Study of College Physics Teaching Model Based on Immersive Learning

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Abstract. College physics plays a key role in the process of training undergraduates. However, the current teaching approaches of college physics cannot meet the needs of the development of application-oriented universities and the renewal of the training mode of application-oriented talents. To tackle with problems existing in College Physics teaching, the paper attempts to explore an immersive learning-based teaching model for the course, expounding the characteristics and implementation process of immersive learning mode in College Physics course with several typical examples. The result indicates that immersive teaching model can enhance the teaching quality of college physics and the quality of talent training, arousing students' interest in College Physics learning and promoting their hands-on ability as well as innovation capability. These results obtained in this paper may provide a promising method to improve the teaching effect of College physics and offer guidance for the reform of college curriculum teaching with similar background.

Keywords: Immersive learning; College Physics course; Applied practice; Teaching

1. Introduction

For students of science and engineering, College Physics, as a significant general fundamental course in polytechnic universities, plays an irreplaceable part in training students' scientific thinking, innovation capability, ability to integrate theory with practice, and practical competence in engineering [1]. However, in the traditional teaching process, teachers always focused on the formation and teaching of theoretical system of physics itself, ignoring the supporting role of the course in students' professional development or their engineering practice and application. The situation resulted in students' superficial or vague cognition on the application of physics knowledge in booming modern science and technology, as well as their insufficient competence of employing physics to analyze or solve applied problems.

Therefore, how to optimize the teaching model to trigger students' independent learning, deepen their knowledge application, and help them achieve their professional development? How to promote the interdisciplinary cross-integration between general fundamental course and diverse disciplines, enabling students fully understand the organic convergence between frontier development or application of their disciplines and physics? How to enhance students' all-round ability and serve the university goal of talent training better? Above questions need to be coped with urgently in teaching reform.

2. Immersive Teaching Model

2.1 Immersive Learning [2][3]

According to CNKI retrieval, the number of available literature on the theme of "immersive learning" has shown an upward trend in recent 20 years, the growth of which is rapid in the last five years particularly. Such tendency indicates that immersive learning is appealing extensive attention. [4] "Immersive teaching refers to a model that enables learners to experience a state of 'immersion' in their learning process, emphasizing educators' ingenious use of a variety of teaching methods to arouse learners' interest in learning. It can be helpful in improving both teaching level and teaching effectiveness." [5]

Research on TEAM Model TBL indicates that "learning by doing" can ensure students' 75% knowledge mastery [6], as shown in Fig.1. In immersive learning which is proposed based on Constructivism Learning Theory and Situated Cognition, the scenarios, activities and interactions designed challenge learners' existing experiences stored in their minds constantly, promoting the learners' active construction of their knowledge.

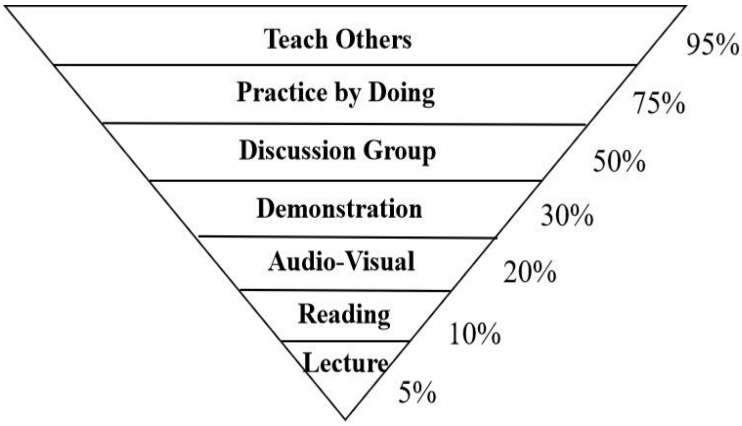

Figure 1. TEAM Model TBL

As show in Fig.1, Practise by doing can effectively improve the level of knowledge mastery. Deploying various methods and carriers to facilitates students' syncretism of their body and mind, immersion-oriented teaching helps them to immerse fully in their learning atmosphere and scenes of problem. In this process, oriented by problems in their learning, learners will engage into an independent and inquiring exploration with whole heart undistractedly. From the perspective of teaching, the in-depth teaching, which creates situations with problem as the focus and triggers students' endogenic learning ability, is the ideal state of immersive teaching. It is more likely to guide students into the kernel of knowledge, deepening both their participation and understanding. Similarly, immersive teaching emphasizes that learning is a process involving the whole body and mind rather than an individual activity occurring "above the neck". The model is in tune with the philosophy of the in-depth teaching that learners should engage multiple senses in their learning process for deeper participation, active construction, meaning acquisition, as well as comprehensive cognition.

2.2 Characteristics of Immersive Learning

"To implement teacher-oriented design plus student-oriented participation with diverse means as the carrier" is the most fundamental feature of immersive learning. The model first expands students' learning space by building a learning community between teachers and students or among students, facilitating students' ability to solve practical problems with acquired knowledge, promoting their effective involvement in the course and enhancing their learning initiative. In addition, different from previous passive mode featured as "teacher-dominant" claiming "teacher talks and students listen", immersive learning proposes an original "student-centered" learning mode in which students participate actively, collaborate independently and explore innovatively, improving the effectiveness of classroom teaching.

2.3 Design principles of immersive teaching model

Immersive teaching mode advocates teaching students in accordance with their aptitude based on specific but diverse learning characteristics. By creating an independent, cooperative and inquiring learning environment, organizing interactive activities with high motivation and strong sense of participation, the teaching focuses on students' needs and activates their mind with the purpose of cultivating students' both practical ability and innovation capacity. Practical experience which is the fundamental path of immersive teaching should always be at the core when conducting kinds of teaching activities. In the immersive teaching process, cases which are practical, explorable, experiential and verifiable should be selected to guide students to personal engagement and experience [7].

The following principles should be upheld when designing the immersive teaching model:

(1) Being teacher-guided. As both organizers and implementers of the whole teaching process, teachers always guide their students' each learning step. Therefore, they should not only make full

preparation before class, but also organize their teaching with appropriate methods, techniques as well as teaching carriers.

(2) Being student-centered. The prominent role of students in the teaching process should be well recognized, and their subjective initiative of participating in teaching should be fully exerted. The completion of teaching tasks will be restricted by students' learning characteristics, so it is necessary to take their individual differences into account.

(3) Being ability-oriented. The teaching should be focused on cultivation of students' self-learning ability, practical ability, adaptability to new things and their innovation capability, being competency-based and ability development-oriented. So advanced requirements, innovativeness, and challenge level of the course should be highlighted to achieve the teaching goal that wraps value shaping, ability training and knowledge learning all in one.

3. Immersion-Based Instructional Design for College Physics Course

3.1 Knowledge Framework

There are six major parts in College Physics course, including Mechanics, Thermology, Optics, Electromagnetism, Special Theory of Relativity, as well as Quantum Physics Foundations. On the premise of national teaching quality standards, all teaching contents of the course are integrated innovatively, and the corresponding teaching resources are sorted into triple layers: theoretical level, applying level and practical level.

Under the guidance of Broad-Based-Admissions classification and with the training of competence as the final goal, the course has produced several versions of teaching courseware for different major groups, built the engineering application case databases and project database of innovative practice for various major categories, and prepared suitable self-made or adapted physical (experimental) teaching aids.

3.2 Scenario Creation

The Theory of Situated Cognition argues that learning is an active process which makes sense with the help of specific problem-solving scenarios, thereby generating excitement and curiosity in learners [8]. Based on prior investigation of students' interest, existing knowledge and problem-solving ability and with the established case base and experiments as carriers, the course chooses proper scenes and experimental teaching aids matching with the specific characteristics of teaching contents. The teaching model, taking problems as the orientation, leads students to more participations in the course and deeper analyses on phenomena, characteristics, principles and applications of their experiments with the help of their acquired knowledge. It turns practical problems into abstract physical models that can be explored with corresponding physical principles, selecting experimental teaching aids on the base of actual engineering practice and avoiding unnecessary technical details.

Embodied in the scenario creation of College Physics course, some practical problems concerning BeiDou satellite navigation and positioning, diving of athletes, figure skating, helicopter flight, and intercontinental missile navigation, etc. are designed in mechanics section of the course. Similar problem-designs include thermometers calibration, vehicle efficiency in different seasons and variation of hot and cold water in thermology section, heating of induction cooker or microwave oven and triboelectrification issue in electromagnetics section, as well as rainbow, prism light decomposition and optical fiber communication in wave optics part. In brief, the creation of scenes should meet the basic requirements of College Physics teaching, reinforcing and deepening students' understanding of basic concepts, developing their ability to analyze and solve problems, increasing their learning motivation and stimulating their thirst for knowledge.

3.3 Role Positioning and Interaction Design

In immersive teaching process, teacher who takes the role of a designer and an organizer should arrange and guide classroom activities. Based on careful survey and design conducted before class, he/she is supposed to arouse students' interests by choosing proper self-made or adapted objects and experimental teaching aids, attracting students to participate in the experiment process actively. The teaching model follows the thinking path from phenomena observing to problem analyzing and solving, then to application expanding. It integrates practical participation into the abstract classroom learning and prepares progressive questions and tasks, achieving the purpose of education in a quiet but penetrating manner. Under their teacher's guidance, students can not only observe and reflect on their academic problems attentively, but also analyze and solve them successfully.

In the teaching of mechanical wave and light polarization, for instance, self-made slits and rainbow rings are used to help students understand the concept of transverse waves polarization. An abstract concept turns to be visibly clear when students simulate the situation that a transverse wave or longitudinal wave passes through slits in diverse directions. Similarly, with the help of a waist twisting apparatus, students can experience turning in outer space and thereby understand the law of conservation of angular momentum. Another typical example is the application of 3D glasses in analyses of light polarization phenomenon. In teaching scenarios mentioned above, students are always put in the central position of most class activities, involving deeply in both teaching and experiment process. They can better experience the pleasure and harvest of learning through their personal participation, visible observation, and problem solving.

Furthermore, professional and frontier disciplinary knowledge is introduced into the College Physics teaching timely. The knowledge extension can assist students to reflect on and discuss the application of physics knowledge in high technology, helping them understand the close connection between physics and the development of science and technology and enhancing their ability to put what have been learned into actions.

In order to further improve students' competence of applying physics knowledge and enhance their innovative thinking, the course draws support from College Physics Innovation Laboratory and Multi-Functional Physics Demonstration Experiment Research Hall. Moreover, to foster students' interest in China Undergraduate Physics Experiment Competition (CUPEC), some seminar questions are carefully chosen or designed based on the relevant research topics of CUPEC. These questions, with an in-depth practical application background, can complement mutually with theoretical knowledge and inspire students' interest in CUPEC.

All seminar topics, derived from students' real life or discipline competitions, are open questions without any emphasis on unique answer. They are more demanding, innovative and challenging. The guidance of teacher enables students to think, discuss and consult literature actively. Besides, it is also beneficial to students' construction of physical models or their simulation and theoretical calculation. Students can not only design their experimental schemes, build experimental devices, but also analyze experimental data. In this way, the shifts from "I'm asked to learn" to "I can learn", "knowledge acquisition" to "knowledge application" can be achieved. Meanwhile, both students' competence of solving practical problems with comprehensive physical knowledge and their all-round development can be facilitated.

4. Conclusions

In short, immersive teaching model sees the following key benefits. First, it arouses students' learning motivation and interest successfully. Second, it reduces students' learning anxiety effectively. Third, it improves students' effectiveness of College Physics learning dramatically.

By designing and implementing immersion-based teaching model in College Physics course, both students' motivation and competence in their learning have been improved. In addition, their interest in physics-related competitions has been promoted significantly as well, with increasing number of awards in their physics or subject contests year by year (especially the number of national achievements). Up to now, more than 200 students have participated in university-level, provincial or national college physics experiment competitions successively.

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