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The Integration of OBE Concept and BOPPPS Teaching Mode in College Physics Course -- Teaching Design of "The effect of Magnetic Field on Current-Carrying Wire"

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Abstract: The integration of Outcome-Based Education (OBE) concepts and the BOPPPS teaching model presents a promising approach to enhancing the quality and effectiveness of college physics courses. This paper explores the potential synergies between these two educational frameworks and proposes a teaching design for integrating them in the context of a specific physics topic: "The effect of Magnetic Field on Current-Carrying Wire." Drawing upon the principles of OBE, which prioritize students' learning outcomes and active participation, and the structured approach of the BOPPPS model, which emphasizes clear instructional objectives and participatory learning, this paper provides a comprehensive framework for teaching design. The proposed approach includes elements such as pre-assessment, participatory learning activities, and post-assessment, all designed to engage students actively and foster deeper understanding of the subject matter. Through a detailed examination of teaching strategies and learning objectives, this paper contributes to the ongoing dialogue on innovative pedagogical practices in college physics education. The findings offer valuable insights for educators seeking to enhance the quality and effectiveness of their teaching methodologies in higher education settings.
Keywords: OBE; BOPPPS; College physics; Teaching reform

1 Introduction

The quality of talent cultivation is a concentrated reflection of the quality of a university. Curriculum teaching is undoubtedly one of the most important factors affecting the quality of talent cultivation, so it is essential for the continuous reform and innovation of teaching. As we know, teaching reform must be supported by advanced teaching concepts and frameworks. After years of teaching reform, a variety of advanced concepts and teaching modes have been put forward, such as the OBE concept and BOPPPS teaching mode, which are widely used and have achieved remarkable results.

The concept of OBE (Outcomes-based Education) was first proposed by Spady in 1980s and has been adopted by many well-known universities at China and other countries since then, and has become the mainstream concept of education reform in the United States and other countries now [1]. This concept emphasizes students' participation in classroom teaching, takes students' final learning outcomes as the goal of teaching design and implementation, and highlights students' expected learning outcomes, the setting reasons, the means to achieve them and the final evaluation of the results [1]. In addition, BOPPPS is a kind of teaching mode widely used in Canadian colleges and universities, which has been introduced into China and used by many college teachers [2]. The model divides the whole teaching process into six parts: Bridge-in, Objective, Pre-assessment, Participatory Learning, Post-assessment, and Summary. These six parts are independent of each other, and each link has a clear role [2]. Both the OBE educational concept and the BOPPPS teaching mode share a common emphasis on putting students at the center, guiding their active participation in classroom teaching, and providing timely assessments.

College physics course (CPC) is a compulsory public basic course for college students majoring in science, engineering, agriculture and medicine. It mainly cultivates students to have a solid theoretical foundation of physics and good innovation ability, as well as lays a good foundation for students to learn subsequent specialized courses. CPC focuses on cultivating students' scientific thinking and abilities, which plays an irreplaceable role in the cultivation of talents of various majors in universities. Therefore, the construction and reform of college physics curriculum are of great significance.

Due to the importance of college physics curriculum, its construction and reform have always been paid attention in various universities, and its teaching quality has been effectively improved. However, there are still some problems to be solved. First, at present, colleges and universities generally compress the number of class hours of CPCs. Taking our college as an example, according to the majors of students, we set up three classes of college physics: A, B and C. Among them, college physics A is mainly for engineering majors, setting up 80 hours; College Physics B is mainly for science (non-physics majors), agriculture and other majors, the total number of class hours is 56; College physics C is mainly for medical and pharmaceutical majors, 48 hours; College physics A, B and C have compressed

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the class hours to different degrees. At present, all of three kinds of CPCs include four parts content, such as mechanics, thermodynamics, optics, electromagnetics, thus teaching content of college physics is more. If teachers still adopt traditional teaching methods, they will inevitably fail to complete the teaching content, or lower teaching requirements. Therefore, improving the teaching effectiveness of college physics within the constraints of limited class hours remains a problem that needs to be addressed.

CPCs are generally offered to students in the first and second years of college, while the students have many professional courses to study during the time, so they may have limited time to devote to CPC. In addition, CPCs are open to students of different majors, and teachers generally do not have students' professional background, or deep understanding of the application of physics to corresponding majors. Thus, teachers are usually prefer to teach essential knowledge of physics, but neglect to introduce the application of physics to students. As a result, the teaching content is disconnected from the actual application, so students do not realize the roles of physics in their professional learning. In fact, it is challenging for students to maintain interest in the courses, and there is a lack of initiative. To change this situation, teachers need to improve the teaching mode.

At present, in college physics teaching, teachers continue to rely on conventional teaching approaches like lecturing, with limited interaction and practice opportunities, lacking of innovation in teaching methods. As we know, teachers play a leading role in teaching activities, not only to teach students knowledge, but also to bear the significant responsibility of arousing students' learning interest and cultivating students' innovative thinking and problem-solving ability. However, the traditional teaching approach, in which students passively accept knowledge, is easy to cause students' weariness of learning, which is more detrimental to the cultivation of students' creativity and critical thinking. Therefore, the continuous innovation of teaching approaches is very necessary.

2. **Literature Review**

In fact, there have been many attempts to reform the teaching of college physics based on OBE or BOPPPS model, and a lot of progress has been made. For example, Li et al. applied OBE concept to CPC, and the research was carried out starting from students, teaching means and methods, and evaluation methods and so on [3]. They found that by using OBE, the teaching quality and students' learning enthusiasm were obviously improved, and the distance between teachers and students is closer, which is further beneficial to the establishment of a good teacher-student relationship. In addition, high demand is asked for teachers in OBE concept. Li et al. presented that the teachers of CPCs need to focus on the three major connotations of OBE concept, such as outcome-based, student-centered and continuous improvement, and teachers should comprehensively improve teaching, such as improve the teaching mode, reform the evaluation system, deepen the reform of the course and achieve success eventually [4]. There are also some teachers trying to apply the BOPPPS mode to the teaching of college physics. Li et al. discussed the application of BOPPPS mode in CPC by taking the content of "Thin film interference and its application" as an example, and found the combination of BOPPPS model and inquiry teaching can stimulate interest and enthusiasm in CPCs both for students and teachers, and finally realize effective teaching [5]. Lv et al. also applied BOPPPS mode to college physics in teaching design of ″Doppler effect″, and found it helps students to change learning initiative from passive acceptance to active inquiry, and thus, improve learning efficiency [6].

Further, based on the above positive effect of OBE concept and BOPPPS mode on teaching, some teachers realize that it is possible that OBE concept and BOPPPS teaching mode are organically integrated to produce better results. In China, many teachers have tried the idea to carry out curriculum teaching reform. For example, Xv et al put the idea into practice to carry out teaching reform of tourism destination management course [7]. Liao et al. took ″the preparation experiment of acetylsalicylic acid″ as an example to explore the integration of OBE education concept and BOPPPS teaching mode in the undergraduate organic chemistry experiment course [8]. While, for CPC, only Xv et al. put forward some principled suggestions on the integration of OBE and BOPPPS teaching mode, but did not give concrete teaching design cases [9]. In addition, no other researchers have reported the integration of OBE and BOPPPS teaching mode in college physics teaching. Thus, it is of great significance to explore the effects and strategies of deep integration of OBE concept with BOPPPS teaching mode in CPC.

3. Teaching Design: Integrating OBE Concept and BOPPPS Teaching Mode

Teaching design plays an important roles in teachers' organization of teaching activities. According to the requirements of the teaching syllabus, teachers systematically plan and organize the whole teaching content, process, methods and means in teaching design, which directly determines the success or failure of a class. Next, I will take "the effect of magnetic field on current-carrying wire" in CPC as an example to discuss the teaching design of the integration of OBE concept and BOPPPS teaching mode.

Before starting the teaching design, it is necessary to analyze the teaching content of this section and the learning situation of students. ″The effect of magnetic field on current-carrying wire″ is an important content of the steady magnetic field in the electromagnetics section of CPC, which is of great significance for students to understand the interaction between electricity and magnetism. The syllabus requires students to understand and master the effect of magnetic fields on current-carrying wires (Ampere's Law and its application). Before, students have learned the basic knowledge of higher mathematics, and in the previous CPC, students learned the basic properties and laws of electrostatic field and steady magnetic field, and have the ability to quantitatively calculate simple electric and magnetic fields by using the calculus method in higher mathematics.

Now, we turn to discuss how to integrate OBE concept with BOPPPS teaching model for the teaching design of "the effect of magnetic field on current-carrying wire". The OBE concept emphasizes taking the final learning outcome of students as the goal of teaching design and implementation, while the six teaching parts of BOPPPS teaching mode also have objective link, so the two modes can be integrated. The teaching goal of this lesson is to master the effect of magnetic field on the current-carrying wire (Ampere's Law). The above goal can be viewed as the knowledge one of this class, based on which we can further set the ability goal -- to calculate the effect of magnetic field on current-carrying wires and coils; and the quality goal -- to cultivate students' innovative consciousness and spirit, deepen their understanding of the internal connection between electricity and magnetism. The teaching design of the integration of OBE concept and BOPPPS teaching mode is shown in Figure 1.

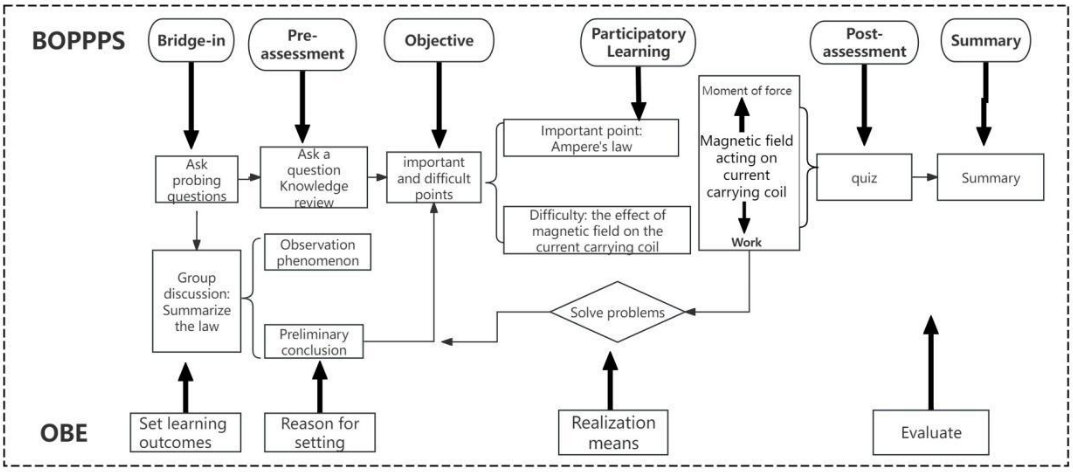

Figure 1. Teaching design diagram of the integration of OBE concept and BOPPPS teaching mode

(1) Bridge-in (B) : Bridge-in is the first link in the six teaching parts of BOPPPS teaching mode. Excellent introduction can not only attract students' attention and stimulate their interest to the course, but also naturally derive the teaching objectives of the content. According to the teaching content of this lesson, inquiring questions are put forward to introduce it: Teachers can play animations or videos (such as Electric Motor) before class, and ask questions to students, the modern industry relies heavily on electric motors. Have you ever known how electric motors work? Students are asked to observe the phenomenon and make judgments based on existing knowledge. Group discussions are suggested for students and they need to participate in the classroom teaching by sending out bullets or contributing papers in the rain class.

(2) Objective (O) : According to the introduction question and the preview before class, it is easy for students to conclude that the electric motors work by the effect of the magnetic field on the current-carrying wire. Thus, it is natural to derive the learning goal of this section, that is, to master the effect of magnetic field on current-carrying wire, which is the teaching focus and difficulty of this section.

(3) Pre-Assessment (P) : Before entering the new course content, in order to successfully realize the teaching plan, teachers are suggested to ensure that students have mastered the relevant contents previously learned as a knowledge reserve for learning the new content. In this process, teachers can adopt the ways of asking questions and simply reviewing. In the lesson, teachers can set the following pre-assessment questions: a. What is the main difference between electric field and magnetic field; b. What are the calculation methods of the magnetic field of the current? c. What is the basic basis for the calculation of magnetic field? d. Formulation of the Biot-Savart law; e. Expression of the magnetic induction intensity of the magnetic field around the infinitely long current-carrying straight wire.

(4) Participatory learning (P) : Participatory learning is the main part of teaching, and it is also the part emphasized both by OBE concept and BOPPPS teaching mode. The implementation means of OBE concept can be effectively integrated with BOPPPS teaching mode, that is, adopting student-centered, avoiding teacher-infused teaching, carefully designing activities to attract students to participate in teaching, and paying attention to the fun of teaching process, so as to mobilize students' enthusiasm and stimulate their internal learning motivation. The participatory learning part of this section is designed as follows:

Important point: Ampere's law

a. Guide students to adopt the same strategy as Biot-Savart's law, select current elements on the current-carrying wire, give the force of current elements from Ampere's law, and then get the force of the current-carrying wire, so that students can understand the idea of differential solution;

b. Guide students to use the right-hand rule to analyze and judge the force direction of the current-carrying wire;

c. Extension - the interaction between two infinitely long current-carrying straight wires parallel to each other; This section allows students to analyze the expression of the interaction between two parallel current-carrying straight wires, and discuss in groups to draw the conclusion that the same direction current attracts each other and the different direction current repels each other.
Integrating ideological and political elements into the teaching process is of great significance to improve the quality of talent training, and can play a sublimation role in teaching effect to achieve the goal of educating people in the whole process. Combined with the historical facts of Ampere's discovery of the effect of magnetic field on current-carrying wires, this lesson emphasizes the persistent pursuit of science by Ampere, so as to cultivate students' innovative consciousness and spirit.
Difficulty: The effect of magnetic field on current-carrying coil
a. The magnitude and direction of the force on each side of the current-carrying coil are calculated by Ampere's law;
b. Guide the students to analyze the rotation tendency of the coil under the action of the magnetic field, and to conclude that the magnetic field has a magnetic moment effect on the current-carrying coil;
c. Question: The relationship between magnetic torque and magnetic induction intensity of the magnetic field and magnetic moment;
d. Discussion: Consider three scenarios, the current-carrying coil with the maximum moment, stable equilibrium and unstable equilibrium, and then it is concluded that in a uniform magnetic field, a planar current-carrying rigid coil is only subjected to magnetic torque, resulting in only rotates, without undergoing translational motion of the entire coil.
High order: The current-carrying coil can rotate under a magnetic field, which means magnetic field does work on the coil, but how to achieve continuous work? Guide the students to discuss the reasons why the coil cannot continue to do work under these conditions, and discuss in groups to find the best solution.
Content: Work of magnetic force
a. The magnetic force does work when the current-carrying wire moves in the magnetic field;
Following the principle of easy first and then difficult, from simple to complex, students are guided to analyze the work done by the ampere force generated by the magnetic field when a single wire moves on the wire frame, and the relationship between work and magnetic flux change is obtained accordingly.
b. The work done by the magnetic torque when the current-carrying coil rotates in the magnetic field;
Students are guided to analyze the work done by the magnetic torque when the current-carrying coil rotates in the magnetic field. Inspired by the expression of work of the magnetic force, the expression of the work done by the magnetic torque is deduced, and the conclusion that the expression is consistent is finally drawn.
Consolidation: Problem 1: a semicircular closed coil with current I, radius R, is placed in a uniform external magnetic field B, and the direction of B is parallel to the plane of the coil. (1) Find the magnitude and direction of the torque subjected to the coil at this time; (2) Find the work done by the magnetic torque when the coil plane turns to a position perpendicular to the magnetic field B under the action of this torque.
(5) Post-Assessment (P) : This part evaluates the teaching effect, which can be used to evaluate whether the expected goal of this lesson has been achieved, and evaluation is also the part that OBE concept and BOPPPS teaching mode emphasize together. Therefore, the outcome evaluation in the OBE concept can be integrated with the post-assessment part of the BOPPPS teaching model. Post-assessment can be done by homework or exercises.
(6) Summary (S) : At the end of the course, teachers summarize the teaching process and students' learning effect, analyze the problems existing in the teaching process, and put forward suggestions for improvement, so as to continuously optimize teaching. Continuous improvement is also emphasized by OBE concept.

4.Conclusion

In conclusion, the integration of Outcome-Based Education (OBE) concepts and the BOPPPS teaching model presents a compelling opportunity for advancing the quality and efficacy of college physics education. By combining the student-centered focus of OBE with the structured instructional framework of BOPPPS, educators can create dynamic and engaging learning experiences that foster deeper understanding, critical thinking, and problem-solving skills among students. The teaching design proposed in this paper for "The effect of Magnetic Field on Current-Carrying Wire" serves as a tangible demonstration of how these frameworks can be seamlessly integrated to promote active learning and meaningful outcomes in the study of physics.
The findings presented here underscore the importance of ongoing innovation and adaptation in pedagogical practices within higher education. As educators continue to navigate the evolving landscape of teaching and learning, the integration of OBE concepts and the BOPPPS teaching model offers a promising pathway towards enhancing student engagement and achievement in college physics courses. Further research and experimentation are warranted to explore the full potential of this integrated approach and its implications for student learning outcomes. Nonetheless, the insights and strategies outlined in this paper provide a valuable foundation for educators seeking to enrich their teaching methodologies and optimize the educational experience for students in college physics course.

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