Learning Achievement and Satisfaction Using Gamification in China Elementary School Mathematics

ผลสัมฤทธิ์ทางการเรียนและความพึงพอใจในการจัดการเรียนรู้ด้วยเกมมิฟิเคชั่นในวิชาคณิตศาสตร์ของโรงเรียนประถมศึกษาในประเทศจีน

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บทคัดย่อ

วัตถุประสงค์ของการศึกษานี้คือ 1) เพื่อพัฒนากิจกรรมการเรียนรู้ด้วยเกมมิฟิเคชั่นเพื่อส่งเสริมผลสัมฤทธิ์ทางการเรียนของนักเรียน 2) เพื่อสำรวจผลสัมฤทธิ์ทางการเรียนของนักเรียนผ่านกิจกรรมการเรียนรู้เกี่ยวกับเกมมิฟิเคชั่นโดยการทดสอบก่อนเรียนและหลังเรียนโดยเปรียบเทียบคะแนนแยกตามเพศ และตรวจสอบความแตกต่างจากการเรียนรู้คณิตศาสตร์ผ่านเกมมิฟิเคชั่นของนักเรียนใน 3 กลุ่ม (ต่ำ กลาง สูง) และ 3) ศึกษาความพึงพอใจของนักเรียนต่อกิจกรรมการเรียนรู้ผ่านเกมมิฟิเคชั่น กลุ่มตัวอย่างคือนักเรียนชั้นประถมศึกษาปีที่ 3 จำนวน 30 คนของโรงเรียนประถมศึกษาของรัฐในมณฑลเจ้อเจียง ประเทศจีน เครื่องมือวิจัยประกอบด้วย กิจกรรมการเรียนรู้เกี่ยวกับเกมมิเคชั่นและแบบสอบถามความพึงพอใจของนักเรียนผ่านเกมมิฟิเคชั่น สถิติการวิเคราะห์ข้อมูล ได้แก่ ค่าร้อยละ ค่าเฉลี่ยเลขคณิต ส่วนเบี่ยงเบนมาตรฐาน ค่า t-test และ ANOVA ผลการวิจัยพบว่า 1) การใช้กิจกรรมการเรียนรู้แบบเกมมิฟิเคชั่นช่วยเพิ่มผลสัมฤทธิ์ทางการเรียนของนักเรียนหลังการเรียนคณิตศาสตร์พื้นฐาน 2) การเปรียบเทียบผลสัมฤทธิ์ทางการเรียนของนักเรียนในกิจกรรมการเรียนรู้เกี่ยวกับเกมมิฟิเคชั่นก่อนและหลังเรียนคณิตศาสตร์พื้นฐานพบว่า (1) การปรับปรุงประสิทธิภาพของนักเรียนชายมีมากกว่านักเรียนหญิง (2) ความสามารถทางคณิตศาสตร์ของนักเรียนเพิ่มขึ้นอย่างมีนัยสำคัญในกลุ่มนักเรียนระดับกลางและระดับสูง 3) กิจกรรมการเรียนรู้ผ่านเกมมิฟิเคชั่น พบว่านักเรียนมีความพึงพอใจในการเรียนคณิตศาสตร์พื้นฐานอยู่ในระดับสูง

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Abstract

The purposes of this study were to 1) study student achievement through gamification learning activities by pre-testing and post-testing; 2) to compare learning achievement scores classified by sex and examine the difference from learning mathematics through a simulation game of students with 3 groups of learning levels (low, medium and high achievement levels); 3) to study the students' satisfaction with online gamification learning activities. The sample of the study were thirty third-grade students of a public elementary school in Zhejiang Province, China. Research tools included pre-tests, online gamification learning activities, post-tests, questionnaire measuring students' satisfaction and learning achievement evaluation form in online gamification teaching. Statistics for data analysis were percentage, mathematics mean, standard deviation, t-test dependent and ANOVA.The results were as follows: 1) Using gamification learning activities is conducive to enhancing students' achievement after teaching Mathematics. 2) Comparing students' achievement scores in gamification learning activities before and after conducting Mathematics revealed (1) improvement of male students' performance is greater than that of female students. (2) mathematics ability increases significantly among middle and high levels students.3) The gamification learning activities had a high level of satisfaction in learning mathematics.

Keywords: *Gamification, Learning Achievement, Satisfaction, Mathematics, Chinese elementary school*

Introduction

In recent years, China has implemented the new curriculum reform education by giving full play to students' ability and subjective initiative, and believing that learning is no longer the absorption of knowledge and culture but should be about

transforming knowledge into actual power so that students can flexibly apply knowledge to life practice. The study is based on online gamification in primary school mathematics teaching. Gamification in primary education is a new knowledge carrier. Tolstoy stated what is needed for successful teaching is not coercion, but a stimulation of students' interest in learning. In learning, interest is the catalyst for creative thinking and intelligence development. It can effectively improve learning efficiency and strengthen the learning effect. The use of games in education is an effective means to stimulate such learning interest and motivation.

One of the main development goals of China's education is to achieve high-quality and balanced compulsory education. The enrollment policy implemented by public primary schools in Zhejiang Province is to "enroll students by dividing areas and enroll nearby". Therefore, the students enrolled have mixed grades, which can represent most primary schools in Zhejiang Province. And with the support of the government, public primary schools have better teacher level, education quality and more investment in education funds, so there is a better educational environment for the subject of this study. mathematics is introduced at a primary school level and is necessary to cultivate students logical and mathematical thinking. The strength of calculation ability will directly affect students' interest in mathematics learning. If the essential mathematics operation ability is poor, students will not be interested in solving mathematical problems (Liu, 2013). In China, many mathematics exercises in the courses are tedious and boring. Teachers ignore the correct oral mathematics practice in teaching, which is difficult to arouse students' interest in learning (Shao, 2017). It finds that students' mathematics learning efficiency will be significantly enhanced if their interest in essential mathematics operation is improved (Jiang, 2017).

gamification has become a research hotspot in education over the past years due to the development of network science and technology and social progress. The combination of games and online education aligns students' psychological characteristics (Liu, 2016). The research on online game learning is increasing on a yearly basis; thus, the research content is more prosperous than ever. The emergence of teaching based on the concept of online game learning provides new teaching models and ideas to solve the problems existing in the classroom (Li, 2018). Many scholars have explored this teaching mode and affirmed that online game learning would gradually play a more significant role in the field of education (Zhu, 2020). This paper will take the essential mathematics operation as the starting point, showing the role of online game learning in primary school mathematics teaching through teaching experiments, and making a theoretical contribution to the research on online game learning in the future.

A quasi-experimental method was used to implement for teaching in the classroom. Online game teaching in classroom adopts the combination of game and mathematics courses. Take the multimedia network classroom as the teaching tool to display the game theme and game steps online so that students can learn mathematics knowledge through mathematics games.

Research Questions

RQ1: Are there any significant differences between pre-testing and post-testing after performing gamification learning activities in teaching mathematics?

RQ2: Is there a significant difference in post-testing achievement based on gender after performing gamification learning activities in teaching mathematics?

RQ3: Is there a significant difference in post-testing mathematics among students of different learning groups (low, medium, and high) after undertaking gamification learning activities?

RQ4: What is the level of students' satisfaction after undertaking gamification learning activities?

Research Objectives

1) study student achievement through gamification learning activities by pre-testing and post-testing;

2) to compare learning achievement scores classified by sex and examine the difference from learning mathematics through a simulation game of students with 3 groups of learning levels (low, medium and high achievement levels);

3) to study the students' satisfaction with online gamification learning activities.

Literature Review

Online gamification learning activities

Poondej, C. (2016) argues that online gamification learning is when teachers integrate game mechanics and thinking into the instructional design of a course, allowing students to engage in gaming activities and gain knowledge from them through an online platform. Online Gamification in mathematics teaching mainly combines the fun of games to arouse students' interest in learning mathematics, motivates students to explore activities in the process of playing games and solving problems, enables students to enjoy the fun of mathematics learning, develops their potential, and achieves the teaching goals of subject knowledge, emotional experience and skill development in parallel (Zamzami, 2018). Games have various outcomes, and mathematics has different ways of dimensionality. Teaching through online games makes it easier for students to understand the diversity of mathematical modes of thinking and get many other answers from teaching. In playing online games, students develop the habit of independent thought. In the long run, students are motivated to create good divergent thinking and independent thinking (Su, C., 2016). The adoption of online gamification teaching mode not only respects students' personality characteristics and learning psychology but also ensures that mathematics teaching and learning is modernized and professionalized; thus, transforming the conventional teaching form, compensating for the shortcomings in traditional teaching and learning, and also contributing to the reform of mathematics teaching and learning (Bullon, J., 2018)

Scholz, Kyle W. (2021) designed the six-step process for gamification learning activity. These first three steps occur before the course begins, and the remaining three steps guide the rest of the gamification learning experience. The steps are shown in Figure 1.

Figure 1 Gamification learning course design framework

Learning Achievement

Achievement is the test and evaluation of learning achievements. Testing is the simplest demonstration and application of the learned knowledge. Achievement reflects a person's mastery of what he has learned, so achievement is very important in identifying whether he has passed the learning (Dornon, 2021). When Karlimah (2015) administered an mathematics operations test to first-grade academics in an elementary school, 60 students were screened and randomly divided equally into two groups of 30 students each. The dependent variable was the test achievements after the sample study, including three mathematics questions and three-word questions.

Students Satisfaction

Based on the theory of pleasure teaching, the current teaching activities should continuously improve students' satisfaction and transform their aversion to learning (Liu, S., 2019). The degree of satisfaction is mainly measured by observing how much students like gamification learning activities on cloud platform, whether they can get a certain sense of achievement after learning relevant knowledge of math operation in the game, and whether they can improve their confidence in mathematics. Various performances of students are observed and recorded.

Research Framework

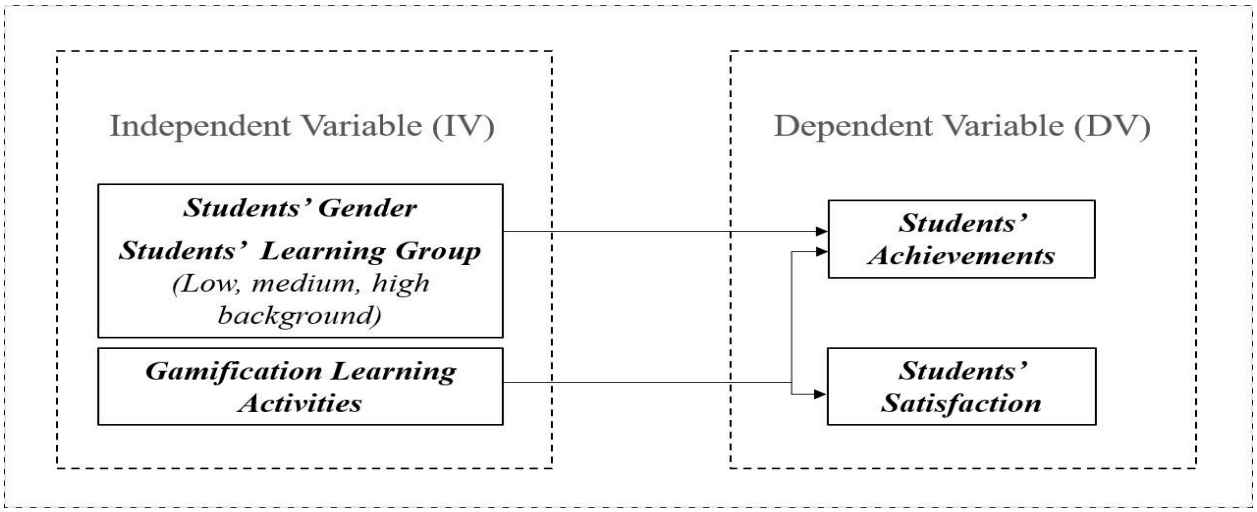

Figure 2 Research framework

Research Methodology

The overall research design was divided into three parts: a pre-test, a post-test, and a questionnaire.

The pre-test refers to the testing of third grade students' mathematics (addition 3 items, subtraction 3 items, multiplication 3 items, division 3 items, and absolute value 8 items, 5 marks each) in a public elementary school in Zhejiang, China, before the start of the experiment. The post-test is identical to the pre-test in that the same types of questions are used to better compare students' levels before and after the test. Between the pre-test and post-test, the lesson plan is used to conduct a teaching experiment for students. Online gamification learning activities lasts for a total of 4 weeks, once a week, 45 minutes at a time. The software includes Kahoot and Quizizz.

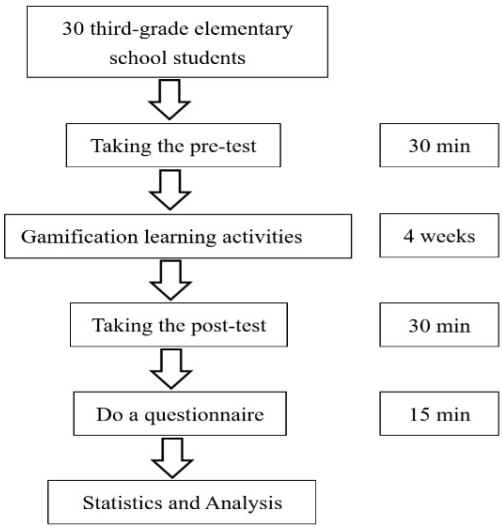

Figure 3 The procedure diagram

Population and sample

The target population included 180 third-grade students of a public elementary school in Zhejiang Province, China. The students came from 6 classes and composed of 88 girls and 92 boys. The researchers assessed the latest math achievements of third grades in the school and found all classes have students with different level of achievements ranging from high to low. Thirty students, 14 girls and 16 boys, were randomly selected from a class. The selected students served as participants of the study. In order to explore the significant differences and their differences in the impact of online games on mathematics learning of students with different learning group. According to the item analysis, determine the high-low grouping standard, take its approximate value as 20%, and record the first 20%, middle 60% and last 20% of the score as three different groups: high group, middle group and low group. Cluster sampling technique was used and online gamification learning activities were implemented to the group. The research was conducted with consents from the students and their parents.

IOC Validated for Pre-posttest and the Questionnaire of students' satisfaction

Validated Pretest post test questions Prior to conducting the main study, eliminate confusion and ambiguities of wording. This study invited three experts: two Math teachers and one educational technology expert to verify by using the Index of Congruency (IOC), to test congruency and content validity of pretest, post-test, and questionnaire in satisfaction.

Evaluation criteria are used to check the consistency between objectives and test items, as follows:

+1 = the test item is considered to be consistent with the goal.

0 = the test item is considered neutral in terms of whether the test item is consistent with the goal.

-1 = the test item is considered to be inconsistent with the target.

For acceptable data, the total average achievement of the project objective consistency (IOC) index is higher than 0.5.

Data collection

The data was collected through pre-tests, post-tests, and questionnaires.

The "pre-test" provided an understanding of the participants' mathematics level, which served as a guideline for the researcher to plan the lessons, set weekly lesson content, and allocate planning time (Mutlu, Y., 2018). The data was based on

the students' achievements on the pre-tests. In addition to the total achievements, there were achievements for each type of questions (oral, written, and mixed mathematics) as well.

The data from the post-test served as a comparison to the pre-test due to the questions on both were identical. Comparisons of mathematics were made based on the students' responses to multiple-choice questions (percent correct, score, response speed, etc.).

There were two types of data from the questionnaire: a specific and quantifiable data on students' satisfaction (15 items) and a more difficult to quantify textual data from students' suggestions (3 items) in which the researcher must analyze himself (Nuari, LF., 2018).

Data Analysis

The pre-test and post-test achievements were calculated to find significant differences through the use of a t-test dependent and standard of deviation (S.D.).

A t-test independent and one-way ANOVA were used to determine differences in mathematics among students' of different gender and learning groups (low, medium, and high) after undertaking gamification learning activities.

The quantitative results obtained from the closed-ended questions in the questionnaire were used to determine significant differences through calculations of mean and standard deviation (S.D.). The results were interpreted as follows:

4.50 – 5.00 = Very High

3.50 – 4.49 = High

2.50 – 3.49 = Moderate

1.50 – 2.49 = Low

1.00 – 1.49 = Very Low

Findings

1. The results of students' achievements

In order to explore students' academic performance after learning mathematics through online games, this part illustrates comparison of the students' pre-test achievements and post-test achievements in the mathematics test and mean achievements, standard deviations and descriptive analysis are presented in Table 1.

Table 1 Comparison of the students' pre-test and post-test achievements in the mathematics test

n=30

Test	N	Mean	S.D.	T	Df	P
Pre-test	30	61.33	14.54	10.69	29	.00**
Post-test	30	79.60	9.67			

**significant level at .05

Results as shown in the above table, the average achievement of the pre-test was 61.33 and the standard deviation was 14.54; The average achievement of the post test was 79.60 and the standard deviation was 9.67. The results show that there are significant differences in students' achievements before and after the test, and the value of t-distribution is 10.69.

2. Effect of online gamification learning on mathematics learning of students of different genders

Through SPSS 22.0 software respectively analyzes the post-test mathematics learning scores of boys and girls in the class, so as to investigate whether there are significant differences between the scores of students of different genders. Using descriptive statistical analysis, it can be seen that there are 16 boys, and the average score in the subsequent test is 78.75; There are 14 girls in total, and the average score in the subsequent test is 80.57. There are certain differences between male — and female students.

Table 2 Independent sample t-test of pre-test and post-test scores of students of different genders

n=30

	Male			Female			T	Significance (double tailed)	Mean difference
	Sample Size	Average value	S.D.	Sample Size	Average value	S.D.			
Post-test	16	78.75	8.46	14	80.57	10.53	2.026	0.048	2.769

From the perspective of gender: it can be seen that the performance of one female student among the 30 students decreased after the experiment, and the female student also increased the most. The increase rate of 11 girls is at the level of 1–25, and 2 girls are at the level of 26–50, accounting for 79% and 14% of girls respectively. There are 16 boys, including 10 at the level of 1–25 and 6 at the level of 26–50, accounting for 62% and 38% of boys respectively. From the above data, the improvement of boys is greater than that of girls.

Through independent sample t-test, explore whether there are significant differences in post-test academic performance between students of different genders, and calculate the effect quantity. The specific results are shown in Table 2. It can be seen from the results in the table that the Levene statistic of the post-test scores of class 1 is 1.128, and the $P = 0.293 > 0.05$ calculated by the homogeneity variance test, which means that the homogeneity test of variance is satisfied under the condition that the significance level is 0.05, which means that the post-test academic scores of students of different genders in class 1 come from the population of different variances. $T = 2.026$, two tailed $P = 0.048 < 0.05$, indicating that the original hypothesis is rejected when the significance level is 0.05, that is, there are significant differences in the post-test scores of students of different genders in class 1. The effect quantity $d = 0.573 > 0.5$, indicating that the difference effect of male and female students' post-test academic performance is a medium effect.

3. Analysis on the influence of online gamification learning on mathematics learning of students with different levels of learning achievements.

(1) Table 3 shows the ANOVA of high-level students. The calculated Levene statistic was 1.987, and the $P=0.126>0.05$ obtained by homogeneity ANOVA test indicates that the homogeneity test of variance was satisfied at the significance level of

0.05. In other words, the post-test scores of the high achievement group were from different populations with the same variance; thus, the conditions of ANOVA were met. There is also a significant difference in the post-test scores of the students in the middle group at F=3.316, p=0.026<0.05, and at significance level of 0.05. Referring to the standardized to evaluate the effect size, the differential effect of posttest scores of the high-level group was a large effect (0.144 > 0.140).

(2) The ANOVA for the intermediate group of students' transcripts is shown in Table 3. The calculated Levene statistic of 0.371 and P=0.774>0.05 for the homogeneity ANOVA test indicates a homogeneity test for variance is satisfied at a significance level of 0.05. It also indicates that the post-test scores of students in the intermediate group are from different populations with the same variance and satisfy the conditions of the ANOVA. There is a significant difference in the post-test academic performance of the intermediate group of students at F=5.791, p=0.001<0.05, and a significance level of 0.05. With reference to evaluate the effect size, the differential effect of post-test scores for the intermediate group was a large effect (0.186 > 0.140).

(3) The ANOVA for the low-level student is shown in Table 3. The calculated Levene statistic of 0.974 and P=0.228>0.05 for the homogeneity ANOVA test indicate that the homogeneity test for variance is satisfied at a significance level of 0.05. It also indicates that the post-test scores of the low-level group of students are from different populations with the same variance and satisfy the conditions of the ANOVA. The one-way ANOVA calculated F=0.402, p=0.752<0.05, indicating that there was no significant difference in the post-test scores of the lower band students at a significance level of 0.05.

Table 3 Summary of homogeneity test and one-way ANOVA of posterior data of high, medium and low-level students

n=30

Level		Levene statistics	D_{f1}	D_{f2}	Significance	Sum of squares	D_f	F	Significance	η^2
High	Between groups	1.987	3	6	0.126	77.783	3	3.316	0.026	0.144
	Within group	-	-	-	-	437.867	6	-	-	-
	Total	-	-	-	-	515.650	9	-	-	-
Medium	Between groups	0.371	3	8	0.774	50.513	3	5.791	0.001	0.186
	Within group	-	-	-	-	223.882	9	-	-	-
	Total	-	-	-	-	274.395	12	-	-	-
Low	Between groups	0.974	3	7	0.228	9.896	3	5.791	0.001	0.186
	Within group	-	-	-	-	459.038	6	-	-	-
	Total	-	-	-	-	468.933	9	-	-	-

4. The students' satisfaction

There were 15 questions in the questionnaire of primary school mathematics teaching effect. The content for all questions came from three dimensions: learners' emotional experience, learners' learning experience, and learners' learning strategies. The statistical analysis of the results for each of the dimensions are presented in Table 4 to Table 6.

Table 4 shows that after three rounds of teaching practice, students have a strong interest in the originally boring and monotonous mathematics learning, and can maintain a more positive learning attitude while learning mathematics . Learning interest and enthusiasm are important to the construction of a strong basis for learning mathematics in primary school. Analysis on the results of the dimension of "emotional attitude of learners". Analysis on the results of the dimension of " learning experience of learners"

Table 4 Analysis on the results of the dimension of "emotional experience of learners"

n=30

Questionnaire title	Consent rate (number)					Mean	SD	Result
	5	4	3	2	1			
Online gamification learning activities were very interesting?	56.67% (17)	33.33% (10)	10.00% (3)	0 (0)	0 (0)	4.47	0.67	High
I liked the system interface of the online gamification learning software.	63.33% (19)	23.33% (7)	6.67% (2)	6.67% (2)	0 (0)	4.43	0.88	High
The online gamification learning activities have made me more confident in learning mathematics.	66.67% (20)	26.67% (8)	6.67% (2)	0 (0)	0 (0)	4.60	0.61	Very High
The online gamification learning activities can improve my enjoyment of mathematics .	53.33% (16)	33.33% (10)	10.00% (3)	0 (0)	3.33% (1)	4.33	0.91	High
In my study, I often use online gamification learning software to get interesting feelings.	40.00% (12)	33.33% (10)	6.67% (2)	6.67% (2)	13.33% (4)	3.80	1.38	High
fell in love with math class through online gamification learning activities.	86.67% (26)	3.33% (1)	3.33% (1)	3.33% (1)	3.33% (1)	4.67	0.94	Very High
Mean	54.45%	25.55%	7.22%	3.33%	3.33%	4.38	0.97	High

Table 5 Analysis on the results of the dimension of "learning experience of learners"

n=30

Questionnaire title	Consent rate (number)					Mean	SD	Result
	5	4	3	2	1			
Online gamification learning activities helped me to improve my basic mathematics learning.	50.00% (15)	33.33% (10)	10.00% (3)	6.67% (2)	0 (0)	4.27	0.89	High
The online gamification learning software was easy and convenient to operate.	63.33% (19)	3.33% (4)	6.67% (2)	6.67% (2)	10.00% (3)	4.13	1.36	High

The online gamification learning activities are very efficient for learning?	43.33% (13)	26.67% (8)	26.67% (8)	0 (0)	3.33% (1)	4.07	1.00	High
Through online gamification learning activities, I can acquire knowledge faster.	53.33% (16)	40.00% (12)	10.00% (3)	0 (0)	0 (0)	4.47	0.62	High
Online gamification learning activities make my thinking more agile	60.00% (18)	40.00% (12)	0 (0)	0 (0)	0 (0)	4.60	0.49	Very High
Mean	54.00%	28.67%	10.67%	2.67%	2.67%	4.31	0.94	High

The data sorting results are shown in Table 5. This shows that the flow experience brought by online game activities enables students to concentrate on completing and challenging online game tasks without the urging and supervision of others, have clear goals and strong internal driving force, to bring the sense of achievement after investment, excitement and challenge in the process, and realize the satisfaction of self-transcendence needs of students.

Table 6 Analysis of the results of the dimension of "learning strategies of learners"

n=30

Questionnaire title	Consent rate (number)					Mean	SD	Result
	5	4	3	2	1			
I enjoyed learning basic mathematics more through online gamification learning activities.	70.00% (21)	10.00% (3)	10.00% (3)	10.00% (3)	0 (0)	4.40	1.02	High
I will use the online gamification learning software for more learning in the future.	63.33% (19)	3.33% (1)	16.67% (5)	6.67% (2)	10.00% (3)	4.03	1.28	High
The interface of the online gamification learning software was colorful.	56.67% (17)	26.67% (8)	13.33% (4)	3.33% (1)	0 (0)	4.37	0.83	High
Online gamification learning activities are more conducive to cooperative learning	73.33% (22)	10.00% (3)	10.00% (3)	3.33% (1)	3.33% (1)	4.47	0.80	High
Mean	65.83%	12.5%	12.5%	5.83%	3.33%	4.32	1.10	High

The four questions in Table 6 investigates and understands the learning strategies of students in learning mathematics after online game learning were introduced.

Discussion

After relevant literature was review, we found that the use of online game learning has been supported by many researchers in the field of primary school mathematics teaching, so it is worth discussing the results of these studies to compare the similarities or differences between the results of the current study and other studies.

Baroody, A. J. (2016) argues that it is essential to shape students' good learning habits. Maf'Ulah, S. (2016) states that it is necessary to arouse their interest in order to improve students' basic mathematics skills. We arrange the students' pre-test scores in descending order from high to low, and take the approximate value of 30%, dividing them into three groups with different learning group: the first 30%, the middle 40% and the last 30%, and record them as high group, middle group and low group accordingly. Through SPSS 22.0 software analyzes the pre-test scores of male and female students in the class to investigate whether there are significant differences between the scores of students of different genders. It can be seen that among the 30 students who participated in the experiment, the achievements of 29 students increased and only one student decreased. This result shows that online gamification learning plays a positive role in improving students' achievement of mathematics learning.

From the perspective of students' cognition, mathematics learning is the learning of "language and mathematical knowledge", "logical knowledge" and "structural knowledge" (Purpura, Napoli & King, 2019). Zhang and Lin (2015) believe that mathematics learning is the learning of "words, symbols and graphic languages and abstract things separated from the content of specific things", that is, mathematics learning is the learning of language and mathematical models. This paper uses descriptive statistical analysis to know that one female student among the 30 students' grades decreased after the experiment, and the biggest increase is also one female student. The increase of 11 female students is at the level of 1 – 25, and two female students are at the level of 26 – 50, accounting for 79% and 14% of female students respectively. There are 16 male students, including 10 at the level of 1 – 25 and 6 at the level of 26 – 50, accounting for 62% and 38% of male students respectively. From the above data, the improvement of male students' performance is greater than that of female students.

The more authoritative view is put forward by Yi, Ying and Wijaya (2019), which holds that mathematics learning is carried out according to the teaching purpose and plan, and a more lasting behavior change process caused by acquiring mathematical knowledge and experience. Hillmayr et al. (2020) divided the mathematics learning level according to the project analysis standard. He ranked the mathematics learning level of students in descending order from high to low, and divided them into three different levels: high group, middle group and low group. The results shows that there is no significant difference in the post-test achievement of the low-level students under the condition of significance level of 0.05. There is a significant difference in the post-test scores of the middle- and high-level students of students when the significance level is 0.05. Therefore, it can be explained that after learning mathematics through online games, middle- and high-level students' mathematics ability increases significantly.

Many scholars have discussed the influencing factors of learning satisfaction from multiple dimensions. Picciano (2021) proposed an online learning theoretical framework of four dimensions: internal drive, cognitive power, willpower and application power to explore the constituent dimensions and influencing factors of online learning satisfaction in primary and secondary schools. It is found that online learning satisfaction has a significant relationship with learning readiness, school environment, teachers' understanding, parents, gender, school stage, school and so on. This paper discusses the third-grade students' satisfaction towards learning mathematics through online games, and analyzes the answers in the questionnaire. The survey results show that most participants (more than 85%) believe that learning mathematics through online games is very interesting and can create a good atmosphere in the classroom. In addition, they also believe that learning mathematics through this method not only helps them remember mathematics skills more easily, but also improves students' interest and satisfaction in learning.

Conclusion

The research on using online gamification to teach mathematics and to enhance learning achievement and satisfaction of primary school students can be concluded as follows:

(1) Using online gamification learning activities to teach mathematics has a certain effect on improving students' learning interest. However, there are differences in the performance of boys and girls with a slightly higher attention among girls than boys. There are also examples in online game courseware that can make students associate with their own real life. The reward and incentive mechanism used in online gamification activities to teach mathematics . The competitive link of doing exercises on online game platform can also increase learners' enthusiasm in class and improve students' interest in learning.

(2) Using online gamification learning activities to teach mathematics provides ideas and methods for teachers to carry out online game teaching. In the process of online game teaching, the author analyzes the course content, teaching objectives and the characteristics of learners, analyzes the conditions and environment of online game teaching, determines the design of online game teaching, selects an online game platform that can provide timely feedback and increase interaction for the classroom, and provides a new teaching method for the majority of junior mathematics teachers in primary schools.

(3) Using online gamification learning activities to teach mathematics provides technical support for primary school mathematics teachers to carry out online game teaching. Most teacher experiences difficulties in carrying out online game teaching. Lack of sufficient resources and technology put limitation to the design of relevant scenes and contents. On the contrary, online game teaching allows for new designs that are relevant to the teaching objectives and contents. Thus, makes an online game courseware suitable for primary students in lower grades. It provides relevant technical support for online game teaching for primary school mathematics teachers.

Recommendations

Recommendations for implementing

(1) Enhance students' subject consciousness

The research shows that in the students' mathematics classroom experience, the experience related to teachers' teaching is better than that related to students' learning, especially the clear indicators and investment indicators of the dimension of teaching experience. However, the study found that students' learning effectiveness (especially academic achievement) is not highly correlated with the clarity and investment of teachers' explanation in teaching, but significantly correlated with the clarity and investment of students' understanding in learning. In the process of classroom teaching, teachers should enhance students' subject consciousness, give full play to students' enthusiasm, and guide students to actively participate in classroom discussion and solve problems independently. At the level of teachers' teaching, we should take understanding teaching as the goal. On the one hand, we should make our teaching clearer and more thorough. On the other hand, we should understand whether students really understand and whether the classroom experienced by teachers is consistent with the classroom experienced by students. Classroom teaching is not a teacher's self-entertainment, but the interactive generation between teachers and students.

(2) Stimulate students' interest in learning

The research shows that although the correlation between students' classroom experience and academic performance is lower than students' satisfaction, the interest index in classroom teaching experience is particularly prominent. The correlation between students' interest in mathematics and mathematics classroom and their academic performance is significantly higher than other indicators. In the teaching process, teachers should pay attention to the combination of teaching usefulness and interest, and explain useful knowledge in a way that students are interested in. Classroom teaching is not only the guidance of knowledge, but also the stimulation of interest. Teachers should combine subject knowledge with students' existing knowledge reserves, real-life experience and topics of interest, so as to make the originally boring and rigid classroom teaching change the vitality of life. If a student is not interested in a course, he may only learn passively in class, and will not spend more time on active learning after class, so the learning effect of students can be imagined.

(3) Cultivate students' creative thinking

The research shows that among students' classroom experience, students' creative experience is the most general, especially liberal arts students. For boys and science students, there is a strong correlation between creation indicators and academic performance. Therefore, in the process of mathematics classroom teaching, teachers should encourage students to solve problems with new methods and ideas, encourage exchanges, cooperation and exchange of ideas among students, lag the so-called "correct answers", learn first and then teach, determine teaching by learning, trigger students' positive thinking and ignite students' creative enthusiasm. The cultivation of this kind of creative thinking is not only for the long-term development of students, it is extremely important and valuable for the future development of society.

Recommendations for further study

1. The research process has to be included into proactive teaching and learning practices to ensure that students take part completely.

2. The learning skills that students will acquire after teaching instruction should be defined by using gamification so that activities can be designed according to learning objectives such as critical thinking skills. creative thinking skills.

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