
Research on Case Design of Comprehensive Practice Activities in High School Mathematics

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Abstract – Both the "Compulsory Education Mathematics Curriculum Standards (2022 Edition) ^[1]" and the "General High School Mathematics Curriculum Standards (2022 Edition)" emphasize the need to integrate comprehensive practical activities into teaching, indicating their important position in mathematics teaching. At the same time, both the curriculum standards and textbooks recommend conducting comprehensive practical activities in the form of research projects, which will redefine the way high school mathematics is taught and learned in practice ^[2]. Mathematics comprehensive practice activities emphasize students' active participation and exploration, and have profound educational value. Therefore, how to educate people through comprehensive mathematical practice activities has become a very worthwhile research question.

Keywords – Comprehensive Practice Activities, Mathematics Learning, Core Competencies.

I. RESEARCH BACKGROUND

Mathematics is one of the core subjects in the basic education stage. Currently, mathematics education faces problems such as high academic pressure, tight classroom time, and heavy tasks, which make teachers, students, and parents pay more attention to exam taking skills training. This heavy scoring education has to some extent improved students' exam scores, but it has neglected the cultivation of students' comprehensive qualities. In this context, comprehensive practical learning, which requires more time and energy, is difficult to fully implement.

Comprehensive practical activities enable students to explore and think, which is an important breakthrough in the new curriculum reform. The 2022 version of the "Mathematics Curriculum Standards for Ordinary High Schools"^[4] proposes a so-called new learning method and emphasizes that comprehensive mathematical practice activities are a process in which students personally experience the activities, actively explore and solve mathematical problems in their daily lives ^[iv]. It focuses on the process of the activity, not the outcome.

II. RESEARCH PURPOSE AND SIGNIFICANCE

2.1. Research Objective

This article starts from the comprehensive practical activities of mathematics, and based on the cognitive and comprehensive practical abilities in core competencies, combined with the thinking characteristics of high school students, designs acceptable comprehensive practical activity teaching cases that meet curriculum standards, textbooks, and students' interests, so that comprehensive practical activities have good teaching effects, thereby increasing students' gains through comprehensive practical activities, enriching their learning methods of mathematical knowledge, improving core competencies, and further optimizing the design of comprehensive practical activity plans, providing reference opinions for frontline teachers in middle schools.

2.2. Research Significance

Enrich the learning methods of high school students, enhance their core mathematical literacy, broaden their

horizons, and improve their action ability and hands-on awareness in practical activities ^[5]. While actively exerting students' subjective initiative, it also transforms the knowledge imparted to students into actively acquiring knowledge, observing and using mathematical knowledge in real situations, optimizing mathematical comprehensive practice activities, providing reference value for mathematics teachers, exploring mathematical knowledge in real life, and enriching the teaching methods of mathematics on the basis of fully utilizing the resources of mathematical comprehensive practice activities.

At present, the teaching design and curriculum implementation of middle school mathematics comprehensive practice activities are not yet perfect ^[6]. It is necessary to understand their teaching status and carry out specific teaching design, which is conducive to enriching the relevant research on cultivating students through mathematics comprehensive practice activities ^[7].

III. THEORETICAL BASIS

3.1. Constructivist Theory

Constructivism advocates that students are the main body in the teaching process, and teachers, as the leaders of the teaching process, help students explore and solve problems during the teaching process. Mathematical comprehensive practical activities are an essential practical course for students in the process of learning mathematics. Students learn in context, practice in the process, stimulate their thinking, discover and solve problems through continuous adjustment, and thus enhance their mathematical core literacy.

3.2. The Theory of Integration of Knowledge and Action

The theory of integration of knowledge and action proposes that "learning through life, learning through experience, and learning through practice" is an important way to acquire knowledge, and practice is the key to true knowledge. Mathematics comprehensive practice activities emphasize the experience of life, promote the deep development of students' thinking, and enable students to actively learn and conduct in-depth research through relatively relaxed and enjoyable practical activities. Through practice, students can better understand the charm of mathematics.

3.3. Humanistic Theory

Humanistic theory emphasizes the subject status of students in the learning process, values each learner in the learning process, and respects individual differences of each student. Humanism provides direction for the case design of mathematical comprehensive practical activities, starting from students' psychological characteristics, designing practical activities that students can understand and are interested in. At the same time, in the activity, the teacher is just a moderator, encouraging and guiding students to truly realize their "selves" and reflect the joy of practical activities.

IV. DEFINITION OF CORE CONCEPTS

Mathematics Comprehensive Practice Activity:

In this article, mathematical comprehensive practice activities are learning activities that focus on students' active participation and independent exploration. In the process of carrying out activities, students discover, analyze, and solve problems based on their existing experience background, and teachers play a guiding role. T-

-throughout the entire activity process, more attention should be paid to practice.

V. PRINCIPLES AND BASIC ELEMENTS OF HIGH SCHOOL MATHEMATICS

Comprehensive Practical Activity Design

Based on the content and characteristics of high school mathematics comprehensive practice activities and the ideological and behavioural characteristics of high school students, and based on the relevant theories mentioned in the previous text, the design principles and basic steps of high school mathematics comprehensive practice activities are summarized as follows:

5.1. *Design Principles*

(1) *Educational Principle*

Mathematics comprehensive practice activities are one of the ways to cultivate students' core competencies. The design of the activity plan should clarify specific goals, content, and the design of the plan. The core competency cultivation goals should be integrated into the activity content, allowing students to practice, learn collaboratively, and explore together, and implement educational objectives in practice.

(2) *Principle of Comprehensiveness*

The focus of mathematical comprehensive practice activities is on synthesis, which not only includes the learning of mathematics, but also the learning of knowledge from other disciplines and the connection between mathematics and other disciplines. At the same time, attention is paid to the flexible application of mathematical knowledge and methods, as well as the exploration of the problem at different levels and depths. Therefore, in the process of topic selection and design, comprehensiveness is necessary.

(3) *Principle of Feasibility*

The principle of feasibility for specific cases of comprehensive practical activities should be reflected in whether they are suitable for implementation and operation, taking into account various conditions such as schools, teachers, and students. The overall grasp of the time, location, and personnel arrangement of the activities should be made, and the safety of the activities should be considered during the design process. Possible problems should be planned and avoided before the activities are carried out, and corresponding measures should be taken.

5.2. *Basic Steps*

(1) *Identify Problems and Determine the Theme of Practical Activities*

In the stage of identifying problems, teachers need to consider multiple factors. In addition to the specific content requirements stipulated in the curriculum standards and textbooks, they also need to grasp the behavioural characteristics of students and the specific requirements for cultivation, in order to enhance students' learning motivation. At the same time, the theme of practical activities should be consistent with the teaching progress of the course, closely centred around the content of teaching, and the two complement each other.

(2) *Explore Problems and Conceptualize Activity Plans*

In this stage of the activity plan, it is necessary to include the time and location of the activity, the objectives of the activity, the format of the activity, as well as the evaluation method and reflection at the end of the activity. The selection of activity time and location needs to consider the number of participants, transportation convenience, specific routes, safety guarantees, etc. The activity objectives and specific content should be in line with the curriculum standards, textbooks, and students' acceptance level. Pay attention to students' understanding of the value of mathematics and the transformation of mathematical ideas. In the process of inquiry based learning, understanding and mastering the knowledge learned is more helpful in establishing students' emotional attitudes and values.

5.3. *Achievement Display, Formal Implementation, and Practical Optimization*

At this stage of learning, students need to play the role of "masters", and mathematical comprehensive practical activities should enable students to immerse themselves in practical activities. Students should learn with joy and can use various forms such as pictures, videos, and reports to report and display, summarize and communicate in different ways, enhance students' subjective initiative, and effectively improve their participation rate and enthusiasm in practical activities.

Pay attention to the division of labor and cooperation among group members: Students should have a sense of cooperation. Each person in the team has different roles, abilities, and personalities, which makes it easy for members to learn from each other's strengths and weaknesses during the cooperation process and motivate each other.

5.4. *Summary Evaluation, Evaluation Summary, and Emotional Motivation*

This stage is conducted after the presentation of student achievements and can be divided into two parts: summary and evaluation. In the summary stage, it can be done by the teacher or by the students themselves. During the process, in addition to summarizing mathematical knowledge, it is also necessary to summarize the process of activity implementation, teaching methods applied, and learning attitudes.

The evaluation process reflects students' learning attitude, cooperation awareness, expression level, and ability to overcome difficulties, allowing students to clearly see what level they are at in various aspects. At the same time, teachers should guide and avoid correcting students' shortcomings, and give recognition and encouragement to those who perform well.

Typical Case Design of High School Mathematics Comprehensive Practice Activities.

(1) *Teaching Topic:*

The cross-sectional problem of a cube.

(2) *Teaching Objectives:*

1. By thinking and understanding the interface of a cube, understanding the cross-sectional shape of a cube, and cultivating students' ability to observe, think, and reason about things in the process of exploration activities.
2. By exploring activities, students can exercise their practical ability and spatial awareness, enhance their ability to overcome difficulties, and improve their interest in learning mathematics.

(3) *Key and Difficult Points:*

Key point: In the process of exploring the cross-sectional shape of a cube, let students learn independently and collaboratively to draw conclusions.

Difficulty: Being able to analyze problems from different perspectives and comprehensively analyze all situations.

(4) *Course Type:*

Teaching Practice Course.

(5) *Teaching Content:*

Part One:

- (1) Teaching session and time allocation: Identify problems, create scenarios, 5 minutes.
- (2) Teacher activity: Five minutes, scenario: There are many cross-sectional shapes in life, such as cutting watermelon, cutting bread, etc. Cutting a geometric object will result in their cross-sectional shapes, which will also be different shapes from different angles. Present the topic of this lesson: Today, let's study a special common aggregate: a cube and its cross-sectional shape.
- (3) Student activity: Keep up with the teacher's ideas and carefully consider the questions raised by the teacher.
- (4) Design intention: To propose real-life problems, stimulate students' interest in learning, enable them to quickly understand the meaning of cross-sectional shapes, and cultivate their ability to discover mathematical problems in real-life situations.

Part Two:

- (1) Teaching session and time allocation: Exploring questions, 8 minutes.
- (2) Teacher activity: Guide students to interact in groups, discuss between groups, and share their own conclusions. The role of the teacher in guiding and inspiring students during the process is to stimulate their thinking.
- (3) Student activity: Conduct group discussions and share results. Students can prepare some props, such as potatoes, radishes, etc., for hands-on practice and finally draw conclusions.
- (4) Design intention: Create a scenario to guide students to engage in exploratory learning activities, solve problems on their own, and enhance their interest in mathematics learning.

Part Three:

- (1) Teaching session and time allocation: Achievement presentation stage, 25 minutes.
 - (2) Teacher activity: Guide students to present their achievements in groups. After the presentation, if there are any deviations or errors in the students' understanding, the teacher can provide guidance and guide them to continue exploring.
 - (3) Student activity: Group collaboration to showcase achievements.
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- (4) Design intention: To encourage students to learn through the process of problem-solving through 'learning by doing'.

Part Four:

- (1) Teaching session and time allocation: Summary and evaluation stage, 7 minutes.
- (2) Teacher activity: Teacher summarizes: What knowledge did you learn during the process of exploring the cross-sectional shape of a cube? What idea? What are the gains? And conduct a comprehensive evaluation of the results and process.
- (3) Student activity: Follow the teacher's ideas and summarize this lesson.
- (4) Design intention: To help students consolidate the knowledge content of this lesson and stimulate their enthusiasm for designing practical activities on their own after class.

VI. CONCLUSION AND PROSPECT

6.1. Main Conclusions

Mathematical comprehensive practice activities emphasize students' active participation and independent exploration based on problems. In this activity, students discover, analyze, and solve problems based on their own experiential background, while teachers only play a guiding role. The entire activity process focuses on students personally practicing. Mathematical comprehensive practical activities have high educational value and are implemented in every aspect.

6.2. Shortcomings and Prospects

In summary, integrating practical activities into mathematics teaching is of great significance, but the results of this study indicate that there are still many problems in the application of practical activities in actual teaching. The implementation of practical activities requires multi-level and multi-dimensional cooperation from schools, parents, teachers, and students in order to achieve better results. At present, due to the influence of exam oriented thinking, the effectiveness of practical activities is far from ideal. However, in order to cultivate students' comprehensive development in morality, intelligence, physical fitness, aesthetics, and labour, and to contribute to the design of mathematical comprehensive practical activity cases, we provide students with more complete, systematic, and scientific practical opportunities, and provide reference for future research.

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