LEARNING ACHIEVEMENT AND SATISFACTION USING GAMIFICATION IN PRIMARY SCHOOL ARITHMETIC

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ABSTRACT

The purposes of this study were 1) to develop gamification learning activities to enhance students' learning achievement 2) to compare students' achievement through gamification learning activities by pre-testing and post-testing, and 3) to study students' satisfaction with gamification learning activities. The subject of the study were thirty third-grade students of a public elementary school in Zhejiang Province, China. Research tools included online gamification learning activities, pre-test, post-test and questionnaires measuring students' satisfaction with online gamification teaching. Statistics for data analysis were percentage, arithmetic mean, standard deviation, and t-test dependent. The results were as follows: 1) Using gamification learning activities was conducive to enhancing students' achievement after teaching Basic Arithmetic Operations. And the average score of the three experts was 4.53, so the level of the lesson plan was the highest. 2) Students' achievement in the post-test was higher than in the pre-test. 3) Learning activities after gamification was beneficial to improve students' satisfaction with basic arithmetic teaching was rated high.

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CHAPTER 1

INTRODUCTION

1.1 Research background and problems

With the advent of the Internet age, significant changes have taken place in society, bringing specific changes to learning and life. In today's social life, our understanding has changed from knowledge education to the development of human nature, and learning is no longer confined to continuous practice. The learning content has jumped out of the teaching materials. According to the 13th five-year plan for national education, new educational regulations have been formulated to accelerate the modernization of primary education (Ren, 2016). The development of primary education must take classroom education as the starting point of educational reform. Pay attention to the construction of the learning atmosphere and let students change their learning habits imperceptibly. Pay attention to the cultivation of students' spiritual civilization and improve teaching facilities to create a healthy and harmonious campus culture for students. Pay attention to the construction of teachers' teams and professional quality to realize humanistic teaching. As a new group of young people, in the "Digital Age", learners have received all kinds of information from the Internet since birth. They are used to the feeling of shuttling between knowledge and news in the form of hypertext and links. In this environment, their access to information is more interactive and incoherent (Simmons, 2005). The game can provide this kind of nonlinear, jumping and real-time information, which belongs to the knowledge carrier that can control freely.

Elementary school arithmetic is a series of textbooks that teach children about numbers, four operations, calculation formulas of figures and lengths, and unit conversion, laying a good mathematical foundation for calculation in junior high school and daily life. Dutch educator fried enol believes that "arithmetic comes from reality, must also be rooted in reality and applied to reality." Indeed, modern arithmetic requires us to observe with mathematical vision and elaborate the world with mathematical language. From the perspective of pupils' arithmetic learning psychology, students' learning process is not a passive absorption process but a reconstruction process based on existing knowledge and experience. Therefore, it is will make children learn more actively for learning by doing and playing, and transforming abstract mathematical relations into familiar cases in students' life. From the perspective of our educational objectives, while imparting knowledge, we should pay more attention to cultivating students' comprehensive abilities such as observation, analysis and application. From the perspective of modern society, this view is still correct. In recent years, China has implemented the new curriculum reform education, advocated giving full play to students' ability and subjective initiative, and believed that learning is no longer the absorption of knowledge and culture but should transform knowledge into actual power so that students can flexibly

apply knowledge to life practice.

Children need game teaching because, in the past classroom learning, they often have the characteristics of high investment and low return, which runs counter to modern information education and quality education. A good education needs to help students have more personal abilities while teaching students knowledge. It needs to respect students' learning interests, meet students' personalized needs, and achieve a more efficient classroom. The game is the nature of children. In the game, primary school students can get more attention and inquiry ability, develop thinking and activate the brain. This topic base on online gamification in primary school arithmetic teaching. First of all, the game in primary education is a new knowledge carrier. Compared with traditional books, radio, television and multimedia, educational games can better convey the themes and contents that they cannot carry or have poor effects (Chen, 2007). Such as scientific experiments, mathematical competition and answers, medical simulation, etc. Using the concept of the game in education can make learning more enjoyable, make people feel happy, and be more willing to invest in learning. In the game scene, learners are no longer face the traditional Classroom, teaching aids and educational materials but integrate into the scene through their senses and reactions. For example, many novels, stories and movie plots can become educational games. For example, the English text "my fair lady" can enable students to recite the text better, learn more English grammar and knowledge points, and experience the ideology and culture described in the film. Learners can use the carrier of educational games to transform the boring knowledge into exciting activities to be more proactive and fun through the learning way. Secondly, the use of games in education is an effective means to stimulate learning interest and motivation. Tolstoy said, "what need for successful teaching is not coercion, but to stimulate students' interest in learning." In learning, interest is the catalyst to stimulate creative thinking and develop intelligence. It can effectively improve learning efficiency and strengthen the learning effect. It can see that students' interest in learning is of great significance to learning itself. To a certain extent, they can achieve true active learning, students start active learning because they become interested in learning. Therefore, in teaching, we can see that teachers are very willing to insert some small games in the teaching process to improve the classroom atmosphere and stimulate students' interest. Finally, the game in education is an exploratory creative process. In the game, there is uncertainty in everything. It has no specific goal and no chance to come back. Every choice made by players will have a various of effects on the outcome. It is precise because of this unknown and uncertainty that games become a process of stimulating imagination and creativity. Adding the concept of games to education is conducive to children's intellectual development, making their minds more flexible and generating more creative ideas and practices. With the addition of games, education can mobilize students' enthusiasm, participate in the learning process wholeheartedly, and promote the development of advanced thinking.

In today's society, online gamification learning has closely combined with education. Based on the needs of the era of "smart education" in the field of education,

the Ministry of education proposed to upgrade the existing education network and campus network in the national education development plan of the 12th Five Year Plan. It suggested that the new generation of education network is the basis of future education informatization, and the value of "smart education" lies in the informatization of educational resources (Yang, 2013). Online gamification learning is an educational activity that takes the Internet and learns through games. It mainly includes two categories: digital games and game activities. Teachers can use the Internet to transfer specific knowledge and information to learners employing games. The Internet is timely, which can ignore the limitations of teaching space and time. Using games as a way of communication between teachers and learners is more vivid, getting rid of the one-way preaching mode. Online game learning should pay attention to cultivating students' creativity with people-oriented, respect human nature, which is conducive to the development of students' multiple intellectual quality (Olsson, 2015).

Gamification in the context of learning can be referred to as gamified learning (Armstrong, 2017). In training and Learning, this means add elements of gaming into the instructional strategy with the goal of increasing engagement, motivation and participation. Thus, gamification is not a product in the way that a (serious) game is; gamification in the context of learning is a design process of adding game elements in order to change existing learning processes (Deterding, 2011). Gamification is not the same as gaming. Typically, games are made simply to add interest or fun. Gamification should make your solution more interesting, but it needs to also have a purpose that will enhance your instructional design and meet your goals. Since gamification is not usually used to replace teaching, but to improve teaching, effective teaching content is a prerequisite for the success of gamification (Landers, 2014). The goal of gamification is to directly affect learning achievements. On the other hand, according to the learning achievements obtained by gamification, it is assumed that these gamification activities adjust the relationship between teaching content and student satisfaction (Landers, 2014).

The combination of the Internet and educational games is a primary significant. We say that games and modern information society have similar attributes, such as fragmentation, discontinuity, strong interaction, etc. (Zhu, 2012). These characteristics make games combined with the Internet to interact and better serve education. Nowadays, information technology is an ability that most young people must master, which can be seen everywhere in life. However, the country trains comprehensive talents, which is a necessary condition to adapt to the development of the times. The core literacy of students' cultivating is not only the national requirement for education in the new era but also the urgent need to improve national quality and improve national competitiveness. Under the guidance of national policies, arithmetic also puts forward the core literacy system of cultivating students' thinking, improving students' logicality and cultivating students' active inquiry ability. To promote the cultivation of students' quality, we must reform the existing learning methods, take online educational games as learning tools, combined with the game classroom mode, improve the teaching effect and achieve the educational goal of

cultivating students' mathematical literacy. From the perspective of students' self-description, online game teaching is conducive to creating efficient interactive intelligent teaching and meeting students' personalized needs. In education, each student's personality has specific differences. In learning, we can find that each students have different learning habits and learning rhythm. Students' differences should be respected with people-oriented, and educators should formulate unique teaching plans from the students' perspective. The critical factors in online game teaching can improve learners' interest in learning. Pursuing goals can stimulate learning motivation and keep trying to achieve success; The primary feedback mechanism enables learners to immediately understand their learning results and make adjustments.

Arithmetic is the basis of primary school arithmetic learning and the necessary knowledge to cultivate students' logical thinking and mathematical thinking. It plays a specific role in business, daily life, science and technology. With the reform of exam-oriented education, learning ability and students' ability have gradually become the key objectives of education, making the arithmetic education in primary schools move towards a more humanized road. In this regard, many scholars have also studied the problem of arithmetic teaching. In the teaching of arithmetic in primary school, the operation ability is the content of the basic level of core quality. It is the critical point to help students solve more practical problems in the future, which is of great help to students' arithmetic learning (Lan, 2016). The strength of calculation ability will directly affect students' interest in arithmetic learning. If the essential arithmetic operation ability is poor, students are not interested in many mathematical problems (Liu, 2013). Many arithmetic exercises in the course are tedious and boring. Teachers ignore the correct oral arithmetic practice in teaching, which is difficult to arouse students' interest in learning (Shao, 2013). You Caiping believes that under the background of teaching reform, the transformation of teaching mode is significant, and the traditional model of teaching is no longer suitable for today's teaching (You, 2016). Under the influence of exam-oriented education, Students have been doing a lot of exercises as the primary way of knowledge, which makes many students tired of learning. In our actual teaching, we can also find that many primary school students hate the essential arithmetic operation in arithmetic, and they often make mistakes in their homework, which makes it more difficult to be interested in arithmetic. The arrangement of math exercises by teachers is unchanged. The accumulation of many rigorous practices can not play a good role in educating and guiding students. In the new educational environment, teachers are required to pay attention to not only computing skills but also students' practical ability in the basic arithmetic operation, innovating consciousness to stimulate students' subjective initiative (Wang, 2002). Arithmetic teaching should follow the pace of today's educational reform and shift the focus of learning from cultural knowledge to students' ability. It finds that students' arithmetic learning efficiency will be significantly enhanced if their interest in essential arithmetic operation can improve (Jiang, 2017). Primary school students are young and like games. The correct application of game teaching can promote the development of primary school students' arithmetic learning

ability (Du, 2010).

In recent years, with the development of network science and technology and social progress, online game learning has become a research hotspot in education. The combination of games and online education aligns students' psychological characteristics (Liu, 2016). After consulting academic papers on the Internet, the author found that the research on online game learning is increasing year by year, and the research content is more prosperous than before. The emergence of teaching based on the concept of online game learning in teaching research and practice provides a new teaching model and idea 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 people's knowledge-seeking field (Zhu, 2020) .An online game-based learning can create a virtual experience process, develop and improve educational informatization theory, integrate various educational applications and educational technologies, and simulate similar real understanding, working and living environment (Wang, 2017). This virtual experience doesn't limit by time and space and has particular convenience. ¶ Moreover, it can customize all-around and special personality requirements to make learning more humanized, make students more confident and courageous, and realize the flexible transition from learning to practice (Zhang, 2019). China's education industry is greatly changed because the introduction of online game learning and the combination of network convenience and game attraction , letting students' interest in learning further improve. This paper will take the essential arithmetic operation as the starting point, showing the role of online game learning in primary school arithmetic teaching through teaching experiments, and making a theoretical contribution to the research on online game learning in the future.

Therefore, this study aimed to promote the improvement of primary school arithmetic classroom learning efficiency, learning enthusiasm and learning effect. This study used the experimental method to complete the design and implementation of the classroom teaching. Among them, online game teaching in classroom adopted the combination of game and "basic arithmetic operation" courses. Take the multimedia network classroom as the teaching tool to display the game theme and game steps online so that students can learn basic arithmetic operation knowledge through mathematical games. Finally, the experimental results were summarized.

1.2 Research objectives

There were three main objectives of this study such as:

1) To develop gamification learning activities to enhance students' achievement.
2) To compare students' achievement through gamification learning activities by pre-test and post-test.
3) To study students' satisfaction in gamification learning activities.

1.3 Research questions

The main problems of this study were as follows:

RQ1: What are the main components of gamification learning activities?

RQ2: Is there any significant differences in pre-test and post-test after performing learning activities

using gamification is in basic arithmetic operations?

RQ3: What is the level of students' satisfaction from using gamification in learning activities?

1.4 Conceptual framework

Gamification learning activities are independent variables; students' achievement and satisfaction are dependent variables. The relationship between the three can be explained as, if gamification learning activities produce significant results or do not produce effectiveness, it may affect students' performance in the classroom and affect student satisfaction.

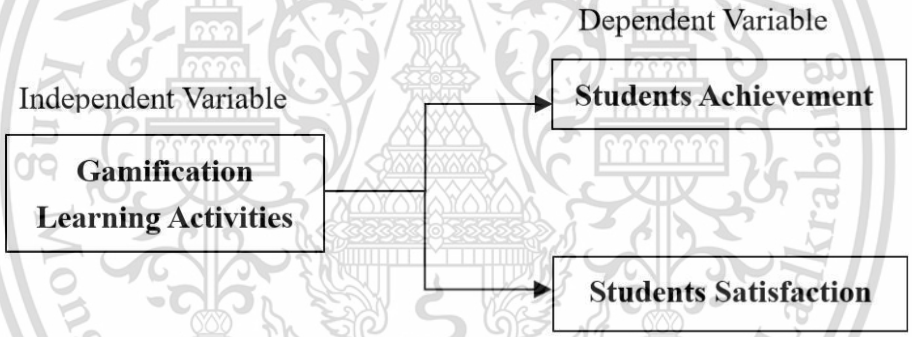

Figure 1.1 Conceptual framework

1.5 Scope of the study

The purpose of this study was to investigate the effectiveness of online gamification learning in basic arithmetic teaching of third-grade students in a public primary school in Zhejiang Province, and to investigate their satisfaction with basic arithmetic learning operations through this approach.

1.6 Definition of terms

Definition of terms of this study are as follow:

1. Basic arithmetic operations

The concept refers to operations performed following the arithmetic rules. Including addition, subtraction, multiplication, division and seeking the absolute

value, etc.

2. Online Gamification learning activities

Online Gamification learning is a game-based learning method, which mainly includes digital games and game activities. Generally, we think that the three essential elements of gamification are points, levels and leaderboards. These three factors can affect participants' satisfaction with needs and stimulate internal motivation. According to learners' inherent interest in games and curiosity about new interactive media, teachers use games as a platform for communication with learners to make the information transmission process more vivid.

3. Learning achievements

Learning achievements can divide into broad and narrow senses. In a broad sense, it refers to students' achievements in learning. In a narrow sense, it refers to the digital evaluation or achievement evaluation obtained by students under a specific learning evaluation model. In general, Among the evaluation criteria for learning achievement, the criteria for grades 1 and 2 are different from those for grades 3, 4 and 5 (Betke, 2017).

Grade 1-2: Grade A above 90; Grade B above 75; Grade C above 60; Grade D is below 60.

Grade 3-5: Grade A above 85; Grade B above 70; Grade C above 60; Grade D is below 60.

4. Student satisfaction

Student satisfaction is committed to making students satisfied. Taking student satisfaction as the quantitative evaluation standard, it is a number that can reflect a specific trend, and it can also express in the form of words.

The dimension of questionnaire survey is to put forward various questions from multiple perspectives and levels around the theme of gamification learning in the form of questionnaire survey, and explain the theme to be understood in the evaluation (Kim, 2015). In the study, the question attributes in the questionnaire were divided into three dimensions: emotion, attitude and behavior.

Likert scale is one of the most commonly used rating and summation scales. These items belonging to the same construct are scored by summation, and individual or individual items are meaningless. The scale is composed of a group of statements. Each statement has five answers: "Highly Satisfied", "Satisfied", "Undecided", "Unsatisfied", and "Highly Unsatisfied", which are respectively recorded as 5, 4, 3, 2, and 1. The total score of each respondent's attitude is the sum of his scores for answering each question. This total score can indicate his attitude or his different states on the scale (Joshi, 2015).

5 = Highly Satisfied

4 = Satisfied

3 = Undecided

2 = Unsatisfied

1 = Highly Unsatisfied

CHAPTER 2

LITERATURE REVIEW

This chapter reviewed the literature and research on online gamification learning activities to improve students' basic arithmetic operations. It divided into seven main areas: (1) Basic Arithmetic Operations; (2) Online Gamification Learning Activities; (3) Examples of Games Used for Teaching basic arithmetic operations in a Classroom; (4) Online Gamification Learning Software; (5) Student Achievements; (6) Student Satisfactions; (7) Relevant Research.

2.1 Basic arithmetic operations

2.1.1 The theory of basic arithmetic operations

(1) Basic Arithmetic Operations and Life Integration Theory

Basic arithmetic operations are the foundation for students to carry out advanced operations in arithmetic later on. Lo Wing Yee. (2020) points out that to make students understand the meaning of basic arithmetic operations more deeply, basic arithmetic operations can be combined with students' real life so that the boring learning of numbers can become learning that can solve problems in life. This mode can make the learning of numbers from abstract learning to a model that combines conceptual learning and symbolic learning. Constanta Olteanu. (2018) also points out that one of the functions of arithmetic learning is to serve life, in which arithmetic operations play a significant role. Connecting basic arithmetic operations to students' lives is consistent with the cognitive characteristics of elementary school students.

In the teaching process, combining cold arithmetic with concrete life situations can stimulate students' interest in learning and penetrate the idea that mathematical operations come from life. In addition, by creating life situations, fun math games and hands-on procedures for students to guide students in arithmetic, students can help them feel and understand knowledge more deeply in situations, games and other practices, and ultimately construct knowledge.

(2) The Theory of Arithmetic Operations Stages

Arithmetic operations perform in stages, consistent with Piaget's theory of individual cognition. In other words, arithmetic operations teach in conjunction with students' personal characteristics. There are four aspects of cognitive teaching theory: first, the goal of teaching for intellectual development; second, the principles of motivation, structure, procedure and reinforcement; third, the structure of subject knowledge; and fourth, the method of discovery teaching. The teaching process of the discovery pedagogy can broadly divide into five stages: first, creating a situation to raise questions; second, using materials to formulate hypotheses; third, testing hypotheses through practice; fourth, drawing conclusions based on results; and fifth, refining and sublimating reflective evaluation (Vila-Soto, 2017). This is especially true for students who are still learning basic arithmetic operations, who are much

younger and need more tangible things to support them when performing basic arithmetic operations. Purely digital learning of basic arithmetic operations does not apply to them.

(3) Piaget's Stage Theory of Cognitive Development

Due to different cognitive structures, Piaget believed that individual cognitive development can be divided into four stages: perceptual motor stage (0-2 years old), pre-operation stage (2-7 years old), concrete operation stage (7-11 years old) and formal operation stage (11-15 years old). Elementary school students happen to be in the third stage, the concrete operations stage. Children at this stage already have abstract concepts and multidirectional thinking in their cognitive structure, their thinking can reverse, and they are capable of logical reasoning. Still, they generally need the support of concrete things or images and cannot perform pure symbolic operations (Artemenko, 2017).

Therefore, when teaching arithmetic, it should conform to the law of students' cognitive development, from simple to complex; otherwise it will cause counterproductive effects: appropriate practice, giving full play to students' subjective initiative, combined with the teacher's practical and timely guidance, summarizing arithmetic problems: focus on the learning of arithmetic and algorithms, and pay attention to the learning process, not just the correctness of arithmetic.

2.1.2 Investigation and analysis of the present situation of basic arithmetic operations

Barner, (2016) conducted a questionnaire survey and interviews with upper-grade students and elementary school arithmetic teachers in an elementary school; from the results of the interviews, it is clear that different elementary school arithmetic teachers have different views on arithmetic ability and teachers' understanding of core words, core arithmetic literacy, and arithmetic ability should be strengthened, so that teachers can understand the current situation of students' arithmetic ability and be clear about the factors that affect the development of students' arithmetic ability. They should set an example and form a suitable model in teaching arithmetic skills to develop and improve students' arithmetic skills.

On the other hand, from the students' point of view, he pointed out that the senior students who took the test had some arithmetic ability, but their overall level still needed improvement. He analyzed the reasons for the arithmetic errors of the senior students who took the test: lack of interest in arithmetic; lack of understanding of arithmetic rules and algorithms; poor arithmetic habits; and weaknesses in other core skills.

Baroody, (2016), on the other hand, investigated a rural elementary school and found that the overall situation of students' arithmetic was poor. On the one hand, it is due to poor foundation, and students do not have good arithmetic habits. On the other hand, it is expected to vague concepts, confusion of laws, and unclear arithmetic. In addition, through the analysis of specific operations, it was found that students' ability to flexibly use formulas, laws and arithmetic reasoning was relatively low. He believed that teachers should strengthen the explanation, exploration, summary and training in this aspect in teaching. Chambris, (2018) summarized the typical errors of

basic arithmetic of students in the lower grades of elementary school, including the following four aspects.

1) Poor writing habits and blurred handwriting. The clarity of scripts not only affects teachers' judgment, but also affects students' ability to solve problems. For example, the numbers "6" and "0" are not determined, "1" and "7" are not different, and the difference between "5" and "8" is not clear, resulting in uncertain answers. In addition, the handwriting was light, resulting in unclear handwriting: multiple doodles on one question, overlapping one number over another, and so on, are common effects among students.

2) Poor answering habits, losing questions. Especially for younger students, they often take, do and hand in without knowing if they are right or wrong. Do arithmetic problems just to finish, do not know how to check, and not fit.

3) Poor habits of examining problems and rushing to answer them. The order of operations is the basis of calculation, with brackets to carry out the first calculation, without brackets first, then multiplication and division, then addition and subtraction. The order of work is the basis of analysis and instill in students from the first grade, but the test survey results show that errors still exist.

2.1.3 The Importance of basic arithmetic operations for arithmetic learning

(1) Laying the Foundation for Arithmetic Learning

In China, students require to have the ability to perform basic arithmetic operations with whole numbers, decimals, and fractions at the elementary level. The teaching requirements also emphasize that students should be able to complete the four calculations of integers, decimals and fractions correctly, to achieve a certain degree of proficiency in some of the basic calculations, and to gradually achieve a reasonable and flexible calculation method. Quantitatively, basic arithmetic operations occupy a more significant proportion of analyses in elementary school arithmetic textbooks (Coleman & Crayton., 2016). From addition and subtraction of integers within 20, multiplication by multiplication, and test quotients by mnemonics in the lower grades, to multiplication and division of two-digit integers in the middle grades, to addition, subtraction, multiplication, and division of fractions by four operations in the upper grades, pure computation is taught throughout elementary arithmetic textbooks. In addition, the three significant areas of space and graphics, statistics and probability, and synthesis and practice are all inseparable from basic arithmetic operations. Qualitatively, basic arithmetic operations also play an essential role in training students' meticulous thinking, rigorous satisfaction and quick response.In a word, basic arithmetic operation plays an important role in primary arithmetic teaching.

(2) Promoting Students' Transformation from Figurative to Logical Thinking

Wei, (2018). It points out that the developmental level of students' thinking at the elementary school level is in the period of symbolic thinking and the transformation of symbolic thinking to logical thinking. In general, students in the early elementary grades are predominantly figurative thinkers and then slowly shift to logical thinking, which is extensively developed in most students by the upper elementary grades. Basic mathematical operations can facilitate the transformation

from figurative to rational thinking. The development of basic arithmetic skills is a way to train students to think logically.

(3) Promote Students' Future Development.

Students learn the arithmetic of arithmetic, understand and apply the laws of arithmetic, algorithms to solve arithmetic problems can improve their mathematical arithmetic ability and logical thinking skills, and develop students system, flexible, agile, rigorous quality of mathematical thinking. Secondly, the development of mathematical arithmetic skills can promote the development of other core mathematical literacy, such as students' number awareness, symbol awareness, reasoning ability and modeling thought, which is conducive to the study and research of physics, chemistry, biology and geography (Nur, 2017). Finally, students' independent thinking, cooperative communication, and step-by-step solutions to real-life problems in arithmetic activities can exercise the will to overcome difficulties, enhance self-confidence, and allow students to appreciate the application value of arithmetic. Therefore, arithmetic ability is not only a kind of mathematical operation ability, but also a kind of mathematical thinking ability, which is also a necessary core accomplishment in the future.

2.1.4 Strategies for successful basic arithmetic operations teaching

Maf'Ulah, (2016) states that it is necessary to arouse their interest in order to improve students' basic arithmetic skills.You can choose the way of introduction to stimulate students' interest in learning, the overall students belong to the quiet type more to mobilize interest in learning by introducing games. At the same time, the class is active students create a proper context to introduce so that students experience the process of mental activity of discovering, proposing and solving problems in real life in the context, build mathematical thinking, stimulate interest in learning, and implement it practically with good results.

Baroody, (2016) argues that it is essential to shape students' good learning habits. He summarizes ten proven methods. ①Prepare pens, erasers, books and pack your things before and after class. ②Review the questions as a whole first and check if they are complete with the number of questions. Do the questions in order, without skipping or picking, without missing or repeating. ③Read the problem three times and circle the keywords and questions. ④Write the equation in the blank place aligned with the question number, and write the equation first and then the answer. ⑤When you encounter one you can't do, mark the blanks first and rationalize your time to finish the following questions. (6)Hold the pen correctly, correct writing posture, clear and neat handwriting, and standardize writing arithmetic. ⑦3 minutes before class, oral calculation practice, and table talk to each other about how the problem calculates. ⑧From time to time we will hold contests to replicate numbers and arithmetic in order to sharpen their attention. ⑨Speak aloud so that self-confidence is improved. ⑩Check after doing it if there is enough time the calculation problems can recalculate. Among them, ⑦⑧⑨habits that make their attention get a substantial improvement.

This subsection analyzed the basic theory about basic arithmetic operations, the current investigation of the current situation of basic arithmetic operations, and

pointed out the importance of basic arithmetic operations and the strategied for teaching the results of basic arithmetic operations.

2.2 Online gamification learning activities

2.2.1 The theory of online gamification learning activities

(1) Theories of Online Gamification

Although the game has a long history, the study of online gamification theory has only just begun, which is because the Internet has only continued to drive the development and growth of online games in recent years. Online gamification learning refers to using online educational games as a teaching tool in the instructional design process to increase students' motivation to learn. The theory of online gamification learning is now widely recognized and supported by the community. Poondej, (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. Su, (2016) argues that online gamification learning is the process of instructional design that integrates the concepts and mechanisms of games into the related subjects, turning the tedious learning process into lively and exciting gamification learning. He also points out that online gamification learning activities do not necessarily have to be done only in the classroom. Still, He can also be done in various places such as at home. S Špehar. (2018) argues that the purpose of online gamification learning is to make use of the entertainment of games, according to the characteristics of learners and the cognitive level of learning, combined with online gamification teaching so that students can learn and acquire knowledge in a relaxed state. I believe that online gamification learning makes excellent use of the Internet platform. The rich game activities within the network can be designed as corresponding games for learning (meaning that specific teaching contents and game features combine according to learners' characteristics) so that learners can learn as much subject knowledge as possible in an enjoyable game process and increase their motivation for learning.

In the primary education reform environment, arithmetic education in the lower elementary grades should focus not only on promoting elementary students' cognition but also on students' emotional satisfaction and values. Arithmetic lessons concentrate on thinking, concentrate on problem-solving, and constantly encourage students' inquiry and experimentation to guide them to think, identify issues and investigate them deeply, and eventually develop the learning habit of using their brains and thinking hard (Zamzami, 2018). Online Gamification in arithmetic teaching mode mainly combines the fun of games to arouse students' interest in learning basic arithmetic operations, motivates students to explore activities in the process of playing games and solving problems, enables students to enjoy the fun of arithmetic learning, develops their potential, and achieves the teaching goals of subject knowledge, emotional experience and skill development in parallel.

(2) Multiple Intelligences Theory

Gardner is a famous scholar who studied human intelligence in the psychological sphere and therefore came up with the theory of multiple intelligences. In Gardner's view, there are seven types of human intelligence, including linguistic intelligence, mathematical-logical intelligence, musical intelligence, bodily-kinesthetic intelligence, spatial intelligence, interpersonal intelligence, and self-awareness intelligence (Goksun, 2019).

Linguistic intelligence is the ability to read, communicate, and speak.

Logical-mathematical intelligence is the ability of exponential operation and logical thinking, and also includes the ability of scientific analysis.

Visuospatial intelligence refers to the ability to discriminate and identify the environment, direction, etc.

Musical intelligence involves listening to music and feeling the rhythm of music.

Motor intelligence refers to the use of body movement under the control of the brain to achieve desired goals.

Interpersonal intelligence includes the ability to interact and get along well with others.

Self-awareness includes the ability to know yourself and make lifestyle choices.

Natural cognition involves the ability to recognize the natural world and categorize the various things in it.

Multiple intelligences define as the tendency to describe and think about issues such as life and death, body and spirit. The theoretical premise of play education is the theory of multiple intelligences. This theory assumes that the nine human bits of intelligence are different and relatively independent. Foreign elementary school students have different ways of combining their intelligence, and each elementary school student has their strengths and learning styles, all with unique intelligence (Amin, 2017). Therefore, teachers and parents should be aware of the diversity of children's intelligence and actively promote the development of multiple intelligences together through diverse teaching approaches, understanding the strengths of each child's story and enabling the amplification of these shining points. In addition, educators must recognize students in a holistic and similar manner, understand their individuality and differences, and not demand equal development from every elementary school student across the board.

Different instructional games can impact various aspects of students' intelligence, developing other intelligence in addition to the skills they exhibit. For example, in online mathematical reasoning and arithmetic games, students' logical thinking and math skills are fully developed, as are their intangible language skills and understanding of nature. In the online Basic Arithmetic "Breakthrough" game, students learn not only arithmetic, but also how to work with others through collaboration with in-game characters or PKI.

However, most school education has always focused on developing children's linguistic and logical-mathematical intelligence while neglecting the development and training of children's other intelligences (Hasan, 2019). Therefore,

with multiple intelligence theory, teachers need to fully respect the intellectual characteristics of each elementary school student and use diverse educational approaches and educational models to ensure the maximum and best development of each elementary school student. The design of online games should not only be combined with basic arithmetic knowledge, but also with students' thinking, cognition and interpersonal communication, so as to promote students' all-round development. Based on traditional educational methods, online game learning activities add entertainment and fun, creatively improve students' hands-on skills and imagination, and drive interpersonal skills, language skills, sense of unity and collaboration, and artistic and creative thinking. Online game teaching can give play to the diversity of students' intelligence structure and ensure the all-round development of pupils with foreign intelligence.

2.2.2 The necessity/benefits of gamification learning activities

Lerdpornkulrat, (2016) points out the relevance of using online gamification in primary school arithmetic, which maximizes students' subjectivity, stimulates their thinking and exploration, stimulates their learning potential and arouses their initiative.

Gursoy, (2019) argues that the adoption of online gamification teaching mode not only respects students' personality characteristics and learning psychology but also ensures that arithmetic 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 arithmetic teaching and learning.

Online gamification learning activities can not only make students have a deeper understanding of the learning content, but also reduce the burden of teachers and significantly improve the quality of teaching. (Abdul, 2017).

As an activity that exercises both hands-on and practical skills, adding learning content to online games in which students think and explore arithmetic can enhance their thinking skills and gradually develop a logical mindset of independent thinking in learning. Games have various outcomes, and arithmetic 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 (Vanduhe, 2019).

2.2.3 The roles of gamification learning activities in basic arithmetic operations teaching

Kiraly, (2020) argues that online gamification learning activities can increase students' learning of basic arithmetic. Basic arithmetic in elementary school arithmetic is the primary content that needs to learn in elementary school arithmetic, which is the "first step" for everyone to learn arithmetic and the foundation for learning more complex arithmetic in the future. Basic arithmetic plays a vital role in the whole process of learning elementary school arithmetic. It is worthwhile to design and integrate this component into online games. Ultimately, a well-designed

integration into elementary school arithmetic can be beneficial in increasing students' motivation to learn basic arithmetic.

Nair. and Mathew. (2021) identified low motivation, weak self-control, and short attention span as characteristics of elementary school students. At the same time, they are more interested in new things, quick to accept new things, and playful and active than other age groups, and online gamification learning software is born in this environment. Through the game's charm to stimulate students' interest in learning textbook knowledge, so that they are obsessed with the spirit of the game to learn, no longer to memorize formulas, do the questions, but to become "play to learn", which is an excellent way to improve their understanding of basic arithmetic operations.

2.2.4 Gamification design steps

Henry Setiana and Seng Hansun (2017) pointed out the way application needs logic; games are also internal logic in mind. In case games do warning; it fails to engage the user for a long.

He sees Gamification as a process designed to transform a non-game environment (e.g., learning, teaching, marketing) by integrating game thinking, game design, and game mechanics (game elements) to make it more interesting. Gamification is very effective in creating a usually tedious, unpleasant or less challenging task and making it more interesting. One way this can do is to provide a virtual and non-virtual appreciation that can encourage someone to do "better" than others. Gamification implements the psychological dynamics and mechanisms that make games challenging and addictive. It is a technique that provides information to the system and facilitates stimulating this type of sharing. Figure 2 depicts the elements of Gamification.

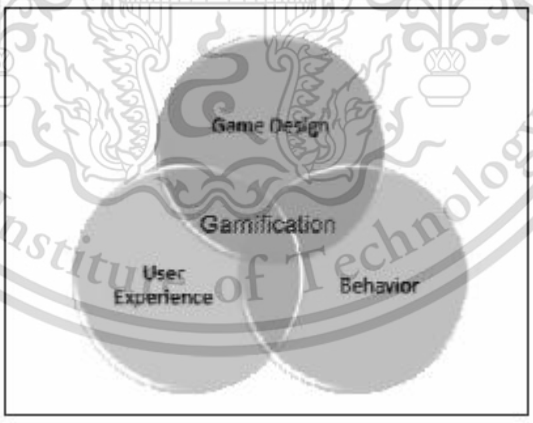

Figure 2.1 Gamification concept

Scholz, (2021) designed the gamification learning activity six-step process. The design framework begins with a core question identified by the instructor and is relevant to the course, which intends to create a meaningful connection between the learner and the content. It also reflects a task-based approach to learning, which begins with a task and allows the learner to decide how to complete it. Expected learning outcomes are necessary for both teachers and learners. The accompanying narrative that links the core questions to the learning outcomes is the critical third step.

The narrative can see as “the fundamental relationship between the skills learned and the fantasy situation (engaging and educational)”. These first three steps occur before the course begins, and the remaining three steps guide the rest of the gamification learning experience. As is shown in Figure 3.

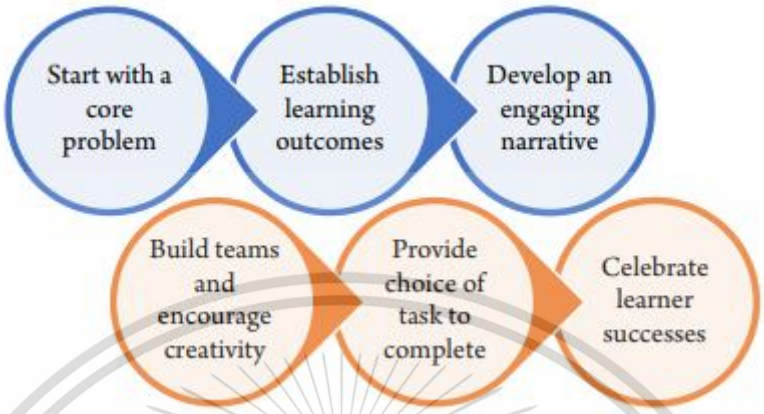

Figure 2.2 Gamification learning course design framework

This part introduces the theory of online gamification learning activities, including online gamification theory and multiple intelligence theory; Secondly, it introduces the benefits of online gamification learning activities, and thinks that online gamification learning activities can help improve students’ motivation to learn arithmetic and spread their ideas. Finally, it points out the function and design steps of online gamification learning activities in basic arithmetic teaching.

2.2.5 Differences between online and traditional gamification

Before the emergence of online gamification teaching activities, teachers let students get a game experience through various classroom activities. Entertainment is the nature of students. The practice of adding games in the Classroom is just suitable for teaching, and game learning comes into being. The traditional game teaching, it includes group competition, team display, knowledge competition, debate competition and so on(Niu&Ren, 2006). In learning, students can constantly improve their knowledge structure, adjust their way of thinking and study creatively. With the emergence of online education, Gamification teaching has more possibilities. Students can realize real-time interaction through the screen. Various educational goals can be completed through breakthroughs and challenges on the screen stimulating students’ interest in learning through virtual badges, points, grades, etc. Although both modes belong to gamification teaching, there are still some differences, as shown in Table 2.1.

Table 2.1 The differences of traditional gamification and online gamification

	Traditional gamification	Online gamification
Educational form	Face to face	internet
Game type	Fixed	Abundant
Participation Requirements	Multi-participant	Single person can participate
Gamification locations	Classroom	Anywhere

2.2.6 Online gamification limitations

Third graders have little Initiative due to their young age, poor self-control, and lack of learning goals. Lower-grade students have not yet formed a clear perception of the purpose and meaning of learning, and the teaching experiment has limited significance.

The quality of students' online gamification learning assignments is difficult to guarantee, which will reduce the validity of teaching feedback.

2.3 Examples of games used for teaching basic arithmetic operations in a classroom

2.3.1 Matchup

Matching games refer to number matching activities in basic mathematical operations. For example, in addition, the number "10" is given as a known option and students are asked to add two, three, or four digits to the addition formula so that the result of adding the four numbers is "10". In this way, the answers to the game are varied and can stimulate students' thinking. Of course, this is not limited to addition, subtraction, multiplication and division. Simple numbers can be displayed to students by comparing fingers, complex numbers can draw, or several students can cooperate by physically posing them, etc. so that students can think through the form of the game. And in the process of thinking, they exercise their basic arithmetic skills (Garcia-Cabot, 2020).

2.3.2 Match pendulum numbers

There are several levels of the Tinder Pendulum Number Game. In the elementary stage of the match-placement number game, 0-9 can form all the numbers, and as long as students are clear about how these ten numbers can pose with matchsticks, they will naturally be able to pose other numbers as well. The intermediate stage means that students make the numbers change by moving matches. For example, if you roll one game, what is the most significant number that 68 can become? The number in the tens place represents tens, so it must be the six in the tens place. If you drive a game from the tens place, the six can only become an 8. But if you move a match from the 6 itself, you can turn the six into a 9, so the most significant number is 98. The advanced stage refers to forming a specific number by placing matches and ensuring that the equation holds, which improves students' hands-on skills, thinking skills, and basic arithmetic operations.

2.3.3 Multiplication games

Multiplication games used to practice basic multiplication operations, such as

the “7 times 7” game. Students form a circle and report the numbers in turn (starting with 1). Whenever the number contains seven or a multiple of 7, they do not report the number but call “over” or use other actions instead. If a foul is to be “punished,” for example, 14 is a multiple of 7, and 70-79 contains 7, do not report the number, which students are required to think and react quickly in their heads and perform multiplication in a tense and interesting atmosphere.

To sum up, the theory and role of the article gamification teaching activities introduced, and several types of number operations game activities presented.

2.4 Online gamification learning software

2.4.1 Kahoot

Kahoot is a game-based interactive platform that creates a fun learning space for students and allows them to participate in class through a game quiz! It was developed by a Norwegian online education company and opened to the public for free in late 2013, and is now available in more than 180 countries around the world. (Martín, 2021).

Kahoot provides three forms of interaction, namely test, discussion and survey, to support different activities in the classroom and the process of using Kahoot in the Classroom can divide into three main parts, including preparation, interaction and statistics, where “preparation” and “interaction” are operated by the teacher, Only the “Interaction” part needs to be performed by students (Donkin& Rasmussen, 2021).

I will design a teaching game based on the platform, create the game, set the background music, question order, etc, for the “game”, and then share the PIN code to the students, and the learning can enter to play the “game”. “The game will share with the students, and the teaching can access to play the game. Multi-screen interaction on mobile is one of the main features of Kahoot (Melor Md.& Mohd, 2019). Students can easily create a gamified classroom through the form of gamified question and answer. Teachers can also collect students’ answer data to understand students’ learning; in addition to teachers, students can also use Kahoot to create their questions, which is very convenient for self-assessment and mutual assessment. Teachers can also use Kahoot’s questionnaire and discussion functions to ask students to input their ideas (Debbit, 2019).

2.4.2 Quizizz

Quizizz is an online learning software comparable to Kahoot, also a game that makes learning more interesting for students (Lim, 2021). Quizizz has the following advantages: 1) Fast connection: the website (http://quizizz.com) can be launched fast even in foreign countries. 2) Easy to use: students do not need to register, nor do they need to download an app (Razali, 2020). The website can open on the PC or cell phone, and the game (session code) can enter to participate in the interaction. This website can share with other people through the webpage, email, etc. It can also link to Twitter, Facebook, Pinterest and other websites. Teachers can also share it with students as a slide or print it out and use it as a worksheet. 3) Strong

practicality of teaching: quizzes, knowledge extensions, and learning reports can be displayed through the system. 4) Good entertainment effect: dozens of students answer the questions together, with the stopwatch counting down and the real-time ranking of students on the other side, which makes answering questions more tense and exciting and motivates students to think actively. It makes the questions more exciting and motivates students to think actively.

Quizizz lists two different modes of application (Yudi, 2019).

One is real-time formative assessment in the Classroom. Teachers can use class time to engage the entire class in real-time. Students simply type in the URL join.quizizz.com and password to take the quiz. (the usage is similar to Kahoot).

Another type of quiz is assigned to students by the teacher as an out-of-class assignment. The teacher gives the examination to the students , sets a time to complete the project, and then the students type in the URL (join.quizizz.com) and password to take the quiz.

In either case, the teacher will see the students' answers through the [report] button.

2.4.3 Comparison of Quizizz and Kahoot

As far as page setup is concerned, Kahoot is better.

In terms of operational use, Quizizz is more accessible and more practical to operate. It adds real-time previews, so teachers can preview the screen effects and make instant questions. The content and answer options have fewer character restrictions and can even be beyond reading comprehension. Especially the copy and paste function allows teachers to save a lot of time by not having to type in the question requirements repeatedly. And the words that the teacher wants to emphasize can be marked with different colors to make them more eye-catching (Yudi, 2020).

Quizizz is more versatile, as it can use for classroom activities, online assignments, printable worksheets, and other functions that students can complete independently. However, it doesn't have the competitive feel that Kahoot brings.

For both Kahoot and Quizizz, only multiple-choice questions are available in the quiz section, and there is a lack of open-ended questions. Quizizz still requires manual review by the teacher for open-ended questions.

This subsection focused on two systems that allowed for online gamified learning activities - Kahoot and Quizizz - also called software and were a tool for teachers to conduct online gamification instruction.

2.5 Student achievements

2.5.1 How to define, design and measure the test

When Karlimah. (2015) administered an arithmetic 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 arithmetic questions and three-word questions. The experimental materials show below.

(1) Pre-test material: There were seven questions, the first four questions

were addition, subtraction, multiplication and division questions, and the last three questions were “no brackets”, four diverse operations questions. Students who got the four addition, subtraction, multiplication and division problems correct but could not calculate the three “no brackets” mixed operations problems correctly selected as the official subjects.

(2) Sample learning materials: the sample included three “no brackets” four mixed operations rule samples. One is a single-content sample, i.e., “no brackets” ,four diverse operations sample; the other is a double-content sample, i.e., “no brackets”, four diverse operations application problems.

(3) The test material consisted of three “no-bracket” diverse operations questions and three “no-bracket” diverse operations application questions. Each correct answer scored as 1 point and each wrong answer was scored as 0 points, out of 6 points.

Finally, analysis of the mean score and standard deviation of the tests.

Darnon (2021) randomly selected 206 students from an elementary school to conduct the questionnaire survey. The whole performance pre-test and post-test were questionnaires. First, the study of students’ homework collected by teachers showed that the students’ calculation errors revised. The errors were classified as “revised immediately”, “revised after reminded by teachers”, “not revised even after reminded by teachers” The number of students in each category counted, and the percentage calculated. Then, we surveyed the students’ basic arithmetic operation error sets and calculated the ratios. After a series of instructional guidance to students, then post-test, the post-test is taken in the same way, by comparing the before and after size of the percentage of incorrect revision situation and the rate of wrong set situation, as a way to analyze whether the performance has improved.

The tests in this article refer to the tasks (homework, papers, oral calculations etc.) that teachers assign to students about basic arithmetic operations.

So how can teachers design tests?

First, teachers need to design the difficulty of the test about what students are learning. According to the characteristics of different students, the test questions should be of three levels of difficulty: easy, moderate and difficult.

Second, the range of the test should be within the capacity of the content students are learning. In general, it is not advisable to exceed the scope of students’ learning. However, if teachers feel that most students can keep up and master the test well during the teaching process, they can extend the test content appropriately.

Third, tests should be interesting. Teachers should design tests based on the individual developmental characteristics of elementary school students. Elementary school students are usually curious about new things, so teachers should be creative in their test design.

Fourth, test types should vary. Regarding the type of test of basic arithmetic oral calculation, teachers can choose the path of cooperative test among students, competition test, individual test, etc., or they can choose the way of handwriting and oral expression output. Teachers should use various test types to stimulate students’ interest and motivation.

Once the teacher assigns a test and the student completes the task, some evaluation of the student's test achievements will be required. What are the evaluation criteria? Evaluation criteria also vary.

First, the teacher can design a score for each question and finally count the students' total score through their answers, which is a more intuitive measure.

Second, teachers can ask students to show their parents what they have learned and complete online learning game activities at home. The feedback from students' parents used to understand how well students are doing on the test.

Finally, the teacher observed student behavior and speed of completing tasks to provide a comprehensive measure of student performance.

2.5.2 Factors affecting student achievements

The level of IQ directly affects students' comprehension, thinking ability, memory, reaction speed, receptiveness and so on, which involves students' learning speed. The same learning content can be learned quickly and well by those students with higher IQ, but students with average intelligence need to put in some effort to master it, which gradually widens the gap between student' levels (Geer, 2018).

Of course, in addition to intrinsic factors, acquired learning training can also improve children's intelligence to a certain extent, such as training in memory methods, thinking methods, and so on.

A suitable method can make things twice as good (Elentari, 2017). The same is true for learning; the right approach to education can improve learning efficiency. With equal IQ, those students who have mastered a suitable learning method always perform better.

Smedt, (2016) argues that various aspects of family, teachers, and society impact on students' perceptions, which in turn affects their academic performance.

This subsection focused on the support for student achievement based on achievement motivation theory and the factors that influence student achievements, such as IQ, training, and methods.

2.6 Student satisfactions

2.6.1 Theoretical support of student satisfactions

Modern society is developing rapidly, market competition is intensifying, and the demands of the times are getting higher and higher. People are feeling more and more pressure to live and survive. How to cope with these pressures and maintain the emotional health of individuals to face the challenges of life better is a significant issue in the path of modern people's life. The fast-paced, high-stress life has also spread to students, with increasingly serious problems such as passive learning, paranoid thinking and psychological distortion. Many students are afraid of knowledge, opposed to learning, truant, and some even panic when they see a book, shiver when they pick up a pen, and have associated learning with pain. They do not feel the joy of life, they do not understand the meaning of life, and they lose their enthusiasm and creativity in learning.

Based on the theory of pleasure teaching, this paper argues that the current

teaching activities should continuously improve students' satisfaction and transform their aversion to learning.

2.6.2 Measurement of satisfactions

The degree of satisfaction was 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 basic arithmetic operation. Various performances of students are observed and recorded. This subsection focuses on the supporting factors of students' satisfaction and how to measure students' satisfaction.

2.7 Relevant research

2.7.1 Relevant research in other countries

Tejada-Castro, (2018) proposed the Game Object Model "GOM", which provides a theoretical development framework for educational theory, game design, and game development technology, which is an experiential game model that highlights the importance of feedback in games and involves how to develop game objectives and game task difficulty settings, these game models are constructed in an attempt to integrate education and games effectively.

Liu, (2019) proposed based on game design theory, immersion theory, and experiential learning theory, an experiential game model that combines educational theory with fun design and emphasizes the importance of gamification elements, such as providing immediate feedback, clear goals, and challenges appropriate to the player's abilities.

Kim, (2020) explored the design of educational game software for elementary school classrooms under the guidance of Malone's intrinsic motivation theory and proposed that when designing educational games for elementary school classrooms, the entire process of game design should divide into five parts: game goal design, contextual design, rule design, feedback design, and learner control design based on the elements of intrinsic motivation theory, and the details of intrinsic motivation should be. Finally the authors used the first-grade arithmetic study subjects "Dollars, Corners, and Cents" as a case study to design and produce a game for classroom use.

Bullon, (2018) used students from four teacher training schools as the study subjects and tested their responses to questions before and after the course using the same questionnaire. In addition, teachers need to have a clear understanding of the significance of numbers and operations for the formation of students' arithmetic skills to connect mathematical concepts with arithmetic skills through practice effectively

Rozek, (2020) studied the mathematical arithmetic skills of students in the early elementary grades and found that the learning of critical steps in arithmetic learning has a significant impact on sample learning.

An experimental study by Brown, (2021) found that 7-8-year-old children are in a transition period from intuitive actions to intrinsic figurative counting and

abstract reasoning when performing mathematical operations.

Gursoy, (2019), using a standard spatial model approach, found that fourth and fifth graders in elementary school had a better grasp of elementary operations and a weaker grasp of advanced functions.

Lin, (2019) found through experiments that computer-assisted instruction (CAI) was helpful in improving multiplication operations for second-grade elementary school students.

This subsection focuses on the literature studies related to gamification learning activities, basic mathematical operations on a cloud platform in China and abroad.

2.7.2 Relevant research in China

Xu Kun. (2020) summarized the shortcomings in the current educational game design by analyzing and researching the current situation of educational games at home and abroad and discussed the methods and processes of educational game design by combining the understanding of educational theories. Through the analysis and research on the development trend of educational games and game development technology in the current environment, an educational game designed and developed based on HTML5 technology to meet the physical and mental development characteristics and learning needs of specific learners according to the critical knowledge content required by the curriculum and textbooks.

Mou Qianwen. (2020). Based on the concept of “light game”, we proposed the design of the “Number Operations” classroom educational game based on KaoKao MOBI and designed and produced the “Number Operations” classroom educational game using KaoKao MOBI platform and YouYa.com. “The game apply to classroom teaching practice, and the results test through performance tests and questionnaires.

Chen, (2020), through the creation of problem situations, pointed out that educational games can effectively guide learners to actively construct a knowledge system. The “addition and subtraction” educational game is based on flash technology . It is designed for second-grade students to practice simple addition and subtraction operations, which can fully stimulate learners’ interest in learning and motivate them to learn.

Ma Jing. (2020) proposed a gamification teaching model based on the Matific platform. It points out that educational games can help students combine book knowledge and practical application, and the presentation is vivid, engaging, rich and varied. The operation is also simple, which makes it easier for learners to engage in learning.

CHAPTER 3

RESEARCH METHODOLOGY

This section focused on the study design, participants, research instruments, research procedures, and data collection and analysis.

3.1 Study design

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' basic arithmetic operations (addition, subtraction, multiplication, division, and absolute value) in a public elementary school in Zhejiang, China, before the start of the experiment, in order to have a general understanding and measure of the students' basic arithmetic operations skills, as a basis for the subsequent experiment, and to compare with the post-test to understand the effectiveness of the online gamification learning activities.

The post-test waswas identical to the pre-test in that the same types of questions are used to better compare students' levels before and after the test. However, in order to better show the effect of the experiment, the post-test included additional basic arithmetic operations questions of higher difficulty on top of the basic difficulty of the pre-test questions. Although the article only needs to compare the correct rates of the same types of basic arithmetic questions in the pre-test and post-test, the experimental data obtained from the more difficult basic arithmetic questions can further demonstrate the effectiveness of online gamification learning activities in improving elementary school students' basic arithmetic skills.

The pre-test and post-test are the most important methods of this experiment, and the comparison between them directly reflects the results of the experiment.

Between the pre-test and post-test, the lesson plan was used to conduct a teaching experiment for students.

In addition, the questionnaire was used to understand students' satisfaction with the development of online gamification learning activities (Berkling, 2019). Student satisfaction was committed to student satisfaction. Student satisfaction was used as a quantitative evaluation criterion, which was a number that could reflect specific trends and could also be expressed in textual form.

3.2 Participants

The target population was 180 students (6 classes, including 88 girls and 92 boys) in the third-grade students of a public elementary school in Zhejiang Province, China. The researchers first checked the latest math achievements of third graders in this school, and all classes have students with achievements from high to low. Then 30 students are randomly selected from one of the 6 classes, including 14 girls and 16

boys. These 30 students served as the participants in this study by using cluster sampling technique and implemented online gamification learning activities of all basic arithmetic operations for them. The experiment was conducted with the consent of the 30 students and their parents.

3.3 Research instruments

Part A: Pre-experiment

3.3.1 Develop the online gamification Learning Activities plan

Between the pre-test and post-test, the lesson plan was used to conduct a teaching experiment for students. The teaching experiment mainly used the six-step course learning mode of Scholz and Kyle (2021). In the first week, teachers used the lesson plan to help students with core problems and determine the expected results of learning. In the second week, first practiced the online gamification teaching activities according to the problems and objectives, then encouraged students to participate in the activities, then improved the basic arithmetic operation ability through the gamification learning activities, finally celebrated students' success and summarize the experience of online gamification learning activities. The third week and the fourth week continued the teaching activities as the next cycle.

3.3.2 Validated the content in Online Gamification Learning Plan by experts.

The researcher created the lesson plan based on applying online games to teaching Basic Arithmetic Operations. This lesson plan was designed for four weeks and approved by the researcher's advisor and three experts in the field.

The researcher ran the class based on the lesson plan. The students were taught Basic Arithmetic Operations through gamification learning activities for four weeks. After that, they were assigned to complete both posttest and questionnaire.

The test time was approximately thirty minutes.

3.3.3 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 were 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.

Part B: Experiment

1. Pretest and posttest

The pretest iwas the same as the post-test, mainly for testing Basic Arithmetic Operations skills.

The steps of the pretest and post-test of Basic Arithmetic Operations skills were as follows.

Step 1: The researcher selected the test type. Multiple choice tests were selected for this study.

Step 2: The researcher learned the theory of mathematical operation in primary school and asked questions in the test. In pretest, there were three addition, subtraction, multiplication and division problems, a total of 12, 5 points for one question, a total of 60 points, plus 8 mixed operation problems (5 points for one question), a total of 100 points. In posttest, there were three addition, subtraction, multiplication and division problems, a total of 12, 5 points for one question, a total of 60 points, plus 8 mixed operation problems (5 points for one question), a total of 100 points (Davis, 2019).

Step 3: Both the pre-test and post-test were conducted among 30 third graders. These students belong to the third graders of Zhejiang public primary schools, and then compared the pre and post-Basic Arithmetic Operations achievements of these 30 students.

Step 4: Pre test and post test the participants to explore their basic arithmetic operations knowledge before and after basic arithmetic operations learning through gamification learning activities.

2. Questionnaire

The questionnaire was used to ask about the students' satisfactions towards learning basic arithmetic operations through gamification learning. The researcher did the following steps (Nesset, 2014).

Step 1: The researcher created the questionnaire using both close-ended and open-ended questions. The purpose was to investigate the students' satisfactions towards learning basic arithmetic operations through gamification learning in terms of advantages, disadvantages and other suggestions. The questionnaire consisted of three parts as following (Yannakakis, 2018).

Part 1: This part was used to investigate the students' background information such as gender, age, faculties where the students are studying, and so on.

Part 2: The students' satisfactions towarded learning basic arithmetic operations through gamification learning.

This part was a close-ended questionnaire which was based on Likert-type scales. The participants were asked to rate their degree of agreement on each statement - from number 1-5. The interpretation of each number is described as follows:

5 = Highly Satisfied

4 = Satisfied

3 = Undecided

2 = Unsatisfied

1 = Highly Unsatisfied

Part 3: This part was an open-ended questionnaire. The participants were

asked to express their satisfactions and suggestions towards learning basic arithmetic operations through gamification learning in terms of advantages, disadvantages and other suggestions.

Step 2: The questionnaire was composed of 30 third grade students who were registered in Zhejiang public primary school, but not the sample of this study. After the trial of the questionnaire, Cronbach was applied α The reliability index of the result is calculated by the coefficient formula.

Step 3: The questionnaire was used with the participants in order to explore their satisfactions towards learning basic arithmetic operations through gamification learning (Combefis, 2016).

In the overall lesson plan, the pre-test was used in the first week of the lesson, followed by a series of online gamification learning activities, and the post-test and questionnaire were used later in the online gamification learning activities, at the end of the lesson plan. The pre-test and post-test were written by myself and my school teacher, and the experts who certified its reasonableness were Li Chen and Shan Yanhong.

3.4 Procedure

Step 1: The researcher studied theories of Elementary school arithmetic and online gamification in order to develop the questions in the pretest, post-test and questionnaire.

Step 2: The pretest, post-test and questionnaire were reviewed by the researcher's advisor and another three experts in the field.

Step 3: A pre-test, post-test and questionnaire survey were conducted among the third-grade students in public elementary school in Zhejiang Province. The researchers chose two kinds of research materials, one is the third-grade arithmetic textbook, the other is the online game software. The software includes Kahoot and Quizizz.

Step 4: A group of 30 third grade pupils were arranged to complete the pre-test. These students are studying the third grade course in Zhejiang public schools. The test time is about one hour.

Step 5: The researchers applied the game to the basic operation of arithmetic, designed four kinds of online arithmetic games and formulated teaching plans. The course plan is designed for four weeks to ensure a game based teaching course once a week, which is approved by the consultant of the researcher and three experts in the field.

Step 6: The researcher ran the class based on the lesson plan. The students were taught basic arithmetic operations through gamification learning for four weeks. After that, they were assigned to complete both the post test and questionnaire. The test time was approximately one hour.

The following is the procedure diagram:

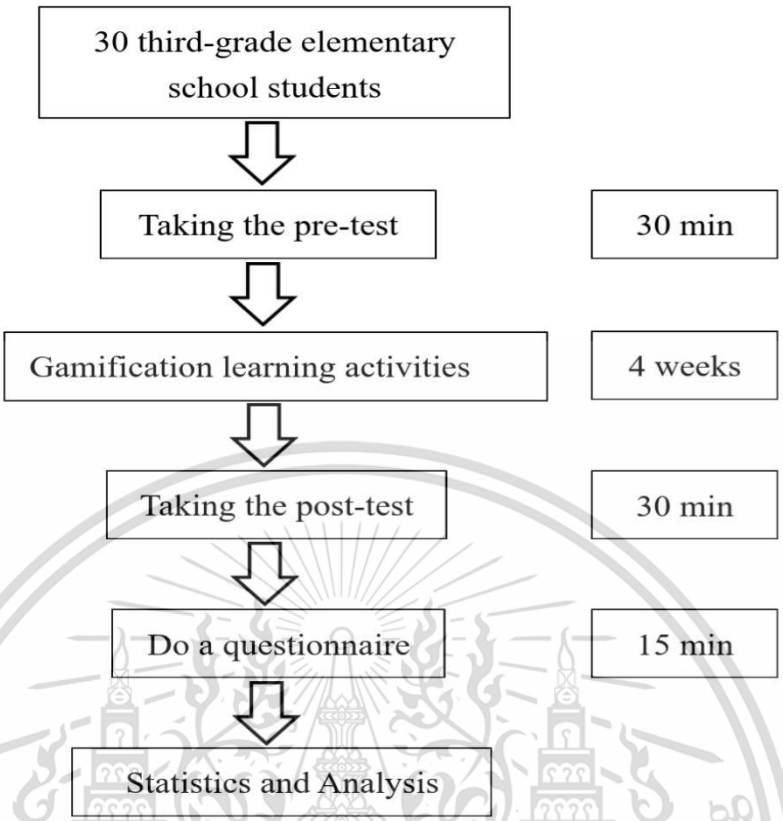

Figure 3.1 The procedure diagram

3.5 Data collection

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

The "pre-test" provides an understanding of the participants' basic arithmetic operation level, which provides a guideline for the researcher to plan the lessons, set the weekly lesson content, and the lesson planning time (Mutlu, 2018). The data are based on the students' achievements on the pre-test, and in addition to the total achievements, there are achievements for each type of question (oral, written, and mixed arithmetic).

The data from the post-test served as a comparison. Because the types of questions on the post-test are identical to those on the pre-test, the pre-test and post-test are comparable. In terms of basic arithmetic operations levels, comparisons can be made by students' responses to multiple-choice questions (percent correct, score, response speed, etc.).

There are two types of data from the questionnaire: first, the scores of the satisfaction measures chosen by the students in the questionnaire, which are specific and quantifiable data; and second, the related suggestions of the students, which are textual data that are difficult to quantify and need to be studied and analyzed by the researcher himself (Nuari, 2018).

3.6 Data analysis

The pre-test and post-test achievements were calculated to find any significant differences by finding the average value of the achievements. To find out the significance of standard deviation (S.D.) and pre-test and post-test achievements, a t-test dependent was used in this study.

The quantitative results obtained from the closed-ended questions in the questionnaire were used to determine any significant differences by calculating the average value and standard deviation (S.D.) of the achievements. The interpretation of the average achievement of the close-ended questionnaire was as follows:

4.50 – 5.00 = Highly satisfied
3.50 – 4.49 = Satisfied
2.50 – 3.49 = Undecided
1.50 – 2.49 = Unsatisfied
1.00 – 1.49 = Highly unsatisfied

The quantitative results obtained from the open-ended questions in the questionnaire reveal, through content analysis, students' perceptions of online gamification.

CHAPTER 4

RESULTS

This chapter reported the research results based on data and quantitative methods to achieve the research objectives. The results of this study come from the pre-test, post-test and questionnaire survey completed by 30 students randomly selected from 6 classes. The data obtained from the research tools reveal the answers to five research questions in this study:

RQ1: What are the main components of gamification learning activities?

RQ2: Is there any significant differences in pre-test and post-test after performing learning activities using gamification is in basic arithmetic operations?

RQ3: What is the level of students' satisfaction from using gamification in learning activities?

The research results were presented in the form of tables and explanations. The results of data analysis were divided into three parts:

(1) Activity design and development. The purpose of this part was to report the main components of online gamification learning activities.

(2) Pre-test and post-test achievements of students. This part reports the results by comparing students' arithmetic test achievements before and after online games.

(3) Student satisfaction analysis. This part describes students' satisfaction after participating in online game learning through charts.

4.1 The activities design and development

This paper designed four activities to verify the impact of online learning activities on primary school students' arithmetic learning ability and attitude. The first activity was to use colored "matches" on Kahoot as students' manual operation tool, which was divided into different levels of game swing number games. The second activity was a number matching activity designed based on basic mathematical algorithms, which required students to add unused numbers to arithmetic formulas, so that students can exercise basic arithmetic skills in the form of thinking games. The third activity was the split game activity. Students must follow two rules: 1) the split game under the rule of addition and subtraction; 2) Split game under the rule of multiplication and division. The fourth activity was the online digital short story activity. Each number was set as a separate number on Kahoot and given a name. Researchers used these "numeric characters" to design short stories about numbers. Students can watch these stories to understand the meaning and operation of numbers. In addition, several numbers can form new numbers with each other, and new stories can be developed. The activities had validated from 3 expert with Likert Scale in every content topic.

The paper was used to test the impact of online game learning on primary

school students' arithmetic performance. In order to ensure that the post-test paper of the experiment has good content reliability and conforms to the knowledge level and ability characteristics of students in our primary school, the research conducted appropriate investigation and deletion on the difficulty and quantity of test questions, and passed the consistency test of three experts.

Table 4.1 Means, standard deviations, and levels of experts' score of the lesson plan

No.	Question items	Mean	S.D.	Level
1.	The lesson plan contains all of the necessary elements.	4.33	0.47	High
2.	The content is suited for the students' level of understanding.	4.67	0.47	Highest
3.	The learning activities are relevant to the subject matter.	4.67	0.47	Highest
4.	Learning activities are designed according to Gamification Learning methods.	4.67	0.47	Highest
5.	Learning activities are difficult and also easy to suit the level of learners	4.67	0.47	Highest
6.	The timing of the activities is appropriate.	4.33	0.47	High
7.	Digital tools applied to the activities are appropriate.	4.33	0.47	High
8.	Digital tools used for activities are sufficient.	4.67	0.47	Highest
9.	Assessment methodologies are appropriate	4.33	0.47	High
10.	Assessment methodologies are accurate and fair.	4.67	0.47	Highest
	Overall	4.53	0.09	Highest

4.2. The results of students' pre-test achievements and post-test achievements

The school involved in this study is a key primary school subordinate to the Provincial Education Commission. On the whole, the students' academic performance can represent the level of most primary school students in Zhejiang Province, and has good experimental conditions. Therefore, it was selected as an experimental school in the study, in order to expand the samples to other schools for further experiments. The subjects were selected from six parallel classes in the third grade of a public primary school in Zhejiang Province, and then 30 students were randomly selected from the six classes. The gender distribution of students is shown in Table 4.1. The 30 students participated in this study by using cluster sampling technology, and implemented online game learning activities of all basic arithmetic operations for them. The

experiment was carried out with the consent of 30 students and their parents.

Table 4.2 Gender distribution of students

Gender	Number of people
Male	16
Female	14
Total	30

The changes of students' achievements before and after the experience are shown in Table 4.2. It can be seen from Table 4.1 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 arithmetic learning.

In order to explore students' academic performance after learning arithmetic through online games, this part illustrates comparison of the students' pre-test achievements and post-test achievements in the arithmetic test and average value achievements, standard deviations and descriptive analysis are presented in Table 4.3.

Table 4.3 Comparison of the students' pre-test and post-test achievements in the arithmetic test

Test	N	Average value	S.D.	T	Df	P
Pre-test	30	61	15	10.69	29	.00**
Post-test	30	80	10			

**significant level at .05

Results as shown in the above table, the average achievement of the pre-test was 61 and the standard deviation was 15; The average achievement of the post test was 80 and the standard deviation was 10. The results show that students' achievement in the post-test is higher than that in the pre-test, and the value of t-distribution is 10.69.

4.3 The students' satisfaction

4.3.1 Satisfaction data

In order to understand the change of learning interest in online game teaching, a questionnaire was issued to show the change of students' interest. The learning interest questionnaire includes three parts: Participants' basic information, satisfaction with learning activities in online games and participants' suggestions, mainly about

learners' emotional experience, learners' learning experience and learners' learning strategies (Table 4.4).

Table 4.4 Analysis of questionnaire dimensions

Questionnaire dimension	Corresponding topic
Emotional experience of learners	1, 4, 6, 9, 14, 15
Learning experience of learners	3, 7, 10, 11, 13
Learning strategies of learners	2, 5, 8, 12

There are 15 questions in the questionnaire of primary school arithmetic teaching effect. The content of the questionnaire is carried out from three dimensions: Learners' emotional experience, learners' learning experience and learners' learning strategies. The answer to the question adopts the liken type five level scale, and option 5 has the highest degree of agreement. Based on this recurrence, option 1 has the lowest degree of agreement. The statistical analysis of the results of each dimension of the questionnaire is as follows.

(1) Analysis on the results of the dimension of "emotional attitude of learners"

The six questions under this dimension are used to investigate learners' emotional attitudes towards online game learning of primary school arithmetic. The data sorting results are shown in Table 4.5.

Table 4.5 Analysis on the results of the dimension of "emotional experience of learners"

Questionnaire title	Average value	S.D.	Level
1. Online gamification learning activities were very interesting?	4.47	0.67	High
4. I liked the system interface of the online gamification learning software.	4.43	0.88	High
6. The online gamification learning activities have made me more confident in learning basic arithmetic operations.	4.60	0.61	Highest
9. The online gamification learning activities can improve my enjoyment of arithmetic.	4.33	0.91	High
14.In my study, I often use online gamification learning software to get interesting feelings.	3.80	1.38	High
15.I fell in love with math class through online gamification learning activities.	4.67	0.94	Highest
Average value	4.38	0.97	High

The six questions under this dimension are designed to investigate the changes of learners' emotional attitude towards online game learning of arithmetic in primary school. From the survey results, 90% of the students said they liked the online game learning method, 86.66% of the students said they were very interested in using the online game learning method to learn arithmetic, 93.34% of the students improved their interest in arithmetic learning through the online game learning method, and 86.66% of the students thought that online games could make them like learning arithmetic. This shows that after three rounds of teaching practice, students have a strong interest in the originally boring and monotonous arithmetic learning, and can maintain a more positive learning attitude to learn arithmetic. Learning interest and enthusiasm will be an important basis for learning arithmetic in primary school.

(2) Analysis on the results of the dimension of " learning experience of learners"

The five questions under this dimension are used to investigate the learning experience of learners in the online game learning process of primary school arithmetic. The data sorting results are shown in Table 4.6.

Table 4.6 Analysis on the results of the dimension of "learning experience of learners"

Questionnaire title	Average value	S.D.	Level
3. Online gamification learning activities helped me to improve my basic arithmetic learning.	4.27	0.89	High
7. The online gamification learning software was easy and convenient to operate.	4.13	1.36	High
10.The online gamification learning activities are very efficient for learning?	4.07	1.00	High
11.Through online gamification learning activities, I can acquire knowledge faster.	4.47	0.62	High
13.Online gamification learning activities make my thinking more agile	4.60	0.49	Highest
Average value	4.31	0.94	High

The five questions in this dimension are designed to understand learners' learning experience in the process of arithmetic learning in primary school. According to the survey results, 83.33% of the students can completely immerse themselves in the learning scene in the classroom online game activities, and urge themselves to complete the online game tasks actively and seriously. 66.67% of the students enjoy

the joy of completing challenging tasks and receiving rewards. 90.33% of the students can stimulate their desire to challenge themselves in online game activities and prefer difficult and challenging tasks. 70% of the students can feel the sense of enrichment, excitement and satisfaction brought by online game learning after completing classroom online game tasks. 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.

(3) Analysis of the results of the dimension of "learning strategies of learners"

The four questions in this dimension are used to investigate the arithmetic learning strategies of learners after arithmetic online game learning. The data sorting results are shown in Table 4.7.

Table 4.7 Analysis of the results of the dimension of "learning strategies of learners"

Questionnaire title	Average value	S.D.	Level
2. I enjoyed learning basic arithmetic more through online gamification learning activities.	4.40	1.02	High
5. I will use the online gamification learning software for more learning in the future.	4.03	1.28	High
8. The interface of the online gamification learning software was colorful.	4.37	0.83	High
12.Online gamification learning activities are more conducive to cooperative learning	4.47	0.80	High
Average value	4.32	1.10	High

The four questions under this dimension are mainly to investigate and understand the learning strategies of students in learning arithmetic after online game learning of primary school arithmetic.

4.3.2 The students' opinions on open ended question

Students' views on the open-ended questions in the questionnaire are as follows:

(1) Advantages of online gamification learning:

Through on-site observation and data analysis, in the process of online game learning, students will search for information through the Internet, ask teachers or classmates, or query in textbooks by themselves. Few students directly give up the task. In this process, although several students always fail, they see that the students around them have completed the task, will think of various ways to solve the problem,

and finally can complete the learning of knowledge, in online gamification learning, primary school students' hearts have been greatly encouraged to enhance their ability and self-confidence to solve problems independently.

(2) Disadvantages of online gamification learning:

However, students have different views. They believe that there are some disadvantages in learning arithmetic through online games. Some students believe that learning arithmetic in this way takes too much time, so it may sometimes be regarded as a time-consuming activity. Moreover, some students commented that while learning arithmetic through this method, they did not get enough opportunities to contact arithmetic. The teaching content in online game-based learning should be skillfully integrated into online games to avoid the separation between online games and teaching content. If only relying on online games to activate the classroom atmosphere instead of integrating the teaching content into online games, although these irrelevant online game contents can stimulate students' interest for a short time, students' attention is easy to be diverted, Students can't quickly enter the learning state because they are nostalgic for the content of online games. Even after the end of online games, when they are asked to summarize what knowledge that they have learned, a large part of students' brains will be blank and unaware.

CHAPTER 5

DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

This chapter summarized the research, and summarizes the research results, discussions, conclusions and suggestions for further research.

5.1 Summary of the study

The purpose of this study was to explore the effectiveness of online gamification learning methods in primary school arithmetic teaching for third graders in a public primary school in Zhejiang Province, China, and students' attitude towards learning arithmetic through online games.

Online game teaching originates from the concept of entertainment education. It is a new teaching mode that introduces online games into classroom teaching to serve classroom teaching. Teachers integrate educational online games into teaching practice according to the psychological characteristics of learners and the situational, interesting and competitive nature of online games, and design and select appropriate learning tools, use appropriate teaching strategies and evaluation methods for teaching. Online game teaching fully embodies the educational concept of "people-oriented". Students are the main body of learning. Through the analysis of students' physical and mental characteristics, online game teaching is designed and implemented, and the classroom "online game" is more in line with the age characteristics of primary school students. Primary school students are lively and active, and it is difficult to concentrate in class. It is easier to stimulate and maintain students' interest in learning by using this teaching method, and then help to improve the classroom teaching effect. With the development of educational reform, the advantages of online game teaching have attracted more and more attention of educators. However, at present, the construction of online game teaching resources and the design and development of teaching cases are relatively weak. Therefore, this study aims to fill the research gap of primary school students' arithmetic online game learning. The research focuses on the test results after learning arithmetic through online games and students' attitude towards learning arithmetic through this method.

The purpose, research questions, research objects, research tools, procedures and data analysis of this study are summarized as follows:

5.1.1 The objectives of the study

The purpose of this study is to investigate three main questions:

1) To develop gamification learning activities to enhance students' achievement.

2) To investigate students' achievement through gamification learning activities by pre-test and post-test.

3) To study students' satisfaction and satisfaction in gamification learning activities.

5.1.2 The research questions

The main problems of this study are as follows:

RQ1: What are the main components of gamification learning activities?

RQ2: Is there any significant differences in pre-test and post-test after performing learning activities using gamification is in basic arithmetic operations?

RQ3: What is the level of students' satisfaction from using gamification in learning activities?

5.1.3 The participants of the study

The researchers first examined the latest arithmetic achievements of third graders in the school. Students in all classes scored from high to low. Then 30 students were randomly selected from one of the six classes. The 30 students participated in this study by using cluster sampling technology, and implemented online game learning activities of all basic arithmetic operations for them.

5.1.4 The research instruments

The study used two tools. The first tool is the pre-test paper and post-test paper, with a total of 20 arithmetic calculation questions: 12 questions are the calculation of addition, subtraction, multiplication and division between two numbers, and 8 questions are the calculation of addition, subtraction, multiplication and division between multiple numbers. The second tool is the questionnaire, which is divided into three parts: Participants' background information, participants' attitude towards learning arithmetic in online games, and their views on the advantages and disadvantages of this learning method.

5.1.5 The research procedures

In order to carry out this study, subjects were assigned to take an arithmetic pretest to explore their mastery of the knowledge they would be taught. Then they received four weeks of arithmetic teaching based on online games. After that, they were assigned to do an arithmetic post-test to explore the changes in their primary school arithmetic knowledge. In addition, they were asked to conduct a questionnaire to express their attitude towards learning arithmetic through this method.

5.1.6 The data analysis

By analyzing the pre-test and post test achievements of subjects' arithmetic ability test, this study finds out whether there is a significant difference in their average achievement. In this study, t-test was used to obtain the standard deviation between pre-test achievements and post-test achievements and its significance. The data collected from the closed-end questions in the questionnaire are analyzed to obtain the average percentage. The quantitative results of the open-ended questions in the questionnaire are analyzed.

5.2 Summary of the findings

5.2.1 Demographic data of the participants

The survey results showed that there was little gender difference among the participants, of which 46.67% were female and 53.33% were male. Most participants (66.67%) were 9 years old. In terms of educational information, most participants

(43.33%) have participated in online game teaching before, 40% of students understand the meaning of online game teaching, and 16.67% do not know what online game teaching is.

5.2.2 The effectiveness of using Gamification Learning in teaching Primary school Arithmetic

This study explores students' arithmetic knowledge through 20 arithmetic topics to show their arithmetic ability before and after learning arithmetic through online games. The results show that the average score of participants in the pre-test is 64.73, and the standard deviation is 10.06. The average score of participants in the post-test is 83, and the standard deviation is 5.16. It can be seen that the score after the test is significantly higher than that before the test. In other words, after learning arithmetic knowledge through online games, participants' arithmetic ability increased significantly.

5.2.3 The students' attitudes towards learning Arithmetic through Gamification Learning

Through 15 closed-ended questions and 3 open-ended questions in the questionnaire survey, this paper discusses students' attitude towards learning arithmetic through online games. The title of the questionnaire is related to the participants' attitude towards learning arithmetic through online games.

The survey results showed that four questions in the questionnaire were rated as the highest level of consistency by the participants, all of which exceeded 90%. Among them is the first question, "is online game based learning activity very interesting?", Question 6 "online game learning activities make me more confident in learning basic arithmetic operations", question 11 "through online game learning activities, I can acquire knowledge faster", and question 13 "online game learning activities make my thinking more agile".

For the open-ended questions in the questionnaire, most participants agreed that learning arithmetic through online gamification learning will not only help them improve their arithmetic ability, but also make them have fun in the learning process. However, participants believed that learning through this method would take too much time, and some participants preferred to learn arithmetic from actual courses.

5.3 Discussion

This section discusses the results of this study and their relationship to other previous relevant studies. The use of online game learning has been supported by many researchers in the field of primary school arithmetic 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.

5.3.1 Research question 1: What are the main components of gamification learning activities?

In recent years, with the rapid development of computer science and network technology, the game industry has developed vigorously, and students can't extricate themselves from online games. The strong attraction of computer games has attracted

the attention of experts and scholars. Experts and scholars are studying how to introduce such popular games into education. The research on educational games started early and began in the early 1980s. In 1980, Bowman integrated video games into instructional design (Squire, 2003). Chen, (2020) believe that game learning is that teachers integrate the thinking and mechanism of games into the teaching of specific disciplines. In the whole teaching activities, students learn knowledge through game, and the role of teachers is transformed into a guide and helper of teaching. Pombo and Marques (2019) believe that gamification learning is to use the characteristics of doubt setting, challenge and cooperation of games, combined with learners' cognitive level and learning characteristics, hide teaching objectives in game activities, and adopt gamification teaching strategies to enable learners to improve their knowledge and skills in a relaxed and pleasant state.

This paper holds that gamification learning is to integrate the concept and mechanism of game into specific disciplines in the process of instructional design. According to the characteristics of learners and teaching content, ingenious problem situations and levels are designed, combined with game teaching strategies to make the traditional boring learning process lively and interesting. Let students "indulge in learning" like "indulge in games", and complete the learning and understanding of subject knowledge in the process of games. In this study, the main component of online game learning activities is to design the basic operation of applying online games to arithmetic. This paper designs four online arithmetic online games and makes a teaching plan. The course plan is designed for four weeks to ensure a weekly online game-based teaching course, which is approved by the consultant of the researcher and three experts in the field.

5.3.2 Research question 2: Is there any significant differences in pre-test and post-test after performing learning activities using gamification is in basic arithmetic operations?

Baroody, (2016) argues that it is essential to shape students’ good learning habits. Maf’Ulah, (2016) states that it is necessary to arouse their interest in order to improve students’ basic arithmetic skills.You can choose the way of introduction to stimulate students’ interest in learning, the overall students belong to the quiet type more to mobilize interest in learning by introducing games. At the same time, the class is active students create a proper context to introduce so that students experience the process of mental activity of discovering, proposing and solving problems in real life in the context, build mathematical thinking, stimulate interest in learning, and implement it practically with good results.

The changes of students' achievements before and after the experience are shown in Table 4.2. It can be seen from Table 4.1 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 game learning plays a positive role in improving students' achievement of arithmetic learning.

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.

5.3.3 Research question 3: What is the level of students' satisfaction from using gamification in learning activities?

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. Elshami, (2021) analyzed the differences of students' online learning satisfaction in demographic variables from the perspective of learners, teachers, courses, environment and overall satisfaction. Torres and Alieto (2019) analyzed the relationship between senior high school students' English learning motivation and online learning satisfaction from the perspective of learning motivation. Shi, Liang and Tsai (2019) based on the structural equation model of influencing factors of students' learning satisfaction in the mixed learning environment, conducted group analysis for different groups of active scholars and contemplative scholars in learning styles, and believed that carrying out rich learning activity design can effectively improve the influence coefficient. Based on the conceptual framework of teacher-student interaction and taking the S-O-R model as the research framework, Yang et al. (2021) constructed the influencing factor model of teacher-student interaction on learner satisfaction in online courses, and concluded that interactive content has the greatest impact on learner satisfaction, and interactive time, intensity and level have a certain impact on learner satisfaction. Gavrilis, Mavroidis and Giossos (2020) concluded that the interaction between learners and teachers and online learning satisfaction showed a significant correlation of more than moderate.

This paper discusses the third-grade students' satisfaction towards learning arithmetic through online games, and analyzes the answers in the questionnaire. The survey results show that most participants (more than 85%) believe that learning arithmetic through online games is very interesting and can create a good atmosphere in the classroom. In addition, they also believe that learning arithmetic through this method not only helps them remember arithmetic skills more easily, but also improves students' interest and satisfaction in learning.

5.4 Conclusion

Through the design and application of online game teaching, this paper discusses the research of online game teaching on improving learners' learning interest. The results are as follows:

(1) With experimental data, online game teaching has a certain effect on improving students' learning interest. The main reason is that the online game courseware applied in the teaching process can create a certain online game scene for students, with a certain story and cartoon animation, which can attract students'

attention. However, there are differences in the performance of men and women in terms of attention, and the attention concentration of boys is slightly higher than that of girls. 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 game teaching and the competitive link of doing exercises on online game platform can increase learners' enthusiasm in class and improve students' interest in learning.

(2) It 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) It provides technical support for primary school mathematics teachers to carry out online game teaching. When most teachers carry out online game teaching, due to limited technology, they borrow online game courseware developed on some platforms for teaching, and cannot design relevant scenes and resources according to their own teaching objectives and contents. During online game teaching, the author designs relevant script design according to the teaching objectives and contents, and makes an online game courseware suitable for lower grades of primary school, finding a suitable platform for design, which can also provide relevant technical support for online game teaching for primary school mathematics teachers.

5.5 Recommendations

5.5.1 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. It can be seen that the most important factor affecting students' learning effectiveness is how students learn in class (although it cannot be denied that this depends largely on how teachers teach). Whether students clearly understand classroom knowledge and whether students actively participate in classroom discussion. Our teaching philosophy has always emphasized the combination of teachers' leading and students' main body. However, in the real classroom, the position dominated by teachers is worthy of its name, and let it go, while the dominant position of students is "in vain" and difficult to implement. It can be seen that some researchers advocate "teaching by learning" and "teaching after learning" has its practical basis. 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. This also confirms that "interest is the best teacher". Only when students are really interested in a subject, they will learn well. If students are interested in a subject, they can learn well. Interest is a very important factor in the process of classroom teaching. At the same time, the research also shows that students' classroom interest experience is generally higher than creative experience, so teachers should pay more attention to stimulating students' learning interest in the process of classroom teaching. Not only what is important, but also how to say it is more important. 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, we should pay more attention to encouraging those students with good mathematical foundation to actively explore and solve mathematical problems with new methods, and support them to carry out in-depth autonomous learning. Moreover, in the creative experience of students, the creativity of teachers in class is significantly better than that of students. It is very valuable for teachers to creatively explain subject knowledge. If teachers can give full play to their creativity to cultivate how to make students dare to create new methods and explore new ideas, it will be more valuable. Like the state and society encourage creative thinking and innovative talents, a classroom with innovative vitality should first have a good classroom atmosphere that encourages creation and a mentality that is not afraid of mistakes and dare to try. In the process of 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.

5.5.2 Recommendations for further study

Researchers believe that the research on students' classroom experience is a topic worthy of further research in the future. Now society is a society that pays more and more attention to human beings. In a human-oriented and people-oriented society, human subjective experience will play a very important role. Therefore, now education will pay more and more attention to students and learning, and pay attention to the research of students' life experience and learning experience. In this study, the six-step course learning mode (Figure 2.2) used in the curriculum plan play a key role. These six steps help the orderly advancement of the curriculum and increase students' interest in the curriculum. At the same time, with the development of science and Technology (Internet, big data, Cloud Computing) and the continuous improvement of research methods, students' personalized teaching and full record learning will become possible in the future. This makes many teaching methods that were originally unthinkable and infeasible become a reality, and the research objects that were originally invisible and unquantifiable have the possibility of visualization and quantification. For example, Kahoot and Quizizz, which were used in this study, made teaching possible through online games, allowing students to learn in interest. Therefore, research such as students' classroom experience not only has practical value needs, but also has necessary means to support, which is more conducive to the rational and justified academic research, both theoretical supports, more data support, and more conducive to the combination of theory and practice.

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APPENDIX A

PRE-TEST

Name: **Duration:30 Minutes**
Student ID Number:
Gender:
Degree Program:

Please circle the correct answer for each of the following questions.

Part I
Items 1-12: 12 items×5 mark each= 60 marks.

1.50+31=?
(a)20 (b)81 (c)31 (d)40

2.20+25=?
(a)45 (a)45 (c)40 (d)60

3.68+72=?
(a)150 (b)140 (c)120 (d)152

4.105-22=?
(a)73 (b)93 (c)83 (d)102

5.85-72=?
(a)13 (b)23 (c)157 (d)33

6.95-68=?
(a)28 (b)31 (c)27 (d)36

7.45×5=?
(a)200 (b)225 (c)180 (d)215

8.15×5=?
(a)60 (b)75 (c)80 (d)65

9.24×8=?
(a)32 (b)125 (c)168 (d)192

10.30÷6=?

(a)5 (b)6 (c)7 (d)8

11.69÷3=?
(a)32 (b)21 (c)23 (d)33

12.121÷11=?
(a)11 (b)12 (c)13 (d)15

Part II
Items13-20: 8 items×5 mark each= 40 marks.

1.85÷5×6=?
(a)20 (b)21 (c)102 (d)99

2.60+47×5=?
(a)295 (a)423 (c)265 (d)535

3.(72+63)÷5=?
(a)32 (b)27 (c)23 (d)28

4.64÷(35-27)=?
(a)9 (b)8 (c)16 (d)14

5.45×9-260=?
(a)145 (b)135 (c)68 (d)32

6.190+360÷60=?
(a)9 (b)20 (c)185 (d)196

7.250÷5-15=?
(a)35 (b)20 (c)253 (d)30

8.(42+58)×12=?
(a)12 (b)12000 (c)120 (d)1200

POST-TEST

Name: **Duration:30 Minutes**
Student ID Number:
Gender:
Degree Program:

Please circle the correct answer for each of the following questions.

Part I
Items 1-12: 12 items×5 mark each= 60 marks.

1.123+69=?
(a)202 (b)192 (c)183 (d)213

2.48+369=?
(a)517 (a)417 (c)407 (d)427

3.127+87=?
(a)204 (b)214 (c)192 (d)194

4.253-158=?
(a)95 (b)82 (c)104 (d)158

5.359-42=?
(a)298 (b)307 (c)289 (d)317

6.284-16=?
(a)277 (b)268 (c)257 (d)234

7.57×9=?
(a)413 (b)602 (c)513 (d)320

8.19×36=?
(a)684 (b)650 (c)544 (d)674

9.148×18=?
(a)2794 (b)2664 (c)2305 (d)2386

10.345÷23=?
(a)22 (b)32 (c)16 (d)15

11.891÷9=?

(a)91 (b)89 (c)99 (d)81

12.437÷19=?

(a)22 (b)23 (c)32 (d)33

Part II

Items13-20: 8 items×5 mark each= 40 marks.

1.125÷5×48=?

(a)1200 (b)1280 (c)1320 (d)1300

2.728÷7÷4=?

(a)25 (a)28 (c)26 (d)31

3.(306-277) ×15=?

(a)240 (b)435 (c)423 (d)543

4.746+612÷6=?

(a)226 (b)227 (c)848 (d)327

5.81×4-231÷11+4×9=?

(a)339 (b)1369 (c)324 (d)1200

6.145÷5×6+42=?

(a)42 (b)95 (c)92 (d)216

7.12×48÷9-(8+37) =?

(a)35 (b)20 (c)253 (d)30

8.18× (423÷47) ×7÷189=?

(a)26 (b)6 (c)19 (d)225

QUESTIONNAIRE

To explore the satisfactions of third-grade students in a public elementary school in Zhejiang, China, toward online gamification basic arithmetic operations teaching activities.

The purpose of this questionnaire is to investigate the satisfaction of third grade students in a public elementary school in Zhejiang, China, with online gamified basic arithmetic operations activities. This questionnaire is for academic research purposes only and your responses will be kept confidential, so please feel free to complete it. This questionnaire is divided into three parts(Li, 2020).

Part 1: Basic information about the participants

Part 2: Participants' satisfactions towards online gamification learning activities

Part 3: Participants' satisfactions and suggestions

Part 1: Basic information about the participants

1. Age:_____
2. Gender:_____
3. Class:_____

Part 2:

Table A.1 Participants' satisfactions towards online gamification learning activities

Items	Highly Satisfied-Highly unsatisfied				
	5	4	3	2	1
1. Online gamification learning activities were very interesting?					
2. I enjoyed learning basic arithmetic more through online gamification learning activities.					
3. Online gamification learning activities helped me to improve my basic arithmetic learning.					
4. I liked the system interface of the online gamification learning software.					
5. I will use the online gamification learning software for more learning in the future.					
6. The online gamification learning activities have made me more confident in learning basic arithmetic operations.					

Table A.1 (Continued)

Items	Highly Satisfied-Highly unsatisfied				
	5	4	3	2	1
7. The online gamification learning software was easy and convenient to operate.					
8. The interface of the online gamification learning software was colorful.					
9. The online gamification learning activities can improve my enjoyment of arithmetic.					
10.The online gamification learning activities are very efficient for learning?					
11.Through online gamification learning activities, I can acquire knowledge faster.					
12.Online gamification learning activities are more conducive to cooperative learning					
13.Online gamification learning activities make my thinking more agile					
14.In my study, I often use online gamification learning software to get interesting feelings.					
15.I fell in love with math class through online gamification learning activities.					

Part 3: Participants' satisfactions and suggestions

Direction: Please give satisfactions or suggestions for the following topics.

1. What are your reasons for being satisfied/ dissatisfied with online gamification learning activities?

   _____

   _____

   _____

2. What do you think are the advantages and disadvantages of online gamification learning activities?

3. What are your suggestions for online gamification learning activities?

LESSON PLANS

Time: Once a week, 45 minutes at a time.
Period: 4 weeks
Target students: 30 third-grade elementary school students
Objectives:
1. Students' level of basic arithmetic operations is improved.
2. Students' interest in basic arithmetic operations is increased.
Week 1:

Subject/Course:	Math		
Topic:	Basic arithmetic operations		
Lesson Title:	Add, Subtract, Multiply and Divide		
Level:	Third grade	**Lesson Duration:**	45 minutes

Lesson Objective:
1) Master the meaning of addition, subtraction, multiplication and division and the relationship between various parts of addition, subtraction, multiplication and division, and learn to use them to solve practical problems. 2) By further studying the significance of addition, subtraction, multiplication and division and the relationship between various parts, students' computing ability and practical application ability can be improved.

Learning Activities：
Teacher introduces four-week lesson plans and schedules to students. And then, class begin: **1）Use the conversation method to introduce the situation, attract students' attention and stimulate their interest in learning.** For example: Teacher: students, did you go with your parents this winter vacation? Where did you go out to play? Student: feel free to answer (went out to play / didn't go out to play) Then show a landscape map with PPT. (for example, Thailand) Teacher: do you know where such a beautiful place is? Student: It's Thailand. Put forward an arithmetic problem about distance. **2）Guide students to think independently and discover the significance of addition and subtraction.** For example: Answer the questions raised in the previous stage.

Ask more questions about addition and subtraction in the situational dialogue. **3）Guide students to sum up the relationship between the parts of addition and subtraction based on what they have learned before.** **The same procedure applies to multiplication and division.** **Finally, consolidate the key points learned in this class and arrange exercises**.

Materials/Equipment and tools :
Arithmetic textbook for the third grade of primary school, PPT

Gamification design step:
1. Core Problem： How to master addition, subtraction, multiplication and division? 2. Establish Learning outcomes： Students can master addition, subtraction, multiplication and division, and feel the fun of learning arithmetic.

Week 2:

Subject/Course:	Math		
Topic:	Basic arithmetic operations		
Lesson Title:	Gamification learning of add, subtract, multiply and divide		
Level:	Third grade	**Lesson Duration:**	45 minutes

Lesson Objective:
1）Master the operation of addition, subtraction, multiplication and division more skillfully. 2）Experience the fun of gamification learning in addition, subtraction, multiplication and division.

Learning activities:
1) Attract students' attention by playing videos For example: Play a video about Gamification learning with Kahoot. (about two minutes) 2) Stimulate students' interest in learning by playing low-level games Let the students open the game software "ihuman" and start playing from level 1. When they break through level 2, let the students stop playing this software. Because the difficulty of level 3 will be higher than the knowledge learned. 3) Cultivate students to actively explore arithmetic through games and promote the

development of students' mathematical thinking.
Teacher shares the PIN code and invites students to enter the "game" interface.
Students play an "online game" with Kahoot.
4) Use the reward mechanism to encourage students.
Teachers set up appropriate reward mechanism according to the activity situation to stimulate students' interest in participating in game activities, such as score ranking, safflower medal, etc.
At the same time, encouraging evaluation should be given to students' classroom performance, so that students can obtain psychological pleasure and satisfaction.

Materials/Equipment:
Arithmetic textbook for the third grade of primary school, Kahoot.

Gamification design step:
3. Develop an engaging narrative: Play a game video. 4. Build teams and encourage creativity: Everyone plays a simple math game to increase students' self-confidence. 5. Provide choice of task to complete : Play Kahoot online game. 6. Celebrate learner successes: Use the reward mechanism.

Week 3:

Subject/Course:	Math		
Topic:	Basic arithmetic operations		
Lesson Title:	Mixed Operations		
Level:	Third grade	**Lesson Duration:**	45 minutes

Lesson Objective:
1) Through inquiry, communication and other learning activities, make students understand "multiplication and division first, then addition and subtraction", guide students to find and summarize the operation sequence of same-level operation and two-level mixed operation, and operate correctly. 2) Cultivate students' ability to formulate comprehensive formulas to solve practical problems, as well as the ability to find, analyze and solve problems. 3) Guide students to feel the close relationship between mathematics and life.

Learning Activities:

1) Creating situations and introducing new courses Teacher: what sports do students like best in winter? Student: skiing, snowman making, snowball fights This is a newly opened ski resort. (show the big screen) in this lesson, we'll learn about the ski resort 2) Combined with the situation, explore new knowledge 1. Find and summarize the operation sequence of the same level operation. For example: Show information: on the first day of opening, there were 230 people in the morning, 70 people left at noon and 150 people came. Teacher: according to the information, what math problems can you ask? Student: how many people are there in the afternoon? (student's solution) 230-70 + 150 = 310 2. Understand and summarize the operation sequence of two-level hybrid operation. For example: Just now, a classmate said he wanted to know how many tickets are for the ski resort. Two days ago, two friends of mine also went to the ski resort. They know that an adult ticket is 60 yuan, and they pay the conductor 200 yuan to buy two. How much should they get back? (student's solution) 200-60*2=80 3. Guide students to sum up the operation order of mixed operation. 3) Finally, consolidate the key points learned in this class and arrange exercises.

Materials/Equipment:
Arithmetic textbook for the third grade of primary school, PPT.

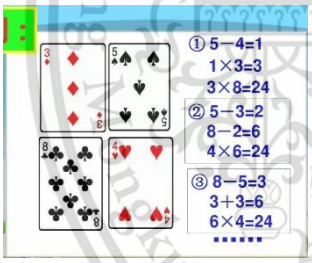
Gamification design step:
1. Core Problem: How to master the operation order of mixed operation ? 2. Establish Learning outcomes： Students can master the operation order of mixed operation, and feel the fun of learning arithmetic.

Week 4:

Subject/Course:	Math

Topic:	Basic arithmetic operations		
Lesson Title:	Gamification learning of mixed operations		
Level:	Third grade	**Lesson Duration:**	45 minutes

Lesson Objective:
1） More proficient in the operation sequence of mixed operation. 2） Through gamification learning, students can more intuitively feel the close relationship between arithmetic and life.

Learning Activities:
) Attract students' attention by playing videos For example: Play a video about Gamification learning with Quizzes'. (about two minutes) 2) Stimulate students' interest in learning by playing "count 24" game. 1. Play four poker cards at a time and use each card, but each card can only be used once. 2. You can use "add, subtract, multiply and divide" to calculate at will, and the calculation result can only be 24. For example: 3) Cultivate students to actively explore arithmetic through games and promote the  development of students' mathematical thinking. Teacher shares the PIN code and invites students to enter the "game" interface. Students play an "online number splitting game" with Quizzes'. The same steps to play an "online number short stories" with Quizizz. 4) Use the reward mechanism to encourage students. Teachers set up appropriate reward mechanism according to the activity situation to stimulate students' interest in participating in game activities, such as score ranking, safflower medal, etc.

Materials/Equipment:
Arithmetic textbook for the third grade of primary school, Chinese Poker and Quizizz.

Gamification design step:
3. Develop an engaging narrative: Play a game video. 4. Build teams and encourage creativity:

Use the most common things (Chinese Poker) in life to connect with mixed operations.

5. Provide choice of task to complete：

   Play Quizizz online game.
6. Celebrate learner successes:
   Use the reward mechanism.

Validation of Lesson plan with Online Gamification Learning Activities in Teaching Basic Arithmetic Operations

Description:
This lesson plan is part of Online Gamification Learning Activities for Teaching Basic Arithmetic Operations to Primary School students. Your responses are valuable and considered highly confidential.

Direction:
Read through the test questions in this form. Please indicate the degree to which each item is congruent with the objective of this study. If you have any comments on the congruence of each question, please record them in the space provided. Tick (✓) to rate the congruence according to the scale below.

The interpretation of each number is described as follows:
5 = strongly agree
4 = agree
3 = undecided
2 = disagree
1 = strongly disagree

Table A.2 Validation of lesson plan

No.	Question items	5	4	3	2	1
1.	The lesson plan contains all of the necessary elements.					
2.	The content is suited for the students' level of understanding.					
3.	The learning activities are relevant to the subject matter.					
4.	Learning activities are designed according to Gamification Learning Methods.					
5.	Learning activities are difficult and also easy to suit the level of learners.					
6.	The timing of the activities is appropriate.					
7.	The teaching materials applied to the activities are appropriate.					
8.	Digital tools used for activities are sufficient.					
9.	Assessment methodologies are appropriate.					
10.	Assessment methodologies are accurate and fair.					

APPENDIX B

LIST AND RULES OF GAMES USED IN THE STUDY

1. Online match-swinging number game

Matches were designed on Kahoot and colorful "matches" were used as a manual manipulation tool for students. There are several levels of match-swinging number games. In the beginner's level, all the numbers from 0-9 can be formed by matches, and once the students know how to make the 10 numbers with matches, they can naturally make other numbers. The intermediate stage means that students make the numbers change by moving matches (Vihavainen,2014). For example, if you move 1 match, what is the largest number that 68 can become? The number in the tens place represents tens, so it must be the 6 in the tens place. The advanced stage refers to forming a specific number by placing matches and ensuring that the equation holds, which improves students' hands-on skills, thinking skills and basic arithmatic operations.

2. Online number matching game

Matching games refer to number matching activities in basic mathematical operations. For example, in addition, the number "10" is given as a known option, and students are asked to add two, three, or four numbers to the addition formula so that the result of adding the four numbers is "10". In this way, the answers to the game are varied and can stimulate students' thinking. This is not limited to addition, subtraction, multiplication and division, of course. Simple numbers can be shown to students by comparing fingers, complex numbers can be drawn or several students can cooperate by physically posing them, etc., so that students can think through the form of the game. And in the process of thinking, they exercise their basic arithmetic skills (Halyadi, H.,2016).

3. Online number splitting game

There are two rules for the splitting game: one is the splitting game under the law of addition and subtraction. For example, the number "14" can be split into "10" and "4", "7" and "7" and so on. The second is the splitting game under the rule of multiplication and division. For example, the number "20" can be divided into "4" and "5", "2" and "10" and so on. The online number splitting game actually requires students to split numbers using a kind of reverse thinking of the basic arithmetic algorithm (Koshy, B.,2017). The positive learning coupled with the reverse thinking game, students' basic arithmetic operations skills are trained from both positive and negative directions, thus prompting students to improve their basic arithmetic operations skills in the online gamification learning activities.

4. Online number short stories

Each number was set up as an individual on Kahoot and given a name. The

researchers used these "number characters" to design short stories about the numbers, which students could watch to understand the meaning of the numbers and their operations. In addition, several numbers can form new numbers with each other and new stories can be developed. Students can design their own stories about basic arithmetic operations and share them with their classmates and teachers to explore the connotations of basic arithmetic acids in a fun story (Juliana & Hao, L.C., 2018). As students watch these videos, teachers can intersperse them with games, such as the number linking game, in which students need to find the results of number-to-number operations through certain calculations, such as "2+7", "10-1", "10-1", "10-1", and "10-1". "10-1", "3*3", "18÷2", etc. can be connected with the number "9".

APPENDIX C

LIST OF EXEXPERTS

The research instruments of the research entitled "Learning Achievement and Satisfaction Using Satisfaction in Primary School Arithmetic" were the online gamification lesson plans, the IOC of a primary elementary school basic arithmetic operation ability pretest, posttest and the questionnaire of students' satisfaction.

List of experts for the online gamification lesson plan and IOC validation

1. Arithmetic expertise
   Li Chen
   Math Teacher at Zhejiang Public Primary School Office
2. Arithmetic expertise
   Shan Yanhong
   Math Teacher at Zhejiang Public Primary School Office
3. Educational Technology expertise
   Dr. Kittisak Panngam
   Educational Supervisor at Nakhonnayok Primary Educational Service Area Office

No.

School of Industrial Education and Technology
King Mongkut's Institute of Technology Ladkrabang
1 Chalongkrung Soi 1, Ladkrabang District,
Bangkok 10520, Thailand

March 7 , 2022

Dear Mrs. Li Chen

Enclosed with the research's instruments

Ms. Tianjie Chen, a master's degree student in Master of Science Program in Technology-Enhanced Learning and Innovation, King Mongkut's Institute of Technology Ladkrabang is working on a thesis title "Learning Achievement and Satisfaction Using Satisfaction in Primary School Arithmetic". Asst. Prof. Dr. Kanyarat Sriwisathiyakun is the thesis advisor.

School of Industrial Education and Technology acknowledge on your professional competence in regarding field, the school would like to invite you as a senior expert to evaluate on accuracy and appropriate of the content on research's instruments. The recommendations and reviews from your assessment will be beneficial to the completeness of Ms. Tianjie Chen's research.

Please consider on this invitation and the school is looking forward and most appreciated for your kind acceptance.

Yours Sincerely,

(Assistant Professor Dr.Worapong Pairindra)

2022/03/07 Time : 15:31:04 Non-PKI Server Sign-In
Signature Code : QQA1A-CkAAlg-A3AEY-AMAA5

No.

School of Industrial Education and Technology
King Mongkut's Institute of Technology Ladkrabang
1 Chalongkrung Soi 1, Ladkrabang District,
Bangkok 10520, Thailand

March 7 , 2022

Dear Mrs. Shan Yanhong

Enclosed with the research's instruments

Ms. Tianjie Chen, a master's degree student in Master of Science Program in Technology-Enhanced Learning and Innovation, King Mongkut's Institute of Technology Ladkrabang is working on a thesis title "Learning Achievement and Satisfaction Using Satisfaction in Primary School Arithmetic". Asst. Prof. Dr. Kanyarat Sriwisathiyakun is the thesis advisor.

School of Industrial Education and Technology acknowledge on your professional competence in regarding field, the school would like to invite you as a senior expert to evaluate on accuracy and appropriate of the content on research's instruments. The recommendations and reviews from your assessment will be beneficial to the completeness of Ms. Tianjie Chen's research.

Please consider on this invitation and the school is looking forward and most appreciated for your kind acceptance.

Yours Sincerely,

(Assistant Professor Dr.Worapong Pairindra)

2022/03/07 Time 15:11:18 Non-PKI Server Sign=N
Signature Code : QQBCA-[illegible]-A0ADk-AOABD

No.

School of Industrial Education and Technology
King Mongkut's Institute of Technology Ladkrabang
1 Chalongkrung Soi 1, Ladkrabang District,
Bangkok 10520, Thailand

March 7 , 2022

Dear Dr. Kittisak Panngam

Enclosed with the research's instruments

Ms. Tianjie Chen, a master's degree student in Master of Science Program in Technology-Enhanced Learning and Innovation, King Mongkut's Institute of Technology Ladkrabang is working on a thesis title "Learning Achievement and Satisfaction Using Satisfaction in Primary School Arithmetic". Asst. Prof. Dr. Kanyarat Sriwisathiyakun is the thesis advisor.

School of Industrial Education and Technology acknowledge on your professional competence in regarding field, the school would like to invite you as a senior expert to evaluate on accuracy and appropriate of the content on research's instruments. The recommendations and reviews from your assessment will be beneficial to the completeness of Ms. Tianjie Chen's research.

Please consider on this invitation and the school is looking forward and most appreciated for your kind acceptance.

Yours Sincerely,

(Assistant Professor Dr.Worapong Pairindra)

2022/03/07 Time: 15:42:04 Non-PKI Server Sign-LN
Signature Code: MwA1A-DcANq-A2ADU-LAMqA3

APPENDIX D

Table D.1 The changes of students' achievements before and after the experiment

Serial number	Gender	Pre-test results	Post-test results	Change before and after
1	Female	45	85	40
2	Male	25	60	35
3	Male	50	85	35
4	Male	30	50	20
5	Male	60	90	30
6	Female	45	70	25
7	Male	70	80	10
8	Male	45	75	30
9	Male	80	85	5
10	Female	40	60	20
11	Female	70	80	10
12	Female	65	80	15
13	Female	80	85	-5
14	Male	65	90	25
15	Male	60	80	20
16	Male	75	90	15
17	Female	55	80	25
18	Male	60	80	20
19	Male	65	80	15
20	Male	70	80	10
21	Male	60	80	20
22	Male	65	80	15
23	Female	70	85	15
24	Male	60	80	20
25	Female	55	80	25
26	Female	65	80	15
27	Female	65	80	15
28	Female	65	80	15
29	Female	90	95	5
30	Female	85	95	10

IOC Pre-test Part I and II

Description:

This test is part of a study Effectiveness of Gamification Learning Activities in Basic Arithmetic Operations. Your responses are valuable and considered highly confidential. This test has 2 sections.

Direction:

Read through the test questions in this form. Please indicate the degree to which each item is congruent with the objective of this study. If you have any comments on the congruence of each question, please record them in the space provided. Tick (✓) to rate the congruence according to the scale below.

+1 = certain that the question is congruent with themes of Effectiveness of Gamification Learning Activities in Basic Arithmetic Operations.

0 = uncertain that the question is congruent with themes of Effectiveness of Gamification Learning Activities in Basic Arithmetic Operations.

-1 = certain that the question is NOT congruent with themes of Effectiveness of Gamification Learning Activities in Basic Arithmetic Operations.

Part I

Table D.2 The results of IOC pre-test part I by three experts

No.	Question items	Expert			∑R	IOC	Result
		1	2	3			
1.	50+31=? (a)20 (b)81 (c)31 (d)40	+1	+1	+1	3	1.00	Used
2.	20+25=? (a)45 (b)55 (c)40 (d)60	+1	+1	+1	3	1.00	Used
3.	68+72=? (a)150 (b)138 (c)120 (d)152	+1	+1	+1	3	1.00	Used
4.	105-22=? (a)73 (b)93 (c)83 (d)102	+1	+1	+1	3	1.00	Used
5.	85-72=? (a)13 (b)23 (c)157 (d)23	+1	+1	+1	3	1.00	Used
6.	95-68=? (a)28 (b)31 (c)27 (d)31	+1	+1	+1	3	1.00	Used
7.	45×5=? (a)200 (b)225 (c)180 (d)215	+1	+1	+1	3	1.00	Used

Table D.2 (Continued)

No.	Question items	Expert			∑R	IOC	Result
		1	2	3			
8.	15×5=? (a)60 (b)75 (c)80 (d)65	+1	+1	+1	3	1.00	Used
9.	24×8=? (a)32 (b)125 (c)168 (d)192	+1	+1	+1	3	1.00	Used
10.	30÷6=? (a)5 (b)6 (c)7 (d)8	+1	+1	+1	3	1.00	Used
11.	69÷3=? (a)32 (b)21 (c)23 (d)33	+1	+1	+1	3	1.00	Used
12.	121÷11=? (a)11 (b)12 (c)13 (d)15	+1	+1	+1	3	1.00	Used

Part II

Table D.3 The results of IOC pre-test part II by three experts

No.	Question items	Expert			∑R	IOC	Result
		1	2	3			
1.	85÷5×6=? (a)20 (b)21 (c102 (d)99	+1	+1	+1	3	1.00	Used
2.	60+47×5=? (a)295 (b)423 (c)265 (d)535	+1	+1	+1	3	1.00	Used
3.	(72+63)÷5=? (a)32 (b)27 (c)23 (d)28	+1	+1	+1	3	1.00	Used
4.	64÷(35-27)=? (a)9 (b)8 (c)16 (d)14	+1	+1	+1	3	1.00	Used
5.	45×9-260=? (a)145 (b)135 (c)68 (d)32	+1	+1	+1	3	1.00	Used
6.	190+360÷60=? (a)9 (b)20 (c)185 (d)196	+1	+1	+1	3	1.00	Used
7.	250÷5-15=? (a)35 (b)20 (c)253 (d)30	+1	+1	+1	3	1.00	Used
8.	(42+58)×12=? (a)12 (b)12000 (c)120 (d)1200	+1	+1	+1	3	1.00	Used

IOC Post-test Part I and II

Description:

This test is part of a study Effectiveness of Gamification Learning Activities in Basic Arithmetic Operations. Your responses are valuable and considered highly confidential. This test has 2 sections.

Direction:

Read through the test questions in this form. Please indicate the degree to which each item is congruent with the objective of this study. If you have any comments on the congruence of each question, please record them in the space provided. Tick (✓) to rate the congruence according to the scale below.

+1 = certain that the question is congruent with themes of Effectiveness of Gamification Learning Activities in Basic Arithmetic Operations.

0 = uncertain that the question is congruent with themes of Effectiveness of Gamification Learning Activities in Basic Arithmetic Operations.

-1 = certain that the question is NOT congruent with themes of Effectiveness of Gamification Learning Activities in Basic Arithmetic Operations.

Part I

Table D.4 The results of IOC post-test part I by three experts

No.	Question items	Expert			∑R	IOC	Result
		1	2	3			
1.	123+69=? (a)202 (b)192 (c)183 (d)213	+1	+1	+1	3	1.00	Used
2.	48+369=? (a)517 (b)417 (c)407 (d)427	+1	+1	+1	3	1.00	Used
3.	127+87=? (a)204 (b)214 (c)192 (d)194	+1	+1	+1	3	1.00	Used
4.	253-158=? (a)95 (b)82 (c)104 (d)158	+1	+1	+1	3	1.00	Used

Table D.4 (Continued)

No.	Question items	Expert			∑R	IOC	Result
		1	2	3			
5.	359-42=? (a)298 (b)307 (c)289 (d)317	+1	+1	+1	3	1.00	Used
6.	284-16=? (a)277 (b)268 (c)257 (d)234	+1	+1	+1	3	1.00	Used
7.	57×9=? (a)413 (b)602 (c)513 (d)320	+1	+1	+1	3	1.00	Used
8.	19×36=? (a)684 (b)650 (c)544 (d)684	+1	+1	+1	3	1.00	Used
9.	148×18=? (a)2794 (b)2664 (c)2305 (d)86	+1	+1	+1	3	1.00	Used
10.	345÷23=? (a)22 (b)32 (c)16 (d)15	+1	+1	+1	3	1.00	Used
11.	891÷9=? (a)91 (b)89 (c)99 (d)81	+1	+1	+1	3	1.00	Used
12.	437 ÷19=? (a)22 (b)23 (c)32 (d)33	+1	+1	+1	3	1.00	Used

Part II

Table D.5 The results of IOC post-test part II by three experts

No.	Question items	Expert			∑R	IOC	Result
		1	2	3			
1.	125÷5×48=? (a)1200 (b)1280 (c)1320 (d)1300	+1	+1	+1	3	1.00	Used
2.	728÷7÷4=? (a)25 (b)26 (c)28 (d)31	+1	+1	+1	3	1.00	Used
3.	(306-277)×15=? (a)240 (b)435 (c)423 (d)543	+1	+1	+1	3	1.00	Used

Table D.5 (Continued)

No.	Question items	Expert			∑R	IOC	Result
		1	2	3			
4.	746+612÷6=? (a)226 (b)227 (c)848 (d)327	+1	+1	+1	3	1.00	Used
5.	81×4-231÷11+4×9=? (a)339 (b)1369 (c)324 (d)1200	+1	+1	+1	3	1.00	Used
6.	145÷5×6+42=? (a)42 (b)95 (c)92 (d)216	+1	+1	+1	3	1.00	Used
7.	12×48÷9-(8+37)=? (a)19 (b)54 (c)1321 (d)653	+1	+1	+1	3	1.00	Used
8.	8.18×(423÷47)×7÷189=? (a)26 (b)6 (c)19 (d)225	+1	+1	+1	3	1.00	Used

IOC Satisfaction Questionnaire

Description:

This Questionnaire is part of a study Satisfaction with Gamification Learning Activities in Basic Arithmetic Operations. Your responses are valuable and considered highly confidential.

Direction:

Read through the test questions in this form. Please indicate the degree to which each item is congruent with the objective of this study. If you have any comments on the congruence of each question, please record them in the space provided. Tick (✓) to rate the congruence according to the scale below.

+1 = certain that the question is congruent with themes of Satisfaction with Gamification learning Activities in Basic Arithmetic Operations.

0 = uncertain that the question is congruent with themes of Satisfaction with Gamification learning Activities in Basic Arithmetic Operations.

-1 = certain that the question is NOT congruent with themes of Satisfaction with Gamification learning Activities in Basic Arithmetic Operations.

Table D.6 The results of IOC questionnaire by three experts

No.	Question items	Expert			∑R	IOC	Result
		1	2	3			
1.	1. Online gamification learning activities were very interesting?	+1	+1	+1	3	1.00	Used
2.	I enjoyed learning basic arithmetic more through online gamification learning activities.	+1	+1	+1	3	1.00	Used
3.	Online gamification learning activities helped me to improve my basic arithmetic learning.	+1	+1	+1	3	1.00	Used
4.	I liked the system interface of the online gamification learning software.	+1	+1	+1	3	1.00	Used

Table D.6 (Continued)

No.	Question items	Expert			∑R	IOC	Result
		1	2	3			
5.	I will use the online gamification learning software for more learning in the future.	+1	+1	+1	3	1.00	Used
6.	The online gamification learning activities have made me more confident in learning basic arithmetic operations.	+1	+1	+1	3	1.00	Used
7.	The online gamification learning software was easy and convenient to operate.	+1	+1	+1	3	1.00	Used
8.	The interface of the online gamification learning software was colorful.	+1	+1	+1	3	1.00	Used
9.	The online gamification learning activities can improve my enjoyment of arithmetic.	+1	+1	+1	3	1.00	Used
10.	The online gamification learning activities are very efficient for learning?	+1	+1	+1	3	1.00	Used
11.	Through online gamification learning activities, I can acquire knowledge faster.	+1	+1	+1	3	1.00	Used
12.	Online gamification learning activities are more conducive to cooperative learning	+1	+1	+1	3	1.00	Used
13.	Online gamification learning activities make my thinking more agile	+1	+1	+1	3	1.00	Used
14.	In my study, I often use online gamification learning software to get interesting feelings.	+1	+1	+1	3	1.00	Used
15.	I fell in love with math class through online gamification learning activities.	+1	+1	+1	3	1.00	Used

APPENDIX E

Pictures of Conducting Research Experiments

Figure E.1 Quizizz Gamification Learning Activities in Class

Figure E.2 PPT Gamification Learning Activities in Class

Figure E.3 Kahoot video teaching

Figure E.4 Kahoot Gamification Learning Activities in Class

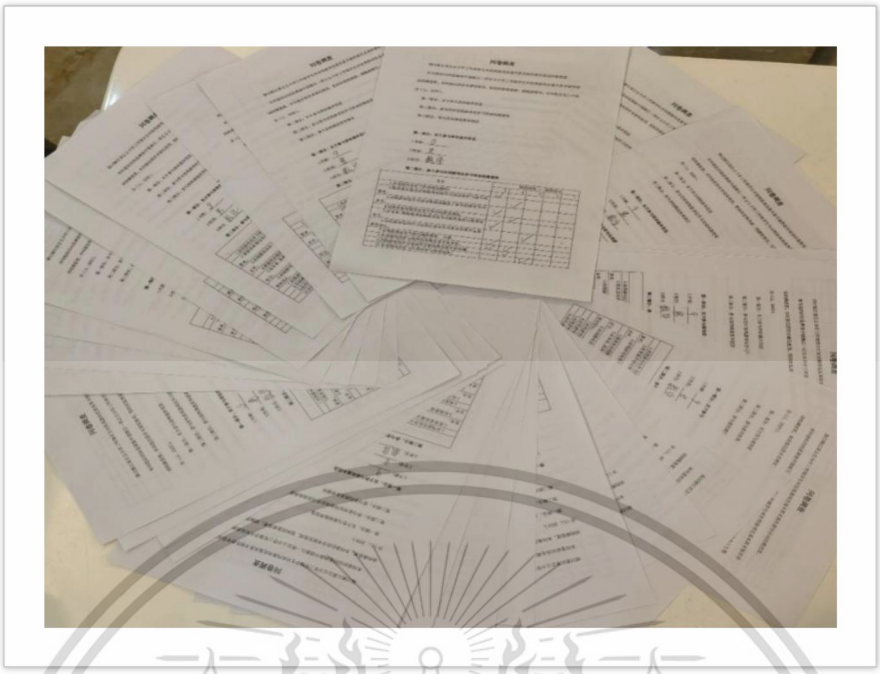


Figure E.5 The front of the paper questionnaire

Figure E.6 The reverse of the paper questionnaire

Figure E.7 Pre-test paper

Figure E.8 Post-test paper

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