Journal of Education and Educational Research
ISSN: 2957-9465 | Vol. 5, No. 3, 2023

Practice and Challenges of Project-based Learning in Physics Education

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Abstract: Physics is a subject with strong practicality, and in the specific learning process, it is usually carried out in real situations, which further highlights the practical characteristics of physics knowledge in human life. Carrying out project-based learning in biology teaching is to enable students to independently construct project-based activities based on new situations around a certain concept, experiment, process, link, etc. In the activity, students are divided into project teams to break down disciplinary barriers and integrate their knowledge to complete specific sub project tasks. Although project-based learning emphasizes students' independent exploration, it does not mean that teachers can be separated from students' learning activities. Teachers need to develop and design project content based on teaching objectives. In the process of project-based learning, students discuss the driving issues and sub problems of the project in a collaborative learning manner. Students can practice by collecting and organizing data, designing exploration plans, or creating plans, thereby building their own understanding of knowledge and problems.

Keywords: Project Based Learning; Physics Education; Practice; Challenges.

1. Introduction

The core literacy of physics requires students to form scientific thinking in the process of learning physics knowledge, have the experimental ability of inquiry and cooperation, and at the same time be able to analyze and evaluate the experimental data of experimental phenomena, and develop a scientific attitude of seeking truth from facts [1]. These are the scientific qualities that students should gradually internalize and have the characteristics of physics during their long-term study of physics. Project-based learning was introduced into China in the 1990s, and it is still in the development stage. People's understanding of project-based learning varies according to its scope, research theme, students' learning situation and school age, but their common elements are certain [2]. Project-based learning transforms the traditional teacher-centered teaching method into student-centered, highlighting students' learning ability rather than teachers' teaching situation [3]. Carrying out project-based learning in biology teaching is to let students independently construct project-based activities based on new situations around a certain concept, experiment, process and link. In the activity, students take the project team as the unit, break the discipline barrier, and synthesize the knowledge they have learned to complete the specific sub-project tasks [4]. Physics teaching needs to pay attention to the study of basic knowledge of physics, and pay more attention to the cultivation of students' ability to learn independently, so as to form the skills of thinking and exploring independently and using physics knowledge reasonably in connection with life [5]. Therefore, in physics teaching, we should change our teaching strategies and adopt some advanced models suitable for subject teaching and learning. In this regard, project-based learning in this paper has carried out research on physics education. To carry out project-based learning, the process of students completing project tasks is the process of learning relevant knowledge, carrying out autonomous and systematic learning and forming systematic literacy [6]. In the process of project-based learning, students discuss the driving problems and sub-problems of the project in a cooperative way. Students can practice by collecting and sorting out information, designing inquiry schemes or making schemes, thus constructing their own understanding of knowledge and problems [7-8]. Teachers can apply the project-based learning method to junior high school physics teaching, which can help students form good physical knowledge application ability while improving the quality of junior high school physics teaching.

2. Overview of Project-based Learning

The abbreviation of project-based teaching is PBL, which is a teaching method proposed by Dewey's student Kerbertrand. This teaching philosophy not only inherits the practical thinking, but also improves it. Project based learning fully affirms the dominant position of students in the learning process, designing certain tasks for them to use the knowledge they have learned to complete the tasks [9]. Project based learning can fully mobilize the learning enthusiasm of every student, allowing them to focus on projects and engage in authentic and effective learning. Project based learning focuses not only on the final project outcome, but also on the process of working towards the project. In project-based learning, students can freely combine, with 3-5 members in each group. This teaching method is conducive to teachers' mastery of class students and personalized design of teaching content and methods. Conducting discussions in the project team can better showcase students' thinking process and improve the quality of project completion. In project-based learning, each student is a very important member of the learning team, with a certain degree of autonomy. They will boldly express their own ideas and opinions, and also carefully listen to and cooperate with the opinions of other members. Each student can fully participate in the learning, changing the habit of only listening without speaking in physics classes. In terms of training objectives, there are also

certain differences between project-based learning and traditional teaching models. Traditional teaching places more emphasis on the breadth of students' learning knowledge, while project-based learning places more emphasis on the depth of learning knowledge and the cultivation of students' autonomy[10]. Before applying project-based learning to teaching, teachers will inevitably learn relevant knowledge, draw on successful cases, conduct multiple analyses and verifications, and improve their teaching ability through the process of integrating knowledge and constantly trying. Therefore, the practical research of project-based learning in high school physics teaching is beneficial for improving teachers' teaching methods, enriching teaching models, and enhancing teaching abilities.

3. The Challenges of Project-based Learning in Physics Education

Physics is a subject with strong practicability. In the specific learning process, it is usually based on real situations, which further highlights the practical characteristics of physical knowledge in people's lives. Therefore, when designing the project theme, teachers should be related to the real physical situation and living environment. Although project-based learning emphasizes students' independent inquiry, it does not mean that teachers can be separated from students' learning activities. On the contrary, compared with traditional teaching, project-based learning tests teachers' teaching ability and ability to control the class situation. It requires teachers to develop and design the project content in combination with teaching objectives, and it also requires teachers to make timely guidance for students' specific conditions, and it also requires teachers to make more targeted evaluations for students' learning achievements, and so on. Therefore, teachers should actively combine the changes in the background of the times and integrate more new elements into "project-based learning", so as to convey innovative ideas to students and make the school a cradle for cultivating high-quality physics talents. Project-based learning is the demand for students to improve their comprehensive learning ability, and discussion can better promote the development of this ability. Because project-based learning is put forward on the basis of pragmatism, it emphasizes the acquisition of experience in the learning process, so the implementation of project-based learning in the teaching process should follow the principle of authenticity. The principles of project-based learning can be divided into the following three points, as shown in Figure 1.

Therefore, in the process of project-based learning, teachers should encourage students to discuss. In the process of carrying out project-based teaching, teachers should change their teaching perspective and combine students' visual thinking to teach. Modern educational media is a product of the combination of information technology and educational reform, which has received attention and promotion from the education community. The authenticity of project-based learning is reflected in multiple aspects. Firstly, the background of project design needs to be authentic and interconnected with students' lives and learning; Secondly, the process of project implementation should be authentic, and the social effects and influence generated by the project should be authentic, able to solve a specific problem in social life.

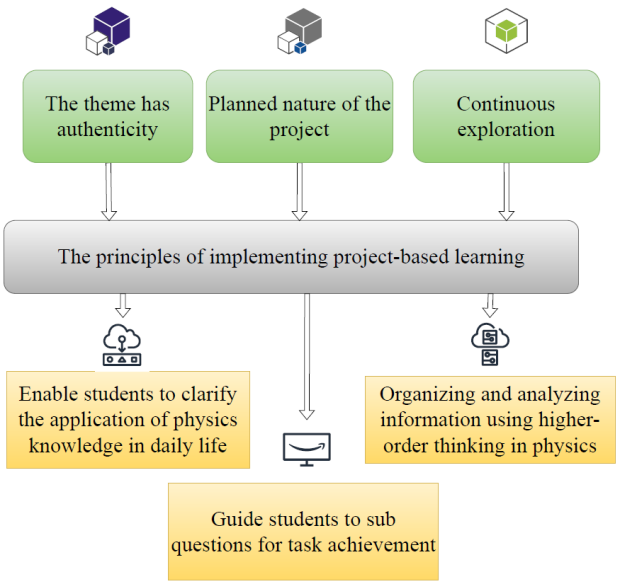

Figure 1. Principles of project-based learning implementation

4. Specific Strategies for Implementing Project-based Learning

4.1. Determine Project Theme

In students' daily lives, the shadow of electromagnetic waves is often found. For example, the microwave oven used in daily life uses electromagnetic waves for work, and the commonly used television and radio use electromagnetic waves for propagation. In teaching, students can be organized and guided to engage in autonomous project-based learning activities targeting this knowledge. Firstly, teachers can determine the project research theme and direction based on the teaching content and students' exploration; Then, students are asked to search for materials on their own after class and engage in independent exploration or collaborative learning to complete this learning task, thereby deepening their understanding of the knowledge points. The traditional physics teaching mode mainly relies on the teacher's narration, and many teaching questions are also raised by the teacher, leading students to answer them. In this way, students may remember physics knowledge, but lack practicality and practicality. Because physics knowledge has a certain degree of abstraction, if students become accustomed to the teacher's indoctrinated explanations, over time, they will lose their curiosity and interest in exploring physics knowledge, and thus become dependent on the teacher's answers and explanations, losing their ability to self-explore. Project based learning group members independently set short-term, mid-term, and long-term learning goals to avoid causing students to develop fear of difficulty. It is recommended that students learn according to the following three objectives, and encourage students with interests, hobbies, and strengths to organize physics prerequisite clubs to integrate learning with future development, and carry out prerequisite learning and research. The learning planning suggestions are shown in Table 1.

Teachers should take the initiative to undertake their own teaching obligations, give full play to the leading role, actively carry out project-based learning, actively combine teaching concepts to innovate teaching methods, and encourage students to actively integrate into the process of knowledge discovery and exploration. Therefore, teachers may wish to organize students to carry out project-based

learning with the theme of "application of electromagnetic waves in life", so that students can master the nature and characteristics of electromagnetic waves in the project-based learning of practical application of electromagnetic waves. Communicate with classmates or teachers in class. According to the emotion of learning and research, teachers can give targeted guidance to students' research process and help students sort out their knowledge.

Table 1. Learning Plan

Categories of learning objectives		Learning Objectives	Targeting student groups	Learning content
Recent goals	Basic learning	Summarize the essential content of current learning	All students	Induction of learned mechanical systems
Medium term goals	Panoramic learning	Understand the required content to be learned	Students with interests and hobbies	Understand the electrical system
Long term goals	Challenging learning	Challenge Physics	Students who are interested in their strengths	Conduct research on prerequisite learning

4.2. Form a Study Group

After determining the project theme and selecting the project content that students want to explore, they can form a team with classmates who have chosen the same project content on their own. Usually, a group with a number of members ranging from 6 to 8 is preferred. Excessive numbers can lead to confusion, resulting in low participation among some students, while a small number can slow down progress and affect efficiency. After the formation of the learning group, specific plans can be discussed around the project content, with clear division of labor, and then each person can execute tasks. They attempted to analyze the working principles of household appliances such as induction cookers and microwave ovens using physical knowledge related to electromagnetic waves, and tested the radiation levels of different household appliances using comparative and experimental methods. Each student fully participated and contributed to the implementation of the project plan. Through the application of modern educational media, teachers can create a scientific and suitable teaching environment, thereby elevating the classroom teaching atmosphere and learning to approach problems with visual thinking. The scope of high school physics learning not only includes basic knowledge, but also includes experiments combined with physics knowledge, as well as scientific knowledge and laws related to life. In this way, students can better overcome various problems in the experiment and conduct more objective analysis of the errors in the experiment. To possess these skills, students must proficiently master the knowledge they have learned, and through the completion of projects, they can effectively enhance their ability to learn independently.

5. Conclusion

The primary goal of project-based learning in physics discipline is to lead students to build a framework of physical knowledge, and to effectively verify and classify physical knowledge and laws through different projects. Physics teaching occupies an important proportion, and project-based learning based on core literacy can cultivate students' scientific inquiry ability and practical innovation consciousness and concept based on subject literacy. Teachers should actively use project-based learning, a new teaching mode, in physics teaching, design project themes based on students' real life, and encourage students to actively participate in project research, so that students can gain something from project-based learning. After students learn physics knowledge, they can also be encouraged to use their physical knowledge to solve problems in real life, thus effectively improving students' ability to explore and solve problems independently. When the students' project-based learning comes to an end and the research report is completed, teachers need to publicly display the students' project results, and the students and teachers will jointly evaluate the project results. Project-based learning provides students with more independent opportunities, which enables them to experience and explore independently in real situations, improve students' thinking quality and promote their all-round development in challenging project tasks.

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