Implementing of the BOPPPS Model on Basic Properties of Fractions Using Hawgent Dynamic Mathematics Software in Elementary Education

Zhuoya Wen[1], Jianlan Tang[1,*]
College of Mathematics and Statistics, Guangxi Normal University, Guilin, Guangxi, China
*tjlwxt@mailbox.gxnu.edu.cn

Abstract

The rapid development of information technology, informationization of education has become inevitable. Starting from the necessity of information-based teaching, this paper introduces the basic structure of the BOPPPS model and analyzes the content of each stage of the model. On this basis, the BOPPPS model is applied to the teaching of basic properties of fractions with the help of Hawgent dynamic mathematics software, in order to provide a theoretical basis for teachers to improve the teaching and methods of elementary mathematics, enhance the efficiency of classroom teaching, and help the implementation of "double reduction".

Keywords: *BOPPPS model; Hawgent dynamic mathematics software; mathematics teaching; basic properties of fractions*

1. INTRODUCTION

With the rapid development of information technology, we have ushered in a new information era, which has not only changed people's production and life style, but also influenced the change and innovation of the education system. Education informatization has become a necessary way to realize education modernization and build a learning society (Zongkai & Ji, 2013).. The arrival of the information era has made education informatization inevitable.

The Mathematics Curriculum Standards for Compulsory Education (2022 Edition) states that "we should focus on the integration of information technology and mathematics teaching and learning, pay attention to the role of big data and artificial intelligence in promoting the reform of mathematics teaching and learning, improve teaching methods, and promote the transformation of students' learning styles" (Ministry of Education of the People's Republic of China, 2022). The 2022 edition of the curriculum standards emphasizes the integration of information technology and mathematics teaching, and we should use information technology well and integrate it with mathematics teaching to better improve teaching and promote the development of students' core literacy in mathematics.

As an important basic course in primary education, mathematics plays a

significant role in students' future learning development as well as social adaptation. At the elementary school level, students' thinking is dominated by concrete images, abstract thinking develops slowly, and they lack abstract mathematical thinking, so when learning mathematical knowledge, they need to use image-concrete objects and situations to assist their understanding (Xiaomin, 2016). At present, many elementary school mathematics classrooms are still stuck in the traditional teaching method, and the problems of "insufficient information-based teaching resources, few information-based teaching methods, and weak information-based teaching ability" need to be solved. Therefore, teachers should pay attention to the application of information technology in classroom teaching, turn abstraction into concrete, present course content intuitively, and improve teaching quality (Helsa & Kenedi, 2019).

Hawgent dynamic mathematics software is a software that uses information technology to assist in mathematics teaching and learning, with the basic features of flexible and convenient operation, powerful mathematics teaching and learning, and a rich series of dynamic resources, as well as the ability to present mathematical objects and thinking mathematically, visually, and dynamically (Dengfeng et al., 2018). It has been shown that the application of Hawgent dynamic mathematics software to assist teaching and learning can improve students' mathematical performance to some extent, and students' comprehension and memory, and thinking level have been improved more significantly (Jianghua, 2018). Under the trend of information-based teaching, Hawgent precisely makes up for the shortcomings in traditional teaching, and can present the teaching contents visually and graphically, which is in line with the developmental characteristics of primary and secondary school students' thinking.

The BOPPPS teaching model originated in Canada as a way for teachers to use to break down lessons and effectively guide them in designing the teaching process and organizing classroom instruction. At present, the BOPPPS teaching model has been introduced and adopted by many teaching institutions in 33 countries around the world, and practice shows that the teaching model combines effect, efficiency and benefit. In the past two years, the BOPPPS teaching model has been widely concerned and promoted in China, but it is mainly applied to the research of higher education teaching, and there is little practical teaching research based on Hawgent and BOPPPS teaching model in elementary mathematics teaching.

Basic properties of fractions is a fifth grade teaching content, which is the application and development of the relationship between fractions and division, and is the basis of subsequent approximate and common fractions, with an important role of carrying on and

starting. The basic properties of fractions are based on the concept of equal size of fractions (Putra, 2019). In traditional teaching, teachers mostly draw blackboard for students to observe the changes of graphs, but the teaching efficiency is low compared with dynamic math software. In order to highlight the key points and crack the difficult points, teachers can use information technology in the teaching process and make use of the quality resources of Hawgent dynamic mathematics software to guide students to observe the change of fraction size with a mathematical perspective to reduce the cognitive load of students and improve the efficiency of classroom teaching (Yuanzhong & Yongjiang, 2019).

Therefore, in this paper, I attempt to design the teaching of basic properties of fractions based on the basic framework of BOPPPS model and combined with Hawgent dynamic mathematics software, and explore the application of BOPPPS model and Hawgent dynamic mathematics software in the teaching of elementary mathematics, in order to provide a theoretical basis for instructors to improve the teaching and methods of elementary mathematics, enhance the efficiency of classroom teaching, and help "double reduction" to be implemented.

2. OVERVIEW MODEL

The model used in this study is BOPPPS teaching model.BOPPPS is a closed-loop feedback teaching model for teaching interaction and reflection (Changdong et al., 2019), and divides the teaching process into 6 stages: B(Bridge-in), O(Objective), P(Pre-assessment), P(Participatory learning), P(Post-assessment), and S(Summary), and its structure is shown in the figure below.

Bridge-in

The main task of this stage is to introduce the content of the lesson, stimulate students' desire and interest in learning, and shift their attention to the class. The teacher needs to pay attention to emphasizing the importance of this section and guiding students to start the new lesson by telling a story, connecting to the knowledge learned before, or showing a video (Danping & Xingyao, 2016).

Objective

The main purpose of this stage is to clarify the learning objectives of the lesson so that students understand what level they should achieve or what knowledge they can gain after learning the lesson. The learning objectives are determined based on three main aspects: cognitive, affective, and skills (Jianxun & Lin, 2016), which indicate the learning direction for students and provide teachers with guarantees for designing and improving instruction.

Pre-assessment

The main task of this stage is to test the students, to understand and analyze the learning situation, and to prepare for subsequent teaching (Weiwei et al.,

2014). The Pre-assessment is set according to students' abilities and teaching content, etc. and can be in the form of questions, discussions, exams and questionnaires, as well as multiple-choice questions, fill-in-the-blank questions and presentation of pre-test results

Participatory Learning

This stage is the main part of classroom teaching. By adopting active learning strategies for students to actively participate in classroom activities, highlighting students' main position, stimulating students' interest and enthusiasm in learning, and achieving classroom teaching objectives through teacher-student and student-student interaction.

Post-assessment

The post-test is mainly to test whether the teaching objectives of the course are achieved and what students have learned through various means, and to feedback the learning effect and improve the teaching better (Suojuan et al., 2017). For different course content, a variety of assessment methods can be used.

Summary

At the end of the class, a lesson summary is needed to help students review what they have learned in this lesson and to preview the content of the next lesson, etc. The summary can be done by the teacher, pointing out the important and difficult points of the lesson, as well as assigning homework, etc.; or it can be guided by the students to deepen their understanding of the knowledge by sorting out the content of the lesson.
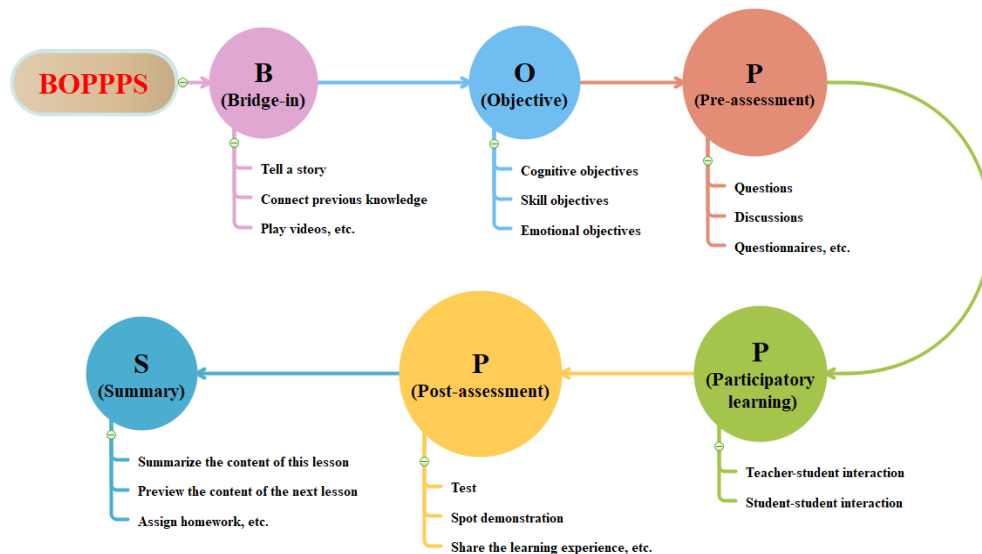

Figure 1. BOPPPS Model

The basic structure of the BOPPPS model is shown in Figure 1. As can be seen from the figure, the model consists of six stages: B(Bridge-in), O(Objective), P(Pre-assessment), P(Participatory learning), P(Post-assessment), and S(Summary), and the above six modules are coherent to form a complete and effective classroom process. Among them, the Participatory learning stage is the main part, which emphasizes the main position of students in classroom activities, which is the fundamental difference between the BOPPPS model and traditional classroom teaching design.

In addition, we can see the main tasks and contents of each phase of the BOPPPS model. The Bridge-in stage introduces new lessons by telling stories, connecting previous knowledge and showing videos to stimulate students' interest in learning; the Objective stage sets learning objectives in three aspects: cognitive, emotional and skills; the Pre-assessment stage tests students by asking questions, taking group discussions or filling out questionnaires to understand their knowledge base; the Participatory learning stage is the main part of the classroom teaching, through teacher-student and student-student interaction, students participate in the classroom and achieve the learning objectives; the Post-assessment stage mainly tests students' mastery of knowledge and whether the learning objectives have been achieved through various means, such as tests, spot demonstration and sharing of learning experiences; the Summary stage summarizes the class, reflects on what has been learned, introduces the next lesson or assigns homework, etc.

In order to achieve better teaching results, the specific steps of each stage need to be combined with the actual application context and the appropriate teaching method.

3. DESIGN MODEL

In this paper, we use the BOPPPS model as a guide to construct a Hawgent-supported instructional design model for basic properties of fractions, and explore how to apply the BOPPPS model to elementary school mathematics classrooms to achieve optimal teaching effectiveness. As shown in Figure 1, the instructional design process of basic fraction properties is also divided into six stages: Bridge-in, Objective, Pre-assessment, Participatory learning, Post-assessment, and Summary, which are elaborated below.

Bridge-in

At this stage, the teacher introduces the basic properties of fractions by telling the story "Pigsy Eats Watermelon" to stimulate students' desire and interest in learning.

The four Tang monks got a watermelon on the way to get the scriptures, the greedy Pigsy wanted to eat more, the master said to give him $\frac{1}{2}$, Pigsy thought it was too little; give him $\frac{2}{4}$

, he still thought it was too little; then the master said to give him $\frac{4}{8}$, Pigsy felt it was a lot, and immediately agreed, but the Monkey King was snickering, do you know why the Monkey King laughed? Through the study of this class, I believe you will have the answer soon.

Objective

At this stage, it is necessary to clarify the learning objectives of the lesson to indicate the direction for teaching. According to the characteristics of students' psychological development and the law of cognitive development, as well as the characteristics of the teaching content of basic properties of fractions, the following learning objectives are set.

Cognitive objectives: to understand the practical meaning of fractions, to understand and master the basic properties of fractions, and to be able to apply the basic properties of fractions to solve practical problems.

Skill objectives: In the process of independent investigation, group exchange and discussion of basic properties of fractions, improve the ability to identify problems, ask questions, analyze and solve problems, and enhance the initial logical thinking skills such as observation, comparison, abstraction and generalization.

Emotional objectives: Through the exploration of the basic properties of fractions, students' interest in mathematics is increased and they can further appreciate that mathematics comes from life and serves life.

Pre-assessment

In this stage, students are mainly tested through the question to understand their grasp of the previously learned knowledge, so as to better carry out subsequent teaching activities.

(1) Express the colored parts as fractions. Can you get an equal set of fractions?

Let students use fractions to represent the coloring part to test their knowledge about fractions, and at the same time, let them find out that the 3 fractions obtained are equal in size, so as to prepare the ideological foundation for learning the basic properties of fractions.

Participatory Learning

At this stage, Hawgent dynamic math software is used to visually display the different shapes, guide students to represent the colored parts with fractions, observe the size of the colored parts, explore the basic properties of fractions, and increase students' classroom participation.

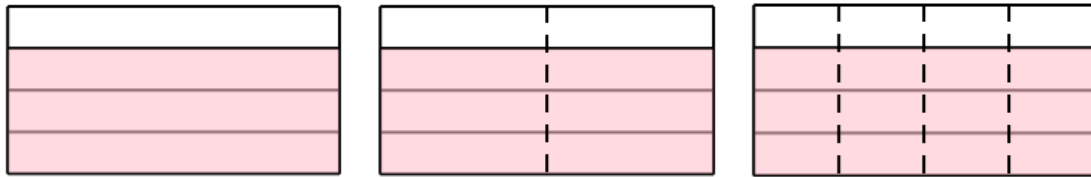(1) Observe the square and use fractions to represent the colored parts.

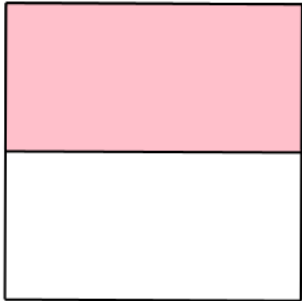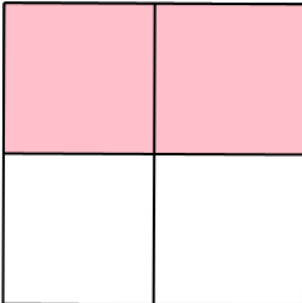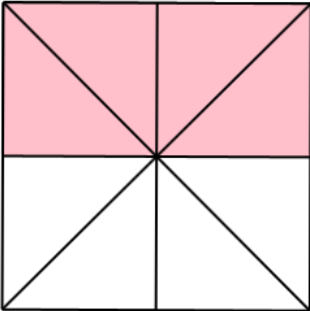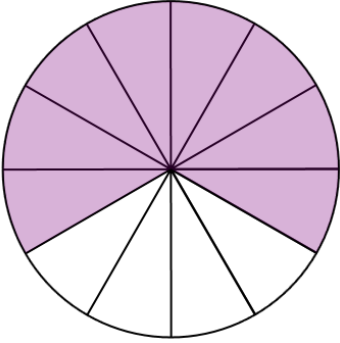Figure 2. Pre-assessment

Table 1. Participatory Learning

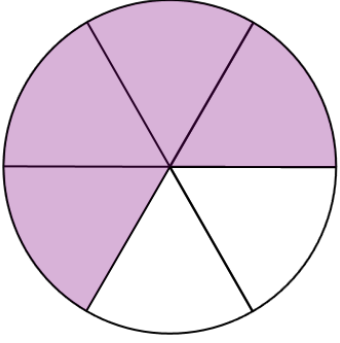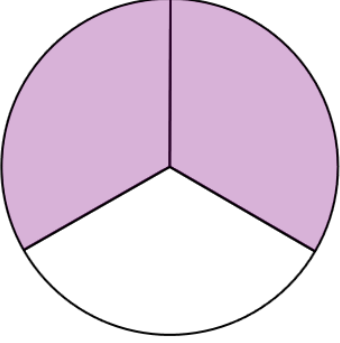| No.	Visual Stages	Explanation
1		First, Hawgent Dynamic Math software is used to display this integrable ware. The square is divided into 2 parts, with the colored part taking up 1 part.
2		Next, keeping the area of the colored part unchanged, change the number of equal parts of the square, which is then divided into 4 parts, of which the colored part takes up 2 parts.
3		Finally, keeping the area of the colored part unchanged, change the number of equal parts of the square, which is then divided into 8 parts, of which the colored part takes up 4 parts.

Table 2. Participatory Learning.

No.	Visual Stages	Explanation
1		First, Hawgent Dynamic Math software is used to display the integrable ware. The circle is divided into 12 parts, of which the colored part takes up 8 parts.
2		Next, keeping the area of the colored part unchanged, change the number of equal parts of the circle, which is divided into 6 parts, of which the colored part takes up 4 parts.
3		Finally, keeping the area of the colored part unchanged, change the number of equal parts of the circle, which is divided into 3 parts, of which the colored part takes up 2 parts.

(3)Group exchange and discussion: What do you find when you observe the two sets of fractions above?

Students exchange and discuss the resulting 2 sets of fractions. With the teacher's guidance, students can find out that for the 1st set of fractions, multiplying the numerator and denominator of $\frac{1}{2}$ by 2 gives $\frac{2}{4}$;

multiplying the numerator and denominator of $\frac{2}{4}$ by 2 gives $\frac{4}{8}$, and the size of the fraction remains the same.

For the 2nd set of fractions, divide the numerator and denominator of $\frac{8}{12}$ by 2 to get $\frac{4}{6}$; divide the numerator and denominator of $\frac{4}{6}$ by 2 to get $\frac{2}{3}$, and the size of the fraction remains the same.

(4) Can you state the conclusion of your findings in one sentence?

The teacher guides students to abstractly summarize and conclude the basic property of fractions: the numerator and denominator of a fraction are multiplied or divided by the same number (except 0) at the same time, the size of the fraction remains the same.
The teacher takes care to emphasize the exception of 0.

Post-assessment

In this stage, students' mastery of the basic properties of fractions and the achievement of the learning objectives are tested through exercises.

1. Now let's see: Why did the Monkey King snigger? Were the watermelons of the same size given to Pigsy by the master?

2. Convert both $\frac{5}{6}$ and $\frac{1}{4}$ into fractions whose denominators are 12 and whose magnitudes remain the same.

Summary

Finally, the teacher guides students to review what they have learned in this lesson to deepen their understanding.

First of all, present the following content on the courseware, and emphasize the review and thinking first. Then ask the students, and emphasize the points for attention.

(1)What have I learned in this class? How did I learn it?

(2)What impressed me most in this class and why?

(3)What other thoughts or discoveries do I have in this class?

4. CONCLUSION

In this paper, I try to explore the application of Hawgent dynamic mathematics software in teaching basic properties of fractions based on the BOPPPS teaching model. The teaching practice shows that the BOPPPS teaching mode supported by Hawgent can stimulate students' learning interest, improve students' learning participation, enhance interactive communication and feedback between teachers and students, and can effectively improve teaching efficiency and teaching quality, which has good application prospects. What ’ s more, this study has certain reference value for mathematics teachers' teaching, and front-line mathematics teachers can try to use Hawgent dynamic mathematics software to assist the teaching of elementary mathematics, improve the efficiency of classroom teaching, and reduce the burden and increase the efficiency better.

REFERENCES

Changdong, W., Hua, J., & Yongqiang, C. (2019). Research and application of BOPPPS teaching method in MOOC instructional design. *Experimental Technology and Management*, 2, 218 - 222. DOI:10.16791/j.cnki.sjg.2019.02.053.

Danping, C., Xingyao, Y. (2016). The Canadian BOPPPS teaching model and its inspiration for higher education reform. *Laboratory Research and Exploration*, *35*(2), 196-200+249.

Dengfeng, X., Nini, C., & Jianlan, T. (2018). Hawgent Haojun dynamic mathematical technology:a "magic tool" for improving students' mathematical cognition. *Research on Teaching in Primary and Secondary School Classrooms, 1*, 9-15.

Jianghua, H. (2018). *Experimental study on applying Hawgent (Hawgent) dynamic mathematics software to assist secondary school mathematics teaching*. Guangxi Normal University.

Jianxun, Z., & Lin, Z. (2016). Effective classroom teaching design based on BOPPPS model. *Vocational and Technical Education, 37*(11), 25 - 28.

Helsa, Y., & Kenedi, A. K. (2019). Edmodo-based blended learning media in learning mathematics. *Journal Of Teaching and Learning in Elementary Education, 2*(2), 107-117. http://dx.doi.org/10.33578/jtlee.v2i2.7416

Ministry of Education of the People's Republic of China. (2022). *Curriculum standards for compulsory education in mathematics (2022 edition).* Beijing Normal University Press.

Putra, Z. H. (2019). Elementary teachers' knowledge on fraction multiplication: An anthropological theory of the didactic approach. *Journal of Teaching and Learning in Elementary Education,2*(1), 47-52. http://dx.doi.org/10.33578/jtlee.v2i1.6964

Suojuan, Z., Xianglin, L., Xiaohan, Y., & Wenbin, X. (2017). Teaching design of flipped classroom under the framework of BOPPPS model. *Computer Education, 1,* 18-22. DOI:10.16512/j.cnki.jsjjy.2017.01.006. eiwei, C., Aihua, B., Qing, L., Zhigang, L., & Yanqin, T. (2014). Teaching design for developing computational thinking based on BOPPPS model and problem-driven teaching method. *Industrial and Information Technology Education, 6*, 8-11+18.

Xiaomin, Z. (2016). Research on the innovation of elementary school mathematics teaching supported by information technology. *China's E-learning, 8*, 115-119.

Yuanzhong, C., & Yongjiang, Z. (2019). A case study on the wisdom education of elementary school mathematics "basic properties of fractions". *China Information Technology Education*, *5,* 61-63.

Zongkai, Y., & Ji, W. (2013). Capacity building of education informatization for sustainable development. *Modern Distance Education Research, 2*, 3-9