with immediate suggestions and feedback, it can increase both extrinsic motivation and intrinsic

motivation of students. For example, after a student completes a task, the teacher immediately rewards him, such as a badge, and then gives him advice, telling him that he is very successful (to specify where it is), and telling the student what he needs to do next. Praise and encouragement can make elementary school students feel proud and happy, and these can increase their intrinsic motivation to learn mathematics in the long term.

4.2. Controlling the Reflection and Discussion Process

To solve the lack of objective learning caused by too much fun in the game, the teacher can arrange a reflection and discussion session after the game.

4.2.1. Reflect on the process of the game

Students can reflect on their behavior in the game during this session. For example, they can think about what they have learned, and the teacher can give some guiding questions at this time, such as "How do you think this game is related to linear equation", or "share the mathematical knowledge you use in this game", etc. Therefore, students can connect the game to professional courses. In this way, students will develop a mathematical understanding of the game, rather than a single understanding of play, which also helps them connect the emotional connection established in the game to mathematics learning [13].

4.2.2. Sharing their feelings

After reflecting, students can share their feelings with other students and exchange what they have learned. Everyone's differences will lead to differences in the mathematical knowledge they learn in the game, so letting them communicate with each other can allow them to absorb more mathematical knowledge and improve their understanding. Note that during the whole process, the teacher should immediately participate in the discussion after the students share, comment on the student's feelings, and give more knowledge. Sometimes the mathematics knowledge that students understand through the game may be wrong, so the teacher needs to participate in the discussion immediately to prevent students from having a wrong understanding of mathematics knowledge.

4.2.3. Connecting the discussion to theoretical teaching

After students share and play, the teacher can connect the discussion to theoretical teaching. There are certain theories and models behind each game, so the teacher can connect the game to theoretical mathematics teaching after the students share it. For example, when students discover the sequence of numbers and the theory of mathematics in the game, their concept of this is vague, but they still have explorations. Therefore, teachers can integrate the traditional classroom form, that is, lecture form, into professional mathematics teaching in this link to ensure that students have sufficient professional knowledge. However, this process needs to be as short as possible, and it also needs to incorporate a lot of interaction between teachers and students in the form of questions and answers. Taking the 50-minute general course as an example, this process should not exceed 10 minutes, because if it is too long, it will also affect the negative emotions of students. This process should also include a summary of the entire lesson.

The whole process of reflection and discussion exercises students' reflection ability [13], and communication ability, and connects their emotions with mathematics. At the same time, the teacher also ensures that the students have absorbed enough professional mathematical knowledge.

5. Conclusion

Through the research and analysis, this paper finds that the competition and winning-losing mechanism in Gamification can enable students to exercise multiple skills, such as teamwork, communication, and critical thinking. However, its reward mechanism sometimes makes students overly addicted to the game and lose intrinsic motivation. Therefore, Gamification will be a good tool in the teaching of primary school mathematics, but it has many uncertainties, which need to be

combined with other pedagogy, such as experiential learning, and it needs teachers to take many actions to maintain the class atmosphere. As a result, it can be integrated into the teaching mode, but it needs to be combined with other teaching methods, and it cannot be used alone.

The main contribution of this paper is to demonstrate the feasibility of using Gamification in primary school mathematics and analyze the applicability of Gamification to primary school. This will facilitate the management of the education system in primary schools. In addition, this research is also helpful to the education methods of other subjects, because the advantages and disadvantages of Gamification are also mostly applicable in the classroom of other subjects.

Current research is lacking for Gamification, and there are not many examples of Gamification being applied to mathematics, and it has not been systematically applied. Future research can pay more attention to how Gamification is combined with other pedagogy, and how it can be effectively integrated into the current traditional teaching mode.

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