
Application of Project-Based Learning in Developing Mathematics Application Consciousness of Chinese Senior High School Students

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Abstract – To a certain extent, high school students in China neglect the relationship between mathematics and life, and generally have low awareness of mathematics application, especially in the external application of mathematics, that is, the application of mathematical knowledge to solve practical problems. With the help of project-based learning teaching method, this paper takes the teaching content of "Estimating the Overall Distribution with the Frequency Distribution of Samples" in senior high school mathematics as an example, and puts forward the teaching design of project-based learning teaching method, which is helpful to cultivate students' awareness of mathematics application.

Keywords – High School Mathematics in China, Project-Based Learning Teaching Method, Mathematics Application Consciousness.

I. INTRODUCTION

Mathematics is a discipline that studies quantitative relations and spatial forms. Its application has penetrated into modern society and all aspects of people's lives. The extensive application of mathematics requires students to have a sense of applied mathematics and to improve the ability of apply mathematical knowledge to solve practical problems. Some Chinese high school students believe that mathematics is made up of independent knowledge. The purpose of learning mathematics is to understand the formulas and theorems and obtain the correct solution to the problem. This idea completely separates the connection between mathematics and life and causes students to the application of mathematics is low and the ability to apply mathematical knowledge to solve practical problems is not strong. Therefore, how to cultivate the awareness of mathematics application of high school students has always been the subject of thinking of the majority of educators. The teaching method of "project learning" is proposed to solve such problems. It can help students establish the connection between mathematics and life and apply mathematics knowledge to solve practical problems^[1]. The extensive application of mathematics also provides a basis for the implementation of project learning^[2], so the use of project learning method can effectively improve the awareness of mathematics application of Chinese high school students.

The main idea of project-based learning is to learn knowledge through learners' experience and solving problems in the real world^[3]. Germinated in the 16th century in the field of European architectural art, the 18th century spread to the United States. In 1938, Dewey, an American educator, believed that teaching was practice-centered and that students could acquire new and real experience in solving practical problems. In this process, knowledge imparting and project development formed mutually. So "doing projects" has become a long tradition in American education. Project learning is rooted in the tradition of "doing projects", so project learning has been practiced for quite a long time in American education. In China, project-based learning started relatively late. Since 2010, project-based learning has been carried out in teaching practice. Educational researchers have implemented specific teaching activities in actual teaching. So far, the theoretical research on project-based

learning is relatively unified and standardized. The theoretical research focuses on the connotation, definition and characteristics of project-based teaching. All of them are learners who acquire knowledge and skills in the process of completing real projects and cultivate high-level thinking ability in the actual situation. The main research topics are project-based learning model design and evaluation system research [4]. However, the application of project-based learning in cultivating students' awareness of mathematical application is relatively small. In China, project learning is still in the initial stage of practice, and the relevant research is not enough. But project learning meets the requirements of high school mathematics core literacy and more in line with the goal of cultivating Chinese students' mathematics application consciousness. Therefore, this paper will further elaborate on the application of project learning in cultivating Chinese students' mathematics application consciousness.

II. UNDERSTANDING OF MATHEMATICS APPLICATION CONSCIOUSNESS

Mathematics application consciousness is a kind of mental state and psychological tendency. In the Annual Edition of Mathematics Curriculum Standards for Compulsory Education (2011), the meaning of mathematical application consciousness is put forward in two aspects. One is that the subject consciously understands the phenomena of the real world and solves practical problems by using mathematical theories, ideas and methods from the perspective of mathematics. The second is to realize that there is a lot of mathematical information in real life, which can abstract real problems into mathematical problems and solve them by mathematical methods. The 2017 edition of senior high school mathematics curriculum standard proposes to cultivate students' core literacy of mathematics. Mathematics application consciousness is the connotation expression and external demand of the core literacy of mathematics, and it is also the focus of cultivating the core literacy of mathematics [5].

The characteristics of mathematics application consciousness include three aspects. First, conscious autonomy. That is the subject can actively connect mathematics with the outside world. This is the basic characteristic of mathematics application consciousness. Second, subjective initiative. It mainly includes subjectivity and creativity, which shows that the subject can actively use mathematical thinking methods to solve problems when it encounters problems. Third, dynamic development. That is to say, the level of application consciousness of the subject is in a state of continuous development. With the growth of the knowledge learned and practical experience, we have a better understanding of the practical background of the application of mathematical knowledge.

In the process of using mathematical knowledge to solve problems, mathematical application ability and mathematical application consciousness complement each other. Mathematical application ability can be divided into two categories: one refers to the ability to use mathematical knowledge to solve pure mathematical problems, that is the internal application of mathematics. The other refers to the ability to use mathematical knowledge to solve practical problems, that is, the external application of mathematics [5]. Influenced by the examination-oriented education in China, both teachers' teaching and students' learning focus on the cultivation of problem-solving ability, ignoring the cultivation of innovative ability and the ability to solve practical problems with mathematical knowledge. As a result, students' awareness of mathematics application is low, which affects the development of students' comprehensive quality.

III. UNDERSTANDING OF PROJECT LEARNING TEACHING METHOD

Project-based Learning (PBL) has many modes. American Barker Research defines project-focused PBL as a set of systematic teaching methods. It is a process of exploring complex and real problems, as well as a process of carefully designing project works, planning and implementing project tasks. In this process, students can master what they have learned knowledge and skills [6]. The term "project" usually refers to the assistant means adopted by teachers in order to stimulate students' interest and improve the teaching effect. The "project" of here is not an accessory to the conventional curriculum, but the main body of learning. The teaching and learning of key concepts should be carried out in this framework. In project learning with curriculum standards as the core, we stimulate students' internal motivation to learn curriculum content by driving questions or authenticity questions.

Mathematical projects are divided into two categories, one is from pure mathematical problems, and the other is from real problems [2]. Practice shows that in teaching, through the project of mathematics originating from practical problems, the connection between mathematics and life can be effectively strengthened, and the formation and development of students' awareness of mathematics application can be promoted.

The planning of project learning includes the following aspects:

1. Project theme. We can draw materials from our daily life, and we can also use the more important topics in the curriculum standards as the basis of project topics.
2. Project scope. The scope of the project should be determined before the project starts. The details are shown in the table below.

	Small project	Big project
Project duration	5--10 days	Nearly a semester
Scope of coverage	One theme One Curriculum Standard	Multidisciplinary Multiple Curriculum Standards
Engineering service	Limited	Extensive
Scope of activities	Complete in class	Entry into the community
Cooperative partner	One teacher	Multiple Teachers and Community Members
Viewers of project results	Students of this class or school	Expert group

3. Learning objectives of the project. Based on the curriculum standards of mathematics in senior high schools, the knowledge and skills goals, process and method goals and emotional attitude and values goals that students should achieve through project learning are formulated. Among them, the number of objectives of each project is not easy to be too much, and too many objectives will lead to the increase of evaluation objectives, which is followed by the evaluation results are not easy to be evaluated, affecting the actual effect of the project.
4. Driving problem. In addition to arousing students' interest, driving problems should also guide students to master the content required by project learning objectives.
5. Project works and evaluation. Including the process documents and final works of the project, the form of the work should fully reflect the learning objectives of the project. Works can be in the form of demonstrations,

papers, exhibitions, models completed in the project. Project learning not only evaluates students' mastery of knowledge, but also evaluates students' real practical activities, such as teamwork, problem solving and so on.

6. Create an ideal learning atmosphere. Teachers can arrange classrooms as offices or laboratories, which can enhance the authenticity of the project and enhance students' sense of ownership of their own project, so as to enhance students' interest and enthusiasm in doing the project.

IV. APPLICATION OF PROJECT-BASED LEARNING IN DEVELOPING MATHEMATICS APPLICATION CONSCIOUSNESS OF CHINESE SENIOR HIGH SCHOOL STUDENTS

According to the understanding of mathematics application consciousness, in order to improve students' mathematics application consciousness, teachers can adopt the following methods: guiding students to understand the extensive application of mathematics in life and production; improving the enthusiasm of high school students in learning mathematics; paying attention to linking mathematics knowledge with real life in teaching, so that students can use the knowledge they have learned more naturally to solve practical problems; To guide students to experience the process of solving relevant problems with mathematical knowledge, the process of mathematization, and to strengthen the cultivation of students' application consciousness in the process of synthesis and practice. However, the traditional high school mathematics teaching mode based on teacher's teaching method can't be widely and comprehensively used, which is also an important reason for students' weak awareness of mathematics application. The research shows that the project learning teaching method can effectively establish the relationship between knowledge and life, knowledge learning and thinking practice, and guide students to observe the world from the perspective of mathematics. While helping students master knowledge, they should improve their ability of solving practical problems, communication and self-management, and cultivate good habits of lifelong learning. Therefore, the application of project-based learning teaching method can effectively help students improve their awareness of mathematics application.

In recent years, through the study of some college entrance examination questions of probability and statistics, it is found that most of these questions are closely related to the reality of life and production, and have a strong practical background. Because students can't understand their realistic background, it is difficult to translate it into probability problem to solve, which adds to the difficulty of this kind of problem [7]. Taking the teaching content of "Estimating the Overall Distribution with the Frequency Distribution of Samples" as an example, this paper gives the teaching design of using project-based learning method to cultivate students' mathematics application consciousness.

1. Project Theme

In order to enrich students' extracurricular life, the school sports room plans to introduce sports equipment. It is necessary to determine the type of introduction and the number of each type according to the students' preferences. The students of the school include students of six grades from grade one to grade three. Each project team makes its own investigation plan, analyses data, writes the introduction plan, and finally shows the introduction plan of sports equipment to the whole class in the form of slides.

This project requires students to select appropriate sampling methods according to the actual situation, formulate a survey plan, and use information technology to analyze the data (such as using Excel software to draw

frequency histogram, frequency distribution polyline chart, etc.), estimate the overall distribution according to the frequency distribution of sample data, and finally form the introduction scheme. In the process of designing the scheme, students can be trained to use mathematical knowledge to solve practical problems, mathematical application consciousness, team cooperation consciousness, communication ability, written presentation ability, and the ability to use information technology.

2. *Project Scope*

Project size	Project duration	Scope of coverage	Engineering service	Scope of activities	Cooperative partner	Viewers of project results
Small project	5 days	Small project One Curriculum Standard	PPT Excel Word	Complete in class	One teacher	Classmates in this class

3. *Learning Objectives of the Project*

Knowledge and Skills Objectives: Understanding the significance and role of distribution; Being able to select appropriate sampling methods to obtain sample data according to the needs of practical problems; Counting frequency distribution tables and drawing frequency distribution histograms; Being able to estimate the overall distribution with the frequency distribution of samples; Written expression ability; Oral expression ability; Team cooperation ability.

Process and Methodological Objectives: To provide the basis for decision-making through the analysis of data, to experience the role of statistics in real life; to perceive the application of mathematical knowledge to solve problems, as well as the ideas and methods of statistics through the exploration of project problems.

Objectives of Emotional Attitudes and Values: Through the process of estimating the total by sample frequency distribution histogram, we can further understand the statistical thought, the role of mathematics in real life, and the guiding role of solving practical problems, and the relationship between mathematical knowledge and real life.

4. *Driving problem. What kinds of Equipment do Sports Rooms need to Import, and What is the Quantity of Each Equipment?*

5. *Project Works and Evaluation*

Survey report: A clear description of the data collected, the data analysis process and the final plan.

Slide: Explain clearly the design of the sports room. The achievement of students' teaching objectives is evaluated by the results of project works.

6. *Create an Ideal Learning Atmosphere*

The sports room will be arranged as an office for students to do projects, enhance the authenticity of doing projects, and improve the enthusiasm of students to do projects.

The design purpose of this project is: to stimulate students' interest in doing projects by using driving problems; to let students understand how to abstract practical problems into mathematical problems, to lead students to experience the process of solving practical problems by using mathematical knowledge, to truly feel the

connection between mathematical knowledge and life, to improve the ability of solving practical problems by using mathematical knowledge; to cultivate students' view of mathematics. To observe the world and ultimately achieve the purpose of raising the awareness of mathematical application. In the process of completing the project, students' team cooperation ability, communication ability and the ability to use information technology are also trained.

V. CONCLUSION

In the process of project learning, we can start from the real practical problems, establish the connection between mathematics and life in the process of solving problems, improve the ability of using mathematical knowledge to solve practical problems, and achieve the purpose of improving students' awareness of mathematical application. At the same time, teachers should also improve their self-cultivation, be good at observing and digging mathematics in life, and design reasonable projects that can help students improve their awareness of mathematics application.

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